



Contextual factors related to implementation of classroom physical activity breaks

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Cite this as: *TBM* 2017;7:581–592
doi: 10.1007/s13142-017-0509-x

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Abstract

Brief structured physical activity in the classroom is effective for increasing student physical activity. The present study investigated the association between implementation-related contextual factors and intervention implementation after adoption of a structured classroom physical activity intervention. Six elementary-school districts adopted structured classroom physical activity programs in 2013–2014. Implementation contextual factors and intervention implementation (structured physical activity provided in past week or month, yes/no) were assessed using surveys of 337 classroom teachers from 24 schools. Mixed-effects models accounted for the nested design. Availability of resources (yes/no, ORs = 1.91–2.93) and implementation climate *z*-scores (ORs = 1.36–1.47) were consistently associated with implementation. Teacher-perceived classroom behavior benefits (OR = 1.29) but not student enjoyment or health benefits, and time (OR = 2.32) and academic (OR = 1.63) barriers but not student cooperation barriers were associated with implementation (all *z*-scores). Four implementation contextual factor composites had an additive association with implementation (OR = 1.64 for each additional favorable composite). Training and technical assistance alone may not support a large proportion of teachers to implement structured classroom physical activity. In addition to lack of time and interference with academic lessons, school climate related to whether administrators and other teachers were supportive of the intervention were key factors explaining whether teachers implemented the intervention. Evidence-based implementation strategies are needed for effectively communicating the benefits of classroom physical activity on student behavior and improving teacher and administrator climate/attitudes around classroom physical activity.

Keywords

Health promotion, Children, Consolidated framework for implementation research, School health, Exercise

INTRODUCTION

Schools are recommended to provide sufficient opportunities for children to obtain ≥ 30 min/day

Implications

Practice: Addressing school climate and intervention-specific attitudes around classroom physical activity is likely to improve rollout efforts that typically focus on skill training and technical assistance.

Policy: Policies to improve school-based physical activity through multiple programs are important and probably necessary, but adopted policies are not likely to be effective without being paired with evidence-based implementation strategies.

Research: Multidisciplinary research is needed to develop and evaluate implementation strategies that can be packaged with classroom physical activity interventions to increase effectiveness in real-world (non-controlled) applications.

This manuscript has not been previously published and it not under review by another journal.

Findings have not been reported elsewhere.

Authors have full control of primary data and agree to allow this journal to review data if requested.

of the total ≥ 60 min/day of moderate-to-vigorous physical activity (MVPA) guideline [1–5]. The Institute of Medicine, among others, recommend a “Whole-of-School” approach, also known as Comprehensive School Physical Activity Programs, which involve a culture of physical activity through recess, physical education (PE), active commuting to and from school, classroom physical activity, before- and after-school options, and staff and family/community involvement [1, 6, 7]. However, many students do not receive the recommended amount of physical activity in school, especially through PE and recess alone [8].

An increasingly popular approach to increase physical activity at school is short blocks of structured classroom physical activity, also known as classroom movement integration [9]. Several evidence-based classroom physical activity interventions are available, such as CATCH [10, 11], Instant Recess [12, 13], TAKE 10! [14, 15], Energizers [16], and PAAC [17]. Although these interventions have been effective for increasing student physical activity when implemented (i.e., in research studies), rates of teachers actually implementing the programs are often low after schools or districts adopt such programs [18, 19]. This underscores the need to understand the contextual factors affecting real-world implementation.

Implementation contextual factors are the elements that surround a particular implementation effort and impact its success [20, 21]. These factors include characteristics of the intervention, social and physical environment, availability of resources, and characteristics of the individuals involved in implementation. Several implementation science frameworks have been developed to organize the conceptualization of implementation contextual factors [22, 23]. Although several studies on classroom physical activity interventions have investigated implementation outcomes (e.g., fidelity, reach/penetration) [24], few have investigated implementation contextual factors in real-world settings (i.e., not lead by researchers), and none could be found that were guided by a consolidated implementation science framework [25]. Understanding how contextual factors relate to implementation can inform the development of improved implementation strategies [26]. For example, if support from other teachers were to emerge as a key implementation contextual factor, interventions could target teacher communication and networking to support implementation.

The present implementation evaluation study investigated a real-world (i.e., non-research led) classroom physical activity intervention. It is important to study real-world implementation because research interventions often do not translate well to practice. The aim of the study was to investigate the association between implementation contextual factors and whether teachers implemented the intervention in elementary school districts that recently adopted a structured classroom physical activity intervention.

