



Implementing classroom physical activity breaks: Associations with student physical activity and classroom behavior



Jordan A. Carlson^{a,*}, Jessa K. Engelberg^b, Kelli L. Cain^b, Terry L. Conway^b, Alex M. Mignano^b, Edith A. Bonilla^b, Carrie Geremia^b, James F. Sallis^b

^a Children's Mercy Hospital, Center for Children's Healthy Lifestyles and Nutrition, 610 E. 22nd St., Kansas City, MO 64108, United States

^b University of California, San Diego, 9500 Gilman Dr., La Jolla, CA 92093 United States

ARTICLE INFO

Available online 19 August 2015

Keywords:

Children
Exercise
Low-income
School health

ABSTRACT

Objective. To investigate the relation of classroom physical activity breaks to students' physical activity and classroom behavior.

Methods. Six elementary-school districts in California implemented classroom physical activity interventions in 2013–2014. Students' ($N = 1322$) accelerometer-measured moderate-to-vigorous physical activity (MVPA) during school and teachers' ($N = 397$) reports of implementation and classroom behavior were assessed in 24 schools at two time points (both post-intervention). Mixed-effects models accounted for nested data.

Results. Minutes/day of activity breaks was positively associated with students' MVPA ($\beta_s = .07-.14$; $ps = .012-.016$). Students in classrooms with activity breaks were more likely to obtain 30 min/day of MVPA during school ($OR = 1.75$; $p = .002$). Implementation was negatively associated with students having a lack of effort in class ($\beta = -.17$; $p = .042$), and student MVPA was negatively associated with students being off task or inattentive in the classroom ($\beta = -.17$; $p = .042$). Students provided with 3–4 physical activity opportunities (classroom breaks, recess, PE, dedicated PE teacher) had ≈ 5 more min/day of school MVPA than students with no opportunities ($B = 1.53$ min/opportunity; $p = .002$).

Conclusions. Implementing classroom physical activity breaks can improve student physical activity during school and behavior in the classroom. Comprehensive school physical activity programs that include classroom-based activity are likely needed to meet the 30 min/day school physical activity guideline.

© 2015 Elsevier Inc. All rights reserved.

Introduction

Public health authorities recommend that schools provide physical activity opportunities to help children meet the 60 min/day physical activity guideline (CDC, 2011; Koplan et al., 2005; Pate et al., 2006; PAG Midcourse Report, 2012; USDHHS, 2008). Elementary schools are recommended to provide children with ≥ 30 min/day of moderate-to-vigorous physical activity (MVPA) through a comprehensive approach that includes physical education (PE), recess, and physical activity opportunities in the classroom and before-and-after school (AAHPERD, 2013; CDC, 2011, 2013; Erwin et al., 2013; Koplan et al., 2005; Kriemler et al., 2011; Pate et al., 2006). Many schools provide insufficient physical activity opportunities, with students in some elementary schools receiving as little as 15–20 min of MVPA during school (Carlson et al., 2013; Turner et al., 2010).

Short classroom physical activity breaks are an increasingly common school intervention. Programs with evidence of efficacy for increasing student physical activity include CATCH (CATCH, 2015; Kelder et al.,

2005), Instant Recess (Instant Recess, 2015; Whitt-Glover et al., 2011), TAKE 10! (Stewart et al., 2004; TAKE 10!, 2015), and classroom energizers (Mahar et al., 2006). However, more research is needed to understand the effectiveness of classroom physical activity breaks in real-world contexts where researchers are not involved in the intervention. Because some evidence suggests an association between classroom physical activity and on-task behavior (Mahar et al., 2006), it is also important to investigate the feasibility and impact of using classroom physical activity breaks as a behavioral management tool.

The primary aims of the present study were to investigate the relation of implementation of classroom physical activity breaks in six California school districts to (1) students' objectively assessed MVPA in school and (2) teacher-reported student behavior.

Methods

Intervention description

In 2013, The California Endowment issued a request for proposals to school districts across California. The objective was to fund districts to implement interventions to incorporate daily 10-minute physical activity breaks in the classroom,

* Corresponding author.

using their choice of an evidence-based program. Seven districts serving economically disadvantaged students across California were awarded \$80,000–100,000 each during the 2013–2014 school year. Six of the seven funded districts participated in the evaluation.

Each district developed a plan unique to their district to support all classroom teachers from grades 1–6 in a minimum of two schools to implement at least one 10-minute physical activity break daily. Interventions began in early Fall 2013 and lasted the duration of the school year. Implementation strategies varied across districts, with primary components in all districts including appointing a district-level coordinator to provide teacher trainings, technical assistance, support groups, and materials specific to classroom physical activity breaks (e.g., handouts, instruction books, videos, websites). All but one district used an evidence-based program such as Instant Recess (2 districts) (*Instant Recess, 2015; Whitt-Glover et al., 2011*), TAKE 10! (1 district) (*Stewart et al., 2004; TAKE 10!, 2015*), and CATCH (2 districts) (*CATCH, 2015; Kelder et al., 2005*). The remaining district used an evidence-informed program they had previously developed and pilot tested.

Participants

Time 1 data collection occurred in the Fall of 2013, after the interventions began due to the timing of the district implementation plans and stipulations of the grant funding. Time 2 data collection occurred in Spring 2014. Time 2 assessments were conducted to assess intervention maintenance and improve measurement precision by having multiple assessments per classroom. Twenty-four elementary schools from the six participating districts were recruited into the study. Each district selected 4–5 schools for evaluation where implementation was most extensive, with the exception of two districts that had only 2 or 3 elementary schools. At least one liaison was appointed in each district to assist with student recruitment and physical activity assessments. For the physical activity assessments, up to 5 classrooms per school (approximately 1 per grade from grades 1–6) were selected by school liaisons to be fairly representative of the school population.

Students who provided assent and parental consent were eligible to participate. Each classroom had a goal of recruiting 15 students. A total of 1322 students from 97 classrooms were enrolled at Time 1 (Mean = 13, SD = 4.7, students per classroom). All classroom teachers of grades 1–6 were asked to participate in the teacher survey, and a total of 397 teachers provided informed consent and were enrolled at Time 1 (this sample included the 97 classroom teachers involved in the physical activity assessments). Retention rates for Time 2 were 90.2% (student physical activity assessments) and 92.9% (teacher surveys). This study was approved by the sponsoring university's human subjects protection committee. The authors have no conflicts of interest.

Measures

Student physical activity at school

Waist-worn Actigraph GT3X+ accelerometers were used to assess children's physical activity during school (*Welk et al., 2007*). School liaisons received online training from research staff and were mailed standardized protocol materials and accelerometers to fit on approximately 15 students/class from 5 classes/school. Each class was selected by the liaison and assessed during what liaisons reported as a typical school week. The same students wore the device on the same day of the week at each time point. Fall 2013 assessments occurred between mid-October and early-December, and Spring 2014 assessments occurred between mid-March and early-May, with two schools completing assessments each week and school order matched between time points. Liaisons completed logs to record the device number and on/off time for each device, and this information was used to eliminate nonwear time from the data. Accelerometer counts were recorded at 5-second epochs with the low frequency extension applied. Minutes of MVPA during school were calculated using the Evenson cut points scaled to the 5-second epoch (*Evenson et al., 2008; McClain et al., 2008*). At least 240 min of valid wearing time, with nonwear time defined as ≥ 60 min of consecutive 0 counts, was required for a student's data to be included in the analysis.

Teacher survey

The week following accelerometer data collection (at both time points), teachers were sent a brief survey. A majority of teachers completed the survey within one week, and responses were not analyzed if received after 4 weeks. The survey assessed basic characteristics (gender, age, years teaching, class size), information on implementation of classroom physical activity breaks,

other physical activity opportunities, benefits of physical activity breaks, and students' classroom behavior. The survey questions were the same across time points except for the "benefits of classroom breaks" items, which were only asked at Time 2.

Classroom physical activity breaks. Physical activity breaks were defined as 10-minute blocks of structured physical activity that were incorporated into instructional time by classroom teachers. Questions were all specific to the current (2013–2014) school year, and asked: Have you been encouraged to hold classroom physical activity breaks? Have you been trained to hold classroom physical activity breaks? Have you ever held classroom physical activity breaks? Have you held classroom physical activity breaks in the most recent school week? How many breaks/week and minutes/break did you provide in the most recent school week? The last question was used to calculate physical activity break minutes/day (number of breaks/week \times average minutes/break \div 5). All other questions had yes/no response options.

Other physical activity opportunities. Three questions were asked: During a typical week, how many minutes of (1) PE do you provide for your students, (2) PE does a PE teacher provide for your students, and (3) recess do your students receive? Response options were: None, 1–29, 30–59, 60–89, and 91+. For some analyses, responses were dichotomized.

Students' classroom behavior. Ten questions were adopted from the 60-item Classroom Behavior and Assets Scale to assess teacher-reported classroom-level student behavior (*Lee et al., 2009*). Questions included four asset items reflecting positive behaviors (items 1–4), and six problem behavior items (items 5–10) covering attention problems, social withdrawal, antisocial behavior, and low motivation (see Table 3 for items). The ten items were chosen because of their hypothesized association with physical activity, based on findings from previous studies (*Mahar et al., 2006; Barros et al., 2009*). Response options were 0 (0 students), 1 (1–2 students), 2 (a few students), 3 (about ¼ of the class), 4 (about ½ of the class), 5 (about ¾ of the class), 6 (most of the class), and 7 (all of the class). Item scores were averaged to create an Asset Scale (alpha = .85) and Problem Behavior Scale (alpha = .87).