METHODS

Intervention description

In 2013, The California Endowment [27] (a foundation with the mission of improving health of Californians) issued a Request for Proposals to school districts across California. The objective was to fund districts to implement interventions to incorporate daily brief (e.g., 5–10 min) blocks of structured physical activity in the classroom,

using their choice of an evidence-based program. Seven districts across California were awarded \$80,000–100,000 each during the 2013–2014 school year. Most schools in the funded districts served a large proportion of economically disadvantaged students, consistent with the goal of the grant program to enhance equity of physical activity opportunities in schools. 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 at least two schools to implement at least one block of structured physical activity daily. Interventions began in fall 2013 and lasted the duration of the school year. Implementation strategies varied across districts, though primary components in all districts included appointing a district-level coordinator to provide teacher trainings, technical assistance, support groups, and materials specific to structured classroom physical activity (e.g., handouts, instruction books, videos, websites). Five districts reported using materials from one or more evidence-based programs such as Instant Recess [12, 13], TAKE 10! [14, 15], and CATCH [10, 11]. The remaining district used an evidence-informed program they had previously developed and pilot tested. The present study did not measure program adaptations, and given that some districts used materials from multiple programs, significant adaptations were likely. The main outcome of the present study was teacher-delivered physical activity in the classroom, which was the target of each of the adopted programs, and type of program used was not a primary factor of interest.

Implementation science framework

The implementation contextual factors assessed were selected from the Consolidated Framework for Implementation Research (CFIR) [28, 29]. CFIR includes a menu of constructs with evidence of associations with effective implementation of a variety of interventions in different settings. Three constructs from the *inner setting* domain (general teacher culture, implementation climate, available resources) and one from the *characteristics of individuals* domain (knowledge and beliefs about the intervention, operationalized here as perceived benefits and perceived barriers to providing structured classroom physical activity) were selected for the present implementation evaluation study based on their expected importance in supporting intervention implementation (see Table 1). CFIR has mainly been used in health service research [30] and has not been used to date to investigate school physical activity programs.

Participants

Each district began implementation in the summer or fall of 2013, with training and rollout occurring prior

Table 1 | Selected constructs from the Consolidated Framework for Implementation Science

Domain	Construct	Short description
Inner setting	Culture	Norms, values, and basic assumptions of a given organization
Inner setting	Implementation climate	The absorptive capacity for change, shared receptivity of involved individuals to an intervention, and the extent to which use of that intervention will be rewarded, supported, and expected within their organization
Inner setting	Available Resources	The level of resources dedicated for implementation and on-going operations, including money, training, education, physical space, and time
Characteristics of individuals	Knowledge and beliefs about the intervention	Individuals' attitudes toward and value placed on the intervention as well as familiarity with facts, truths, and principles related to the intervention

to the spring 2014 semester in all districts. Data collection occurred between the middle and end of the spring 2014 semester. Three districts selected five schools and the other three districts selected four, three, and two schools, respectively, to participate in the evaluation. The schools selected were those where implementation was believed to be most extensive, with the exception of two smaller districts which selected all schools in their district. All classroom teachers of grades 1–6 within the 24 participating elementary schools were invited to participate in the implementation evaluation survey. Of the 431 teachers contacted, 365 (84.7%) returned the survey, and 337 completed all questions used in the present analyses. Thus, the final sample size was 337 teachers. This study was approved by the sponsoring university's human subject protection committee.

Measures

All measures except school economic status were collected from a teacher survey administered over the Internet, with a link sent via e-mail by the research team. The survey assessed general teacher and classroom characteristics, implementation contextual factors, and whether teachers implemented structured classroom physical activity (31 quantitative items and 1 qualitative item). The survey items were developed for the present study, with some being adapted from the Playworks study of school recess [31]. The items are presented in the Appendix, and the content is summarized below.

General teacher and classroom characteristics—Descriptive items and covariates in the teacher survey included teacher gender and age, number of students in their classroom, and whether students received PE from a PE teacher at least 1 day per week.

School economic status—School names were matched with state Department of Education data [32] to identify the percent of students eligible for free or reduced-price lunch, which was used as a proxy measure for school economic status. Higher percentages of students eligible for free or reduced-price lunch reflected lower school economic status.

General teacher support culture—One item assessed how much teachers agreed that teachers at their school generally support each other. Response options were 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree.

Availability of resources in relation to the intervention—Five items assessed whether teachers received (1) training, (2) materials, technical assistance from their (3a) school or (3b) district, and (4) encouragement for providing structured classroom physical activity. Response options differed across items (see Appendix), but all responses in this section were dichotomized as yes/no for analyses. The two technical assistance items were combined into one variable, and the four resource variables were combined into an availability of resources composite by summing the yes responses (Cronbach's alpha = 0.603).