Benefits of classroom physical activity breaks. At Time 2, eight questions were developed for this study to assess the teachers' perceptions of the impact of physical activity breaks on student enjoyment, classroom behavior and performance, and health. Response options ranged between 1 (strongly disagree) and 5 (strongly agree) and were dichotomized as agree/strongly agree vs. neutral or disagree/strongly disagree. An 8-item (overall) and a 4-item classroom (behavior/performance) index were computed by summing the number of benefits rated as agree/strongly agree.

Free and reduced price lunch eligibility

School names were matched with the state's Department of Education data to identify the percent of students eligible for free or reduced-price lunch, which was used as a proxy-measure for school socioeconomic status (SES) (*CA Department of Education, 2013*).

Statistics

Descriptive statistics were calculated at the student, teacher, and school levels. All models employed random intercepts mixed-effects regression to account for the nesting of students within classrooms and/or teachers within schools and were adjusted for district as a fixed effect. Time point (Fall and Spring) was entered as a repeated effect, with the exception of the benefits analyses because benefits were only asked at Time 2. The relation of teacher-reported implementation factors to student MVPA was assessed by regressing student MVPA on six implementation variables. Because of collinearity among the implementation variables, separate models were used. The relation of physical activity to classroom behavior was assessed by regressing the classroom behavior items and scales on teacher-reported implementation in the past week (y/n), as well as on student MVPA, which was averaged at the classroom level. Teacher-reported benefits of physical activity breaks were compared between implementers and non-implementers by regressing the benefits items and scales on teacher-reported implementation in the past week (y/n). To assess the impact of multiple physical activity opportunities on student MVPA, dichotomous variables were created at the teacher level for time in PE, recess, and physical activity breaks, as well as whether there was a dedicated PE teacher. Cut points to create the dichotomous "physical activity opportunities" variables

for the index were informed by current public health recommendations, as well as distributions of the data such that each side of the dichotomy would provide sufficient power for analyses. The index score, representing the number of physical activity opportunities reported, ranged from 0 to 3 because only one teacher reported all 4 opportunities and was grouped with the 3-opportunity classrooms. Student MVPA was regressed on each opportunity and the index, which was tested as both a categorical and linear effect. All models were adjusted for student and/or teacher characteristics. SPSS version 22 was used for all analyses.

Results

Student, teacher and school characteristics are presented in Table 1. Table 2 shows the relation of teacher-reported implementation factors to student MVPA. The interventions began prior to Fall 2013 data collection in all districts. Between Fall 2013 and Spring 2014, average student MVPA during the school day increased from 25.5 to 27.8 min/day ($p < .001$), and the proportion of teachers who reported providing physical activity breaks in the past week increased from 35.5% to 43.8% ($p = .022$). By 2014, those who provided any breaks reported an average of 15.2 (SD = 18.1) min/day of activity breaks.

Students of teachers who reported being encouraged to hold physical activity breaks had 1.84 more min/day of MVPA during school than students of teachers not reporting encouragement. Training on physical activity breaks was negatively associated with student MVPA ($B = -3.52$ min/day). There was no association between holding activity breaks in the past week (y/n) and student MVPA. Students of teachers who reported ever holding activity breaks had 3.14 more min/day of MVPA during school and were 75% more likely to have met the 30 min/day guideline for MVPA during school (OR = 1.75; 95% CI = 1.22, 2.51; $p = .002$). In classrooms where teachers reported never holding activity breaks, an average of 24.2% (SE = 3.6%) of students met the 30-minute guideline versus 35.8% (SE = 3.4%) in

classrooms where teachers reported ever holding breaks. Minutes/day of activity breaks provided had a small positive association with student MVPA ($B_s = 0.06$ – 0.08).

Table 3 presents the relation of student MVPA and teacher-reported implementation of physical activity breaks in the past week (y/n) to student classroom behavior. Classrooms with more MVPA had reportedly fewer students who were off task or inattentive ($\beta = -0.17$) and showed a trend ($p < .10$) for fewer problem behaviors using the abbreviated scale. Teachers who reported implementing activity breaks in the past week reported fewer students who lacked effort or gave up easily ($\beta = -0.17$).

Table 4 presents teacher agreement with benefits of classroom physical activity breaks, shown separately for implementers and non-implementers. Overall, agreement with the benefits was high, ranging from 70.6% to 97.6% in implementers and 61.9% to 96.8% in non-implementers. Enjoyment- and health-related benefits did not differ between implementers and non-implementers. For the classroom behavior/performance benefits, agreement was higher for one item (students' work improves) and showed a trend ($p < .10$) for higher agreement for the other three items among the implementers. Agreement with the classroom behavior/performance index was higher for the implementers.

Table 5 shows the variables that constituted the multiple physical activity opportunities index and its association with students' MVPA. Each additional opportunity was associated with 1.53 more min/day of MVPA during school, where students in classrooms that provided zero opportunities (10.8% of classrooms) had 5.33 fewer min/day of MVPA during school as compared to students in classrooms that provided 3 opportunities (25.3% of classrooms). Fig. 1 shows estimated mean minutes/day for each number of physical activity opportunities.

Discussion

The present evaluation study of teacher-led interventions in mostly low-income elementary schools found substantial, but not ubiquitous, implementation of classroom physical activity breaks (46% implementation rate based on holding breaks in the past week). Level of implementation was positively associated with students' objectively measured physical activity, and students of teachers who reported holding classroom physical activity breaks were 75% more likely to meet the recommended 30 min/day of MVPA during school. These findings suggest effectiveness of classroom breaks for increasing youth's physical activity. Findings that implementation and objectively-assessed student physical activity were associated with better teacher-reported classroom behavior suggest that teachers can use simple classroom activity breaks to improve students' behavior and performance in the classroom.

Teachers who implemented classroom physical activity breaks reported fewer students who lacked effort/motivation. Objectively-assessed student physical activity was negatively associated with teacher-reported off-task and inattentive classroom behavior, and there was a trend for a negative association with the abbreviated problem behavior index. While we expected to find that implementation and physical activity were associated with more of the classroom behaviors assessed, the finding regarding less off-task and inattentive behavior has been supported by a similar study (Mahar et al., 2006), and lacking effort/motivation is similar to being off-task and inattentive. These findings are also supported by abundant research on the positive effects of physical activity on cognition (Donnelly and Lambourne, 2011; Kohl et al., 2013; Sibley and Etnier, 2003). Thus, classroom physical activity appears to be a promising strategy for improving attention in the classroom. Teachers who implemented classroom physical activity breaks had higher levels of agreement with the classroom behavior benefits of physical activity than non-implementers, suggesting that implementers noticed the positive classroom benefits of activity breaks. Teachers' awareness of these co-benefits of physical activity could motivate teachers to continue classroom activity breaks.

Table 1
Student, teacher and school characteristics.

Students	
Number of students assessed in fall 2013	1322
Number of students assessed in spring 2014 ^a	1192
Number of classrooms assessed	97
Mean (SD) students assessed/classroom	13.0 (4.7)
Range of grades included in assessments	1–6
Mean (SD) student age	8.8 (1.5)
% girls	53.7
% Latino	67.8
Mean (SD) accelerometer wear minutes during school	350.6 (24.1)
Mean (SD) accelerometer MVPA during school in Fall 2013	25.5 (11.3)
Mean (SD) accelerometer MVPA during school in Spring 2014	27.8 (12.6)
Teachers	
Number of teachers surveyed in fall 2013	397
Number of teachers surveyed in spring 2014 ^b	365
Mean (SD) number of teachers/school	15.9 (4.4)
Mean (SD) class size	25.7 (12.7)
Mean (SD) teacher age	44.8 (9.9)
Mean (SD) years teaching	16.3 (8.8)
% women	83.4
% reporting >90 PE min/week	31.8
% reporting >60 recess min/week	56.7
Schools	
Number of schools	24
Number of districts	6
Range number of schools/district	2–5
Mean (SD) number of schools/district	4 (1.3)
Mean (SD) free and reduced price lunch eligibility	77.8 (20.4)
Mean (SD) number of enrolled students	490.5 (163.1)
% with a certified PE teacher	50.0

California, USA, 2013–2014.

^a Only students who completed the Fall 2013 accelerometer assessments were asked to participate in the Spring 2014 assessments.

^b Only teachers who completed the Fall 2013 survey were asked to participate in the Spring 2014 survey.

Table 2
Relation of teacher-reported intervention implementation factors to accelerometer-measured student MVPA ($N = 1322$)^a.

	Mean (SD) or %		Relation to MVPA minutes/day across both time points		
	Fall 2013 ^b	Spring 2014	B (95% CI)	β (95% CI)	P value
Encouraged to hold physical activity breaks [y/n]	56.2%	58.1%	1.84 (0.15, 3.52)	0.07 (0.01, 0.14)	.033
Trained to hold physical activity breaks [y/n]	39.5%	46.1%	−3.52 (−4.96, −2.07)	−0.15 (−0.21, −0.09)	<.001
Held physical activity breaks ever [y/n]	64.7%	70.1%	3.14 (1.17, 5.12)	0.12 (0.04, 0.19)	.002
Held physical activity breaks in the past week [y/n]	35.5%	43.8%	−0.12 (−1.71, 1.46)	−0.01 (−0.07, 0.06)	.880
Physical activity breaks minutes/day	5.2 (13.5)	6.4 (14.3)	0.06 (0.01, 0.10)	0.07 (0.01, 0.13)	.016
Physical activity breaks minutes/day if any	16.4 (18.9)	15.2 (18.1)	0.08 (0.02, 0.15)	0.14 (0.03, 0.25)	.012

MVPA = moderate to vigorous physical activity; B = unstandardized regression coefficient; β = standardized regression coefficient; CI = confidence interval. California, USA, 2013–2014.

^a Adjusted for student gender, age, grade, and accelerometer wear time, teacher gender, age, and years teaching, class size, recess time, PE time, school SES, district, nesting of students within classrooms and teachers within schools, and multiple observations.