Implementation climate in relation to the intervention—Three items assessed teacher climate specific to structured classroom physical activity, with teachers reporting how much they agreed that teachers at their school (1a) think that providing classroom physical activity is important, (1b) think that classroom physical activity can improve student learning and behavior, and (1c) support each other to implement classroom physical activity. Two items assessed administrator climate, with teachers reporting how much they agreed that administrators at their school (2a) support teachers and (2b) make it difficult for teachers to provide classroom physical activity. The latter question was reverse coded, and all response options were 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. Items were averaged to create a three-item teacher climate subscale (Cronbach's alpha = 0.761), a two-item administrator climate subscale (Cronbach's alpha = 0.553), and a five-item overall implementation climate composite (Cronbach's alpha = 0.731).

Perceived benefits to intervention implementation—Seven items assessed teachers' perceived benefits to providing structured classroom physical activity. All items were phrased as a statement with response

options being 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. Three items assessed student behavior benefits, capturing whether (1a) conflict is reduced, (1b) students stay on task, and (1c) students' work improves as a result of classroom physical activity. Three items assessed teacher perceptions of student enjoyment benefits, capturing whether students (2a) enjoy, (2b) are upset without, and (2c) feel a sense of accomplishment when they participate in classroom physical activity. A single item assessed (3a) perceived health benefits. Cronbach's alphas for the subscales were 0.831 (three items) and 0.693 (three items). An overall perceived benefits composite was also created (Cronbach's alpha = 0.853).

Perceived barriers to intervention implementation—Six items assessed teachers' perceived barriers to providing structured classroom physical activity. All items were phrased as a statement with response options being 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree. Two items assessed time barriers, capturing whether (1a) it is difficult to find time to provide and (1b) lesson time is disrupted as a result of classroom physical activity. Two items assessed academic barriers, capturing whether (2a) students have difficulty transitioning to academic lessons after and (2b) academic performance is negatively impacted as a result of classroom physical activity. The final two items assessed student cooperation barriers, capturing whether students (3a) do not want to participate in and (3b) do not cooperate during classroom physical activity. Cronbach's alphas for the subscales were 0.853 (two items), 0.665 (two items), and 0.732 (two items). An overall perceived barriers composite was also created (Cronbach's alpha = 0.802). For all regression analyses, barrier variables were reverse coded so that higher scores represented more favorable attitudes toward the intervention.

Teacher suggestions for removing barriers to implementation—One open-ended survey question was used to expand on the quantitative data by capturing more depth and specificity. The question asked teachers for their "suggestions for removing or limiting the major barriers that exist to implementing physical activity during instruction time." Responses were coded by the first author using inductive thematic analyses [33].

Intervention implementation—For the primary dependent variable, teachers were asked whether they had held structured classroom physical activity in the most recent (1) school week and (2) month, with response options of yes/no. Structured classroom physical activity was defined as blocks (e.g., 10 min) of structured physical activity incorporated into instructional time by classroom teachers. The final variable used in the analyses was a composite of these two items, representing whether teachers provided ≥ 1 block of structured classroom physical activity in the past week or month. The

correlation between the two items was $r = 0.71$. An additional item asked about the typical duration of the physical activity blocks provided.

Statistical analysis

Descriptive statistics were calculated for all variables. Intraclass correlation coefficients (ICCs) were calculated for each implementation contextual factor as well as intervention implementation, using mixed-effects logistic regression. ICCs were used to investigate how similar teachers within a school were to one another. ICC values can be interpreted as the proportion of variance between vs. within schools, with higher ICC values indicative of higher homogeneity/ similarity within schools. To investigate the association between implementation contextual factors and intervention implementation (yes/no), intervention implementation was regressed on each implementation contextual factor. High correlations were observed among the 13 independent variables/scales (excludes teacher, classroom, and school characteristics), with 16 of the 78 inter-item/scale correlations between $r = 0.30$ and $r = 0.63$, and 13 between $r = 0.20$ and $r = 0.29$. Due to concerns over multicollinearity, each independent variable (i.e., implementation contextual factor), with the exception of teacher and school characteristics, was tested in a separate model. All models adjusted for teacher and school characteristics and district membership. The implementation contextual factors were standardized to have a mean of 0 and standard deviation of 1 (i.e., z -score) to facilitate interpretation of effect sizes across factors, with the exception of dichotomous variables. Next, each of the four composite scores was dichotomized using a median split (high = 1, low = 0, with barriers being reverse coded) and summed to derive the number of favorable contextual factor composites for each teacher. The percent of teachers implementing the intervention was plotted for each number of favorable contextual factor composites, adjusted for teacher and school characteristics and district membership. A final adjusted mixed-effects logistic model was used to investigate the linear association between the number of favorable contextual factor composites and intervention implementation. All models employed random intercepts mixed-effects logistic regression to account for the nesting of teachers within schools. SPSS version 23 was used for all quantitative analyses.