^b Intervention implementation began prior to Fall 2013 data collection.

It was unexpected that holding physical activity breaks ever, but not holding physical activity breaks in the past week (y/n), was associated with students' physical activity. However, minutes/day of activity breaks in the past week, which we refer to as level of implementation, was positively associated with the students' physical activity. Also unexpected was that training in physical activity breaks was inversely associated with students' physical activity. It is possible that training takes more time to impact behavior. Another possibility is that teachers known to have less physically active students were selected or self-selected into the trainings, which could explain the inverse association between training and students' physical activity. A study of predictors of implementation from this sample found that training was positively associated with level of implementation, so some evidence suggests teacher training is important to the students' physical activity despite the unexpected finding in the present paper.

The effect of classroom physical activity breaks on meeting the 30 min/day guideline for physical activity during school was moderate-to-large, with students who received activity breaks almost twice as likely to meet the guideline. However, the proportion of students meeting the guideline was small (36%) even in classrooms with activity breaks, and the effect of activity break minutes on MVPA minutes was small. A 1-minute increase in reported classroom physical activity breaks was associated with only a 0.06–0.08 min increase in students' objectively-measured MVPA during school. One reason for this small effect could have been due to measurement error in assessing the minutes of activity breaks via teacher report, so better measures are needed in future studies.

The analysis of multiple physical activity opportunities indicated that multiple opportunities are needed to have meaningful effects on the children's physical activity. This finding and previous literature (Donnelly et al., 2009; Carlson et al., 2013) support the comprehensive, or whole-of-school, physical activity program approach recommended by the Centers for Disease Control and Prevention (CDC, 2013) and Institute of Medicine (Institute of Medicine, 2013), among others (AAHPERD, 2013; Erwin et al., 2013; Koplan et al., 2005; Kriemler et al., 2011; Pate et al., 2006). In the present sample, students in classrooms that provided 3 physical activity opportunities had approximately 5 more min/day of MVPA than those in classrooms with no opportunities. While significant, this effect was smaller than that observed by Carlson et al. (2013), where a 19 min/day difference in student physical activity was observed between schools that provided 0–1 vs. 4 physical activity opportunities. The smaller effect observed in the present study was possibly due to less variation in both student MVPA and school physical activity opportunities, resulting from a smaller sample of schools and more low-income schools with limited resources.

Both student MVPA minutes during school and the proportion of teachers reporting implementation of classroom physical activity breaks increased from Fall 2013 to Spring 2014. Given that the interventions began prior to the Fall 2013 data collection, the aforementioned findings are notable because (1) physical activity interventions are often not maintained over a year, and (2) student physical activity has been found to decrease toward the end of the school year (Bruner et al., 2009). It is possible that in the present study, school and/or district

Table 3
Relation of accelerometer-measured student MVPA and teacher-reported physical activity breaks in the past week (y/n) to teacher-reported classroom behavior across both time points.

	IV = Class average accelerometer MVPA minutes/day ^a ($N = 97$)		IV = Teacher reported physical activity breaks in the past week [y/n] ^b ($N = 397$)	
	β (95% CI)	P value	β (95% CI)	P value
Teacher-reported student behavior (dependent variables)				
1. Pay attention in class	0.01 (−0.15, 0.17)	.903	−0.07 (−0.23, 0.09)	.382
2. Cooperate with peers, ability to work with others	−0.01 (−0.18, 0.16)	.891	−0.05 (−0.22, 0.11)	.531
3. Have a positive, cheerful attitude	0.05 (−0.11, 0.22)	.507	0.09 (−0.07, 0.25)	.278
4. Produce work and assignments that are high quality	−0.01 (−0.18, 0.15)	.881	0.06 (−0.10, 0.22)	.473
5. Are defiant or noncompliant	−0.03 (−0.19, 0.14)	.757	0.04 (−0.12, 0.20)	.659
6. Lack effort or motivation or give up easily	−0.11 (−0.27, 0.06)	.214	−0.17 (−0.33, −0.01)	.042
7. Have excessive movement or are out of seat often	−0.01 (−0.17, 0.15)	.899	−0.07 (−0.23, 0.10)	.421
8. Are off task or inattentive during class time	−0.17 (−0.33, −0.01)	.042	−0.06 (−0.23, 0.10)	.490
9. Are unable to change activities or make transitions smoothly	−0.10 (−0.27, 0.06)	.195	−0.07 (−0.23, 0.09)	.401
10. Are unhappy, sad or depressed	−0.10 (−0.26, 0.06)	.217	−0.09 (−0.25, 0.07)	.276
Assets Scale [mean of items 1–4]	0.04 (−0.13, 0.21)	.660	0.01 (−0.16, 0.17)	.941
Problem Behavior Scale [mean of items 5–10]	−0.08 (−0.26, 0.09)	.357	−0.09 (−0.25, 0.07)	.280
Abbreviated Problem Behavior Scale [mean of items 6, 8–10]	−0.14 (−0.31, 0.02)	.080	−0.12 (−0.28, 0.05)	.163

MVPA = moderate to vigorous physical activity; β = standardized regression coefficient; CI = confidence interval; IV = independent variable. California, USA, 2013–2014.

^a Adjusted for student gender, age, grade, and accelerometer wear time, teacher age, gender, and years teaching, class size, school SES, district, nesting of teachers within schools, and multiple observations.

^b Adjusted for teacher gender, age, and years teaching, class size, recess time, PE time, school SES, district, nesting of teachers within schools, and multiple observations.

Table 4

Teacher-reported benefits of physical activity breaks for implementers and non-implementers at Spring 2014 time point (N = 380).

	Number (%) of teachers reporting agree or strongly agree		Likelihood of reporting agree or strongly agree for implementers vs. non-implementers ^a	
	Teachers who had implemented physical activity breaks in the past week (N = 169–170)	Teachers who had not implemented physical activity breaks in the past week (N = 187–192)	OR (95% CI)	P value
1. Students enjoy physical activity breaks	166 (97.6%)	184 (95.8%)	1.04 (0.38, 2.81)	.472
2. Students are upset if no physical activity breaks	125 (73.5%)	126 (65.6%)	1.18 (0.71, 1.96)	.518
3. Classroom conflict is reduced after physical activity breaks	129 (76.3%)	117 (61.9%)	1.60 (0.98, 2.61)	.060
4. Students stay on task more after physical activity breaks	152 (89.4%)	152 (80.4%)	1.88 (0.98, 3.61)	.056
5. Students' work improves after physical activity breaks	145 (85.3%)	140 (74.9%)	1.88 (1.04, 3.37)	.036
6. Students feel accomplishment after physical activity breaks	150 (88.8%)	149 (78.8%)	1.75 (0.90, 3.37)	.097
7. Students sweat and breathe hard during physical activity breaks	120 (70.6%)	126 (67.0%)	1.07 (0.65, 1.76)	.781
8. Physical activity breaks improve students' health	165 (97.1%)	184 (96.8%)	0.94 (0.34, 2.58)	.904
All benefits index [sum items 1–8]	M = 6.8 (SD = 1.6)	M = 6.2 (SD = 1.9)	B = 0.34 (−0.04, 0.07)	.077
Classroom behavior/performance benefits index [sum items 3–6]	M = 3.4 (SD = 1.1)	M = 3.0 (SD = 1.4)	B = 0.31 (0.04, 0.58)	.027

OR = odds ratio; B = unstandardized regression coefficient; M = mean; SD = standard deviation. California, USA, 2013–2014.

^a Adjusted for teacher gender, age, and years teaching, class size, school SES, district, nesting of teachers within schools, and multiple observations.

support and teacher commitment increased over the school year, suggesting potential maintenance of the intervention.

Strengths and limitations

A strength of the present study was the ability to study effectiveness of real-world interventions on both student physical activity and classroom behavior, the latter of which has been understudied. The programs were developed and led by school staff in low-income schools and were adapted from evidence-based practices (e.g., Instant Recess, CATCH, TAKE 10!) (CATCH, 2015; Instant Recess, 2015; Kelder et al., 2005; Stewart et al., 2004; TAKE 10!, 2015; Whitt-Glover et al., 2011). Most studies have investigated researcher-led interventions, whereas the present study may be more generalizable to real-world practice. Another strength was the use of accelerometers and two assessments (Fall and Spring), both of which helped minimize measurement error.

Table 5

Additive relation of teacher-reported physical activity opportunities to accelerometer-measured student MVPA across both time points (N = 1322 students)^a.

	Number (%) of teachers at Time 2	B (95% CI)	P value
Model 1: Individual opportunities			
Physical activity breaks ≥3 min/day [y/n]	79 (40.7%)	1.30 (−0.16, 2.77)	.081
PE ≥90 min/week [y/n]	70 (36.3%)	1.66 (0.02, 3.29)	.047
PE teacher [y/n]	83 (42.9%)	2.39 (−0.15, 4.93)	.065
Recess ≥30 min/week [y/n]	153 (78.7%)	0.74 (−1.04, 2.52)	.415
	Number (%) of teachers at Time 2	Mean (SE) MVPA minutes/day	P value (linear)
Model 2: Index			
0 opportunities	21 (10.8%)	23.21 (1.82)	–
1 opportunity	43 (22.1%)	25.66 (0.96)	–
2 opportunities	81 (41.8%)	26.79 (0.85)	–
3–4 opportunities	49 (25.3%)	28.54 (0.99)	–
Index score [0–3]	M = 1.81 (SD = 0.94)	B = 1.53 (95% CI = 0.58, 2.48)	.002

MVPA = moderate to vigorous physical activity; PE = physical education; B = unstandardized regression coefficient; CI = confidence interval; SD = standard deviation; SE = standard error.

California, USA, 2013–2014.

^a Adjusted for student gender, age, grade, and accelerometer wear time, teacher gender, age, and years teaching, class size, school SES, and district.