RESULTS

Descriptive statistics for the teacher and school characteristics and implementation contextual factors are presented in Table 2. A majority of teachers (83.8%) were female, and relatively few classrooms (35.8%) had ≥ 1 day per week of PE

Table 2 | Descriptive characteristics and within-school agreement (ICCs) for teacher-reported implementation contextual factors and intervention implementation ($N = 337$)

	Mean (SD) or %	ICC ^a
Teacher and classroom characteristics		
Teacher female (yes/no)	83.8%	NA ^b
Teacher age (years)	45.0 (10.1)	0.125
Class size (percent of students)	25.4 (13.4)	0.170
≥1 day/week of PE provided by PE teacher (yes/no)	35.8%	0.491
School characteristics		
Economic status (%FRPL)	77.5 (20.4)	NA ^b
General teacher support culture		
Teachers support each other (1 item, range 1–4)	3.2 (0.5)	0.072
Availability of resources for classroom PA		
Training for classroom PA (1 item, yes/no)	47.1%	0.282
Materials for classroom PA (1 item, yes/no)	51.0%	0.166
Technical assistance for classroom PA (2 items, yes/no)	87.8%	0.178
Encouragement for classroom PA (1 item, yes/no)	60.0%	0.122
Overall availability of resource composite (4 items, range 0–4)	1.6 (1.1)	0.250
Implementation climate for classroom PA		
Teacher climate (3 items, range 1–4)	2.8 (0.5)	0.099
Administrator climate (2 items, range 1–4)	2.8 (0.5)	0.114
Overall implementation composite (5 items, range 1–4)	2.8 (0.4)	0.138
Perceived benefits to implementing classroom PA		
Classroom behavior benefits (3 items, range 1–4)	2.9 (0.5)	0.054
Student enjoyment benefits (3 items, range 1–4)	3.1 (0.5)	0.115
Student health benefits (1 item, range 1–4)	3.3 (0.5)	0.060
Overall perceived benefit composite (7 items, range 1–4)	3.1 (0.4)	0.109
Perceived barriers to implementing classroom PA		
Time barriers (2 items, range 1–4)	2.5 (0.7)	0.053
Academic/teaching barriers (2 items, range 1–4)	2.1 (0.6)	0.079
Student cooperation barriers (2 items, range 1–4)	1.9 (0.6)	0.125
Overall perceived barrier composite (6 items, range 1–4)	2.2 (0.5)	0.094
Intervention implementation		
≥1 block of classroom PA in past week (1 item, yes/no)	46.8%	0.089
≥1 block of classroom PA in past month (1 item, yes/no)	56.5%	0.069
≥1 block of classroom PA in past week or month (2 items, yes/no)	59.2%	0.079

FRPL free or reduced price lunch eligible, ICC intraclass correlation coefficient, NA not assessed, PA physical activity, SD standard deviation

^a Interpreted as the proportion of variance between vs. within schools, with higher ICC values indicative of higher homogeneity within schools

^b The ICC for teacher gender is not presented due to problems with model convergence; ICC was not assessed for FRPL because it was measured at the school level

provided by a PE teacher. Most schools were low SES, as indicated by the percent of students eligible for free or reduced price lunch (mean = 77.5, SD = 20.4). General teacher support culture (mean = 3.2 out of 4) was rated higher than intervention-specific teacher and administrator climate (mean 2.8 out of 4). Approximately half of teachers reported receiving training and materials on the intervention. Perceived benefits were moderate to high (means = 2.9–3.3 out of 4, indicating that teachers generally agreed to strongly agreed with the benefit statements), and perceived barriers were moderate to low (means 1.9–2.5 out of 4, indicating that teachers generally slightly disagreed with the barrier statements). Classroom behavior improvement was the lowest rated benefit (mean = 2.9), and time was the highest rated barrier (mean = 2.5). About 59% of teachers reported

providing ≥1 block of structured classroom physical activity in the past week or month. In teachers who were providing any structured classroom physical activity, 10 min was the most frequently reported duration of the physical activity blocks (by 35.1% of participants), followed by 5 min (14.9%), 15 min (12.5%), and 20 min (11.9%).

Homogeneity of responses within schools was generally low, with the exception of whether ≥1 day per week of PE was provided by a PE teacher (see ICCs in Table 2). Excluding general teacher and school characteristics, homogeneity was highest for receiving training on the intervention (ICC = 0.282). Of the four composite variables, the availability of resource composite had the highest within-school homogeneity (ICC = 0.250), followed by the implementation climate composite (ICC = 0.138) and perceived benefits and barriers

Table 3 | Associations between teacher-reported implementation contextual factors and implementation of structured classroom physical activity ($N = 337$)