Weaknesses included the inability to assess pre-post intervention changes, because implementation began prior to the Time 1 data collection. This exemplifies a challenge in timing evaluations of existing public health programs. The lack of a control or comparison condition was another weakness, requiring a process analysis approach to understand the likely effects of the intervention. Using teacher reports for the implementation and classroom behavior measures may have led to measurement error, particularly due to the potential for teachers to over-report their level of implementation to show compliance with district efforts. Future studies should attempt to directly observe these activities. P value adjustments were not performed because (1) each set of tests was based on a distinct a-priori research question, and (2) we chose to be less conservative due to the focus on external validity. Future studies should test effectiveness of classroom physical activity breaks in other samples to determine if findings are replicable. Though physical activity of each participant was assessed for only one day, students from grades 1–6 were assessed to provide five days of assessment per school. To better assess within-classroom variation in physical activity, future studies should assess the same students over multiple days.

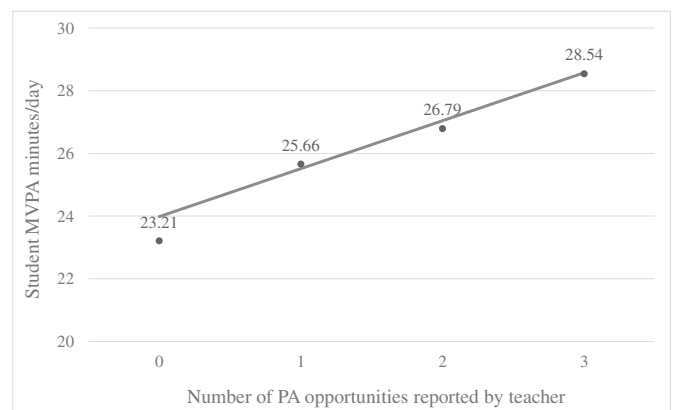


Fig. 1. Accelerometer-measured student MVPA by number of teacher-reported physical activity opportunities (N = 1192 students). MVPA = moderate to vigorous physical. Note: Physical activity opportunities were physical activity breaks ≥3 min/day [y/n], physical education ≥90 min/week [y/n], physical education teacher [y/n], and recess ≥30 min/week [y/n]. Points represent estimated means and the line represents the linear association from the regression equation (p = .002). California, USA, 2013–2014.

Conclusions and implications for practice

Teacher implementation of classroom physical activity breaks was related to higher student physical activity during school and better on-task and attentive behavior in the classroom. The present findings suggest that, to meet the 30 min/day school physical activity guideline (CDC, 2011; Koplan et al., 2005; Pate et al., 2006), comprehensive school physical activity programs are needed (CDC, 2013; IOM, 2013). Evidence is accumulating that incorporating PE, recess, and classroom and before-and-after school physical activity opportunities can have additive effects on children's physical activity (PAG Midcourse report, 2012). Supporting teachers to implement physical activity in the classroom could lead the teachers to notice the benefits that go beyond health and, ultimately, improve uptake and sustainability of activity breaks. Promoting classroom physical activity as a tool for improving students' behavior and academic performance may be a more effective approach than simply communicating the health benefits of physical activity, which are not as directly apparent or as relevant to teachers as the classroom benefits.

Conflict of interest

The authors declare that there are no conflicts of interests.

Acknowledgments

This study was funded by The California Endowment. The California Endowment was not involved in the analyses and interpretation of these data. The lead author was funded by NIH grant T32 HL79891.