	Intervention implementation (≥ 1 block of structured classroom PA in past week or month)	
	OR (95% CI)	Pvalue
Teacher and classroom characteristics		
Teacher female (yes/no)	1.22 (0.67, 2.23)	0.517
Teacher age (years)	1.02 (1.00, 1.04)	0.123
Class size (percent of students)	0.98 (0.96, 1.01)	0.226
≥ 1 day/week of PE provided by PE teacher (yes/no)	0.91 (0.53, 1.57)	0.733
School characteristics		
Economic status (%FRPL)	1.00 (0.98, 1.01)	0.655
General teacher support culture		
Teachers support each other (z -score)	1.21 (0.96, 1.54)	0.109
Availability of resources for classroom PA		
Encouraged to hold classroom PA (yes/no)	2.93 (1.81, 4.72)	<0.001
Trained to hold classroom PA (yes/no)	2.33 (1.41, 3.84)	0.001
Received materials for classroom PA (yes/no)	1.91 (1.18, 3.09)	0.009
Access to technical assistance for classroom PA (yes/no)	2.68 (1.28, 5.62)	0.009
Implementation climate for classroom PA		
Teacher climate (z -score)	1.47 (1.15, 1.88)	0.002
Administrator climate (z -score)	1.36 (1.06, 1.73)	0.014
Perceived benefits to implementing classroom PA		
Classroom behavior benefits (z -score)	1.29 (1.02, 1.64)	0.037
Student enjoyment benefits (z -score)	1.24 (0.98, 1.57)	0.073
Student health benefits (z -score)	1.18 (0.94, 1.49)	0.161
Perceived barriers to implementing classroom PA ^a		
Time barriers (z -score)	2.32 (1.75, 3.07)	<0.001
Academic/teaching barriers (z -score)	1.63 (1.26, 2.09)	<0.001
Student cooperation barriers (z -score)	1.15 (0.91, 1.46)	0.238

Each variable within general teacher support culture, implementation climate for classroom PA, availability of resources for classroom PA, perceived benefits to implementing classroom PA, and perceived barriers to implementing classroom PA was tested in a separate model due to high correlations among variables. General teacher and school characteristics were tested in the same model and entered as covariates in all other models in addition to district membership

FRPL free or reduced price lunch eligible, NA not assessed, OR odds ratio, PA physical activity

^a Reverse coded

composites (ICCs = 0.109 and 0.094). Within-school homogeneity was lower for implementing the intervention (ICC = 0.079).

Table 3 presents associations between the implementation contextual factors and intervention implementation. Teacher and school characteristics were not associated with intervention implementation nor was general teacher support culture. Nine of the 12 intervention-specific implementation contextual factors were associated with intervention implementation. Of the four resource items, encouragement had the strongest association with intervention implementation (OR = 2.93), but associations were strong for all four resource items (ORs = 1.91–2.93). Both teacher and administrator climate were associated with intervention implementation (ORs = 1.47 and 1.36). One of the three benefits (classroom behavior, OR = 1.29) and two of the three barriers (time and academic, ORs = 2.32 and 1.63) variables were associated with intervention implementation. Time barriers and academic barriers had the strongest associations with intervention implementation of all the

continuous independent variables (this excludes availability of resources which were measured as yes/no).

Figure 1 shows the additive association of the number of favorable contextual factor composites (availability of resources, implementation climate, perceived benefits, and perceived barriers) with intervention implementation. Almost 13% of teachers had zero favorable composite scores, 25.3% had a favorable score on one composite, 28.5% had favorable scores on two composites, 21.9% on three composites, and 11.1% on all four composites. Each additional favorable contextual factor composite was associated with a greater likelihood of implementing the intervention (OR = 1.64), with another 42 teachers (12.5% of the sample) implementing the intervention for each additional composite. About 85% of teachers with favorable scores on all four composites reported implementing the intervention, compared to 36% of teachers with zero favorable scores.

Table 4 presents teachers' suggestions for removing the major barriers to implementing the

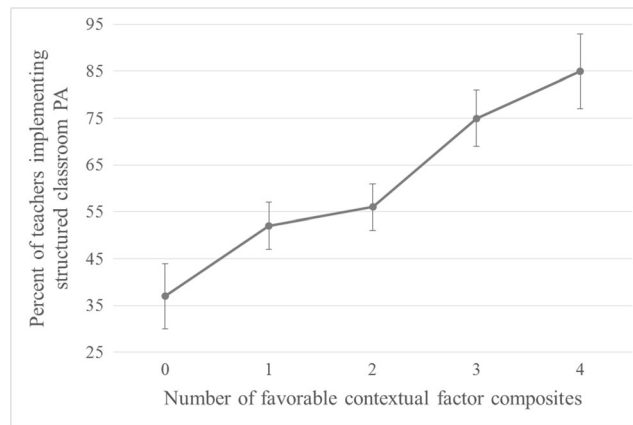


Fig. 1 | Additive association of number of implementation contextual factor composites and implementation of structured classroom physical activity ($N = 337$). PA physical activity. The number of favorable contextual factor composites was scored as a sum of dichotomous values (high/low) from the availability of resources, implementation climate, perceived benefits, and perceived barriers (reverse coded) composite scores. The linear effect of each additional composite was OR = 1.64 (95% CI = 1.33, 2.03), $p < 0.001$. The error bars represent ± 1 standard error