References

- American Alliance for Health, Physical Education, Recreation and Dance [AAHPERD], 2013. Comprehensive school physical activity programs: helping students achieve 60 minutes of physical activity each day [Position statement] (Reston, VA).
- Barros, R.M., Silver, E.J., Stein, R.E.K., 2009. School recess and group classroom behavior. *Pediatrics* 123, 431–436.
- Bruner, M.W., Chad, K.E., Verrall, T.C., et al., 2009. Examination of physical activity in adolescents over the school year. *Pediatr. Exerc. Sci.* 21, 421–435.
- California Department of Education, 2013. Data & Statistics Available at <http://www.cde.ca.gov/ds/> (Accessed May 21).
- Carlson, J.A., Sallis, J.F., Norman, G.J., et al., 2013. Elementary school practices and children's objectively measured physical activity during school. *Prev. Med.* 57 (5), 591–595.
- CATCH (Coordinated Approach to Child Health), 2015. Available at: <http://catchinfo.org/> (Accessed January 2).
- Centers for Disease Control and Prevention (CDC), 2011. School health guidelines to promote healthy eating and physical activity. *Morbid. Mortal. Wkly.* 60, 1–71.
- Centers for Disease Control and Prevention (CDC), 2013. Comprehensive School Physical Activity Programs: A Guide for Schools. US Department of Health and Human Services, Atlanta, GA.
- Donnelly, J.E., Lambourne, K., 2011. Classroom-based physical activity, cognition, and academic achievement. *Prev. Med.* 52 (Suppl. 1), S36–S42.
- Donnelly, J.E., Greene, J.L., Gibson, C.A., et al., 2009. Physical Activity Across the Curriculum (PAAC): a randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. *Prev. Med.* 49 (4), 336–341.
- Erwin, H., Beighle, A., Carson, R.L., Castelli, D.M., 2013. Comprehensive school-based physical activity promotion: a review. *Quest* 65 (4), 412–428.
- Evenson, K.R., Catellier, D.J., Gill, K., Ondrak, K.S., McMurray, R., 2008. Calibration of two objective measures of physical activity for children. *J. Sports Sci.* 26 (14), 1557–1565.
- Instant Recess, 2015. Available at: <http://www.instantrecess.com/> (Accessed January 2).
- Institute of Medicine, 2013. Educating the Student Body: Taking Physical Activity and Physical Education to School. The National Academies Press, Washington, DC.
- Kelder, S., Hoelscher, D.M., Barroso, C.S., Walker, J.L., Cribb, P., Hu, S., 2005. The CATCH kids club: a pilot after-school study for improving elementary students' nutrition and physical activity. *Public Health Nutr.* 8 (2), 133–140.
- Kohl III, H.W., Cook, H.D., Institute of Medicine, 2013. Educating the Student Body: Taking Physical Activity and Physical Education to School. The National Academies Press, Washington, DC.
- Koplan, J., Liverman, C.T., Kraak, V.I., 2005. Preventing Childhood Obesity: Health in the Balance. National Academy Press, Washington, DC.
- Kriemler, S., Meyer, U., Martin, E., van Sluijs, E.M.F., Andersen, L.B., Martin, B.W., 2011. Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. *Br. J. Sports Med.* 45, 923–930.
- Lee, S.W., Shaftel, J., Neaderhiser, J., Oeth, J., 2009. Development and Validation of Instruments to Assess the Behavior and Assets of Students at the Classroom Level. Presentation at the 116th Annual Convention of the American Psychological Association, Toronto, Ontario, Canada (Available at: https://cete.ku.edu/sites/cete.drupal.ku.edu/files/docs/Presentations/2009/shaftel200908_behavior.pdf. Accessed January 2, 2015).
- Mahar, M.T., Murphy, S.K., Rowe, D.A., Golden, J., Shields, A.T., Raedeke, T.D., 2006. Effects of a classroom-based program on physical activity and on-task behavior. *Med. Sci. Sports Exerc.* 38 (12), 2086–2094.
- McClain, J.J., Abraham, T.L., Brusseau, T.A., Tudor-Locke, C., 2008. Epoch length and accelerometer outputs in children: comparison to direct observation. *Med. Sci. Sports Exerc.* 40 (12), 2080–2087.
- Pate, R.R., Davis, M.G., Robinson, T.N., Stone, E.J., McKenzie, T.L., Young, J.C., 2006. Promoting physical activity in children and youth: a leadership role for schools: a scientific statement from the American Heart Association Council on nutrition, physical activity, and metabolism (physical activity committee) in collaboration with the councils on cardiovascular disease in the young and cardiovascular nursing. *Circulation* 114, 1214–1224.
- Physical Activity Guidelines for Americans Midcourse Report Subcommittee of the President's Council on Fitness, Sports & Nutrition, 2012. Physical Activity Guidelines for Americans Midcourse Report: Strategies to Increase Physical Activity Among Youth. U.S. Department of Health and Human Services, Washington, DC.
- Sibley, B., Etner, J., 2003. The relationship between physical activity and cognition in children: a meta-analysis. *Pediatr. Exerc. Sci.* 15, 243–256.
- Stewart, J.A., Dennison, D.A., Kohl III, H.W., Doyle, A.J., 2004. Exercise level and energy expenditure in the TAKE 10! in-class physical activity program. *J. Sch. Health* 74 (10), 397–400.
- TAKE 10!, 2015. Available at: <http://www.take10.net/> (Accessed January 2).
- Turner, L., Chaloupka, F.J., Chiqui, J.F., Sandoval, A., 2010. School Policies and Practices to Improve Health and Prevent Obesity: National Elementary School Survey Results: School Years 2006–07 and 2007–08 vol. 1. Bridging the Gap Program, Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago, Chicago, IL (Retrieved from <http://www.bridgingthegapresearch.org>).
- US Department of Health and Human Services, 2008. Physical Activity Guidelines for Americans Retrieved from <http://www.health.gov/paguidelines/pdf/paguide.pdf>.
- Welk, G.J., Corbin, C.B., Dale, D., 2007. Measurement issues in the assessment of physical activity in children. *Res. Q. Exerc. Sport* 71 (Suppl. 2), S59–S73.
- Whitt-Glover, M.C., Ham, S.A., Yancey, A.K., 2011. Instant Recess: a practical tool for increasing physical activity during the school day. *Prog. Community Health Partnersh.* 5 (3), 289–297.