intervention. Insufficient resources was the most endorsed theme (endorsed by 36.2% of teachers), followed by scheduling time (21.6%), and teacher and administrator climate (14.6 and 14.1%). Teachers generally desired easy activities that could be implemented quickly without disrupting academics. Buy-in from administrators and other teachers and teacher autonomy (e.g., scheduling flexibility) were commonly noted barriers.

DISCUSSION

The present study of schools in districts that recently adopted structured classroom physical activity

programs identified several factors that explained teacher implementation of classroom physical activity. While time/scheduling has been noted as a key barrier to implementation of classroom physical activity in previous studies [25, 34–36], the present study identified several additional factors that supported or inhibited implementation. Teachers were more likely to implement the intervention if they received resources to support implementation, administrators and other teachers in the school viewed the intervention positively, they perceived that the intervention could improve classroom behavior, and they perceived that they could fit the intervention into their schedule without disrupting academic lessons. An additive

Table 4 | Suggestions from teachers for removing the major barriers that exist to implementing structured classroom physical activity ($N = 185$)

Theme	Percent of responses	Example quotes
Insufficient resources	36.2%	-A full time PE teacher to alleviate some of the planning of another lesson -Implement a school wide program with more support -Give teachers more ideas of how to implement it -Somehow show ways to implement quick activities that take very little time
Scheduling time	21.6%	-Flexibility in instruction schedules. Discretion of teacher -Build it into the schedule so I can still teach my lessons and the students can experience physical activity
Administrator climate	14.6%	-Administration has to support it and make it a priority -Allowing teachers to implement physical activity at any time of day by principals
Teacher climate	14.1%	-Teachers need to see the benefits -Getting the whole school to participate
Competing with academics	10.8%	-Less pressure on teachers to meet/cover academic standards -Provide lesson plans where physical activity is part of the academic lesson, not just a break for distraction
Student participation	2.7%	-There is no answer for kids who cannot settle back down, it is just their nature. But it does make it disruptive for the kids who are trying to get back on task

Of the 185 participants who responded to this open-ended question, 39.8% reported providing ≥ 1 block of structured classroom PA in past week or month, whereas 58.1% of participants who did not respond to this question reported providing ≥ 1 block of structured classroom PA in past week or month

association was found for four key implementation contextual factors (having sufficient resources, favorable teacher and administrator climate, and favorable attitudes about the benefits and barriers to intervention implementation). The intervention was implemented by 85% of teachers with all four attributes and only 36% of teachers with none of the attributes. Findings suggest that in addition to providing sufficient resources, improving attitudes and climate around the intervention among both teachers and administrators could increase the number of teachers implementing structured classroom physical activity after district adoption.

Not surprisingly, teachers who received encouragement, training, materials, and technical assistance for implementing structured classroom physical activity were about one to two times more likely to implement the intervention than teachers who did not receive these resources, suggesting that the resources provided were generally effective. However, only about half of teachers reported receiving training and materials, and just over half reported that they were encouraged to implement structured classroom physical activity by someone in their school or district. These low rates suggest that there are barriers to receiving these resources, which could include “push” barriers such as insufficient resources to train all teachers and “pull” barriers such as many teachers not wanting to attend the trainings.

Climate in the present study represented how supportive administrators and other teachers in the school were of the intervention, as viewed by the respondents (i.e., teachers). Climate is an organizational construct that has been related to implementation of evidence-based interventions in multiple studies [37, 38]. The present study is among the first to quantify associations between school climate and teacher implementation of structured classroom physical activity. These findings are in agreement with previous evidence from qualitative studies suggesting the importance of support from both administrators and other teachers in implementing classroom physical activity [35, 36, 39, 40]. Although evidence-based implementation strategies exist for improving organizational climate (e.g., [26]), few if any are specific to school physical activity. Evidence from both the fields of organization psychology and education administration is likely needed to develop effective implementation strategies around school climate for implementing structured classroom physical activity, suggesting the importance of multidisciplinary teams. The finding that intervention-specific climate, but not general teacher support (not specific to the intervention), was related to implementation suggests that implementation strategies should target intervention-specific attitudes/support rather than general support/culture [41].

Some but not all of the perceived characteristics of the intervention, assessed as perceived benefits

and barriers to implementing structured classroom physical activity, were significantly related to intervention implementation. Lack of time and interference with academic lessons were the top barriers in relation to implementation, which is in agreement with previous studies [25, 34, 35]. Teachers who perceived that classroom physical activity could improve classroom behavior, but not those who perceived that classroom physical activity was important to health, were more likely to implement the intervention, suggesting the importance of promoting classroom physical activity as a behavior-management tool rather than a health-improvement tool. Several studies have documented associations between classroom physical activity and classroom behavior and student academic performance [5, 16, 42, 43]. Perceived student enjoyment of and cooperation with classroom physical activity were rated positively in the present study but were not associated with implementation, suggesting that perceived student attitudes are not a major barrier to implementation.

A key finding of the present study was that each of the major constructs measured—resources, climate, perceived benefits, and perceived barriers—had an additive linear association with implementation. For each additional construct scored as favorable, teachers were 64% more likely to implement the intervention. This finding indicates that implementation strategies need to be developed to address each of these constructs to have the greatest effects on classroom physical activity. This evidence of cumulative over singular implementation supports is similar to the consensus that multiple physical activity interventions are needed to adequately support school-based physical activity (i.e., the Whole-of-School approach or Comprehensive School Physical Activity Programs) [3, 6, 44–46]. An implication of present findings is that implementation strategies that target multiple implementation contextual factors are needed to adequately support schools to implement physical activity interventions. Present findings also indicate that the multidimensional CFIR [28] generalizes well to the new application of school physical activity interventions.

Teacher and school characteristics such as teacher age and gender, class size, and school SES were not related to intervention implementation. This is a positive finding because these characteristics are not easily modifiable. The implication is that structured classroom physical activity can have similar levels of success in low-income schools as compared to higher-income schools. However, national observational data in the USA shows that teachers in low-SES schools are less likely to use structured classroom physical activity than those in higher-SES schools [47], suggesting that more efforts are needed to improve equity. In agreement with previous research, the qualitative findings of the

present study suggest that teachers desire structured classroom activities that are easy to manage, quick, and not disruptive of academics [48].

Strengths and limitations

The present study was among the first to investigate contextual factors in relation to implementation of structured classroom physical activity. Study strengths included the application of a consolidated implementation science framework to a more community-based setting (as opposed to a health service setting) [30] and investigation of additive effects of multiple implementation contextual factors. There are also some limitations. The dependent variable of intervention implementation relied on teacher reports of whether they implemented ≥ 1 block of structured classroom physical activity in the past month or week, which was an imprecise measure, did not capture duration of physical activity blocks (an important factor related to health impacts and implementation feasibility), and was potentially subject to social desirability bias. This dependent variable also did not capture regular, daily implementation, which is commonly the goal of classroom physical activity programs. Future studies should assess whether contextual factors differentially affect regular vs. any implementation of classroom physical activity. It is possible that even fewer teachers than the reported 59% implemented the intervention, and that some teachers only implemented the intervention a few times rather than regularly. Future studies should objectively assess intervention implementation by teachers when possible, such as by using the System for Observing Student Movement in Academic Routines and Transitions (SOSMART) [49]. Future studies should also investigate whether implementation rates continue to improve over time or decrease. Implementation fidelity was not assessed, so little is known about what the interventions looked like as implemented, or what adaptations were made to the evidence-based programs. Most of the schools served lower-SES students, and this limited range in SES may have limited our ability to detect whether SES was associated with implementation. The lower internal consistency (Cronbach's $\alpha = 0.553$) for the administrator climate scale suggests that more or different (e.g., phrased in the same conceptual direction) items may be needed to better assess this construct. Although we used the Consolidated Framework for Implementation Research to inform the study [28, 30], we only measured a subset of constructs in the framework, so other unmeasured contextual factors (including those not covered in CFIR) may also be important for explaining implementation of structured classroom physical activity and should be investigated in future studies. For example, teachers' perceived confidence to implement structured classroom physical activity has been related to implementation in

previous research [50]. The districts and schools were not randomly selected, which may limit generalizability of these findings to other districts and schools.

Implications and avenues for future research

Several efforts exist in research and practice to disseminate classroom physical activity interventions. These efforts often include providing training, materials, and technical assistance, and many are large-scale statewide efforts [51–53]. Although only some of such efforts have been evaluated, a common finding has been that many teachers do not implement classroom physical activity even after their district or school adopts a program [18, 19, 53]. Similarly, only about half of teachers in the present study implemented the intervention based solely on self-report. Next steps in research are to develop and test implementation strategies, over and above training and technical support, to incorporate into the large-scale rollouts that are already occurring. Effective implementation strategies are likely to be those that target classroom activity-related attitudes of both teachers and administrators (i.e., school climate) [35], as well as evidence-based individual/teacher-level behavioral strategies such as goal setting, monitoring, and feedback [54].

CONCLUSIONS

Availability of resources, teacher and administrator support/climate, and teacher attitudes, all specific to the intervention, had an additive association with implementation of structured classroom physical activity. The difference in implementation rates between teachers with favorable scores on one construct vs. those with favorable scores on all four constructs was substantial—36 vs. 85%. The development and testing of multidimensional implementation strategies for improving implementation of classroom physical activity should be a research priority, given that evidence-based classroom physical activity interventions exist [10–17], and several large-scale rollout efforts are already underway [51–53]. Strategies from the fields of organizational psychology, education administration, and individual-level behavior change can be applied to improve implementation. A focus on implementation strategies pertinent to each school context is critical, as evidence-based programs may not yield expected results without careful consideration of their potential to be influenced by school contextual factors.

Compliance with ethical standards All participants provided informed consent to participate.

The Helsinki Declaration was followed.

Institutional Review Board approval was obtained from the University of California, San Diego, prior to the administration of the study.

Funding: This study was funded by The California Endowment.

Conflict of interest: The authors declare that they have no conflicts of interest.

Human rights and welfare of animals: No human rights were violated. No animals were included.

Appendix. Teacher survey items

Teacher and classroom characteristics

1. What is your gender?	Female		Male			
2. What is your age?						
3. How many students are in your class on average?						
4. On a typical week, how many days of PE do your students receive from a PE teacher (do not count PE provided by you)?	0	1	2	3	4	5

Item 4 was recoded as PE teacher yes (1-5) vs. no (0)

General teacher support culture

1. Teachers at my school generally support each other.	SD	D	A	SA
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SD=strongly disagree; D=disagree; A=agree; SA=strongly agree

Available resources

1. Did you receive training on holding physical activity during instruction time in the 2013-2014 school year (or Summer 2013)?			Yes	No	Don't know	
2. The materials I received improved my ability to successfully implement physical activity during instruction time. (mark NA if you did not receive materials)	SD	D	A	SA	NA	
3a. There is at least one person in my school who can provide me with guidance for implementing physical activity during instruction time.			SD	D	A	SA
3b. There is at least one person in my district who can provide me with guidance for implementing physical activity during instruction time.			SD	D	A	SA
4. Are you encouraged by your school or your district to hold physical activity during instruction time?			Yes	No	Don't know	

SD=strongly disagree; D=disagree; A=agree; SA=strongly agree; NA = not applicable

Don't know was recoded as no; item 3 was recoded as received materials yes (SD, D, A, SA) vs. no (don't know);

item 4 was recoded as technical assistance yes (A or SA to 4a or 4b) vs. no (SD or D to 4a and 4b)

Implementation climate

1a. Other teachers at my school think it is important to provide students with physical activity during instruction time.	SD	D	A	SA
1b. Other teachers at my school think providing physical activity during instruction time can improve students' learning and behavior.	SD	D	A	SA
1c. Teachers at my school support each other to implement physical activity during instruction time.	SD	D	A	SA
2a. Administrators at my school provide support to teachers for providing physical activity during instruction time.	SD	D	A	SA
2b. Administrators at my school make it difficult for teachers to provide physical activity during instruction time.	SD	D	A	SA

SD=strongly disagree; D=disagree; A=agree; SA=strongly agree

Perceived benefits

1a. Conflict in the classroom is reduced after students participate in physical activity during instruction time.	SD	D	A	SA
1b. Students stay on task more after they participate in physical activity during instruction time.	SD	D	A	SA
1c. Students' work improves after they participate in physical activity during instruction time.	SD	D	A	SA
2a. Students enjoy participating in physical activity during instruction time.	SD	D	A	SA
2b. Students are upset if they have to miss the physical activity during instruction time.	SD	D	A	SA
2c. Students feel a greater sense of accomplishment when they participate in physical activity during instruction time.	SD	D	A	SA
3. Participating in physical activity during instruction time helps improve students' health.	SD	D	A	SA

SD=strongly disagree; D=disagree; A=agree; SA=strongly agree

Perceived barriers

1a. It would be/is difficult for me to find time for physical activity during instruction time.	SD	D	A	SA
1b. Implementing physical activity during instruction time cuts into important lesson time.	SD	D	A	SA
2a. It is difficult for students to transition to the academic lesson after holding physical activity during instruction time.	SD	D	A	SA
2b. Implementing physical activity during instruction time has negative impacts on students' academic performance.	SD	D	A	SA
3a. Students do not want to engage in physical activity during instruction time.	SD	D	A	SA
3b. Students would/do not cooperate when I hold physical activity during instruction time.	SD	D	A	SA

Intervention implementation

1a. During the most recent month you have been teaching, have you held structured blocks of physical activity during instruction time with your students, not including Physical Education?	Yes	No
1b. During the most recent week you have been teaching, have you held structured blocks of physical activity during instruction time with your students, not including Physical Education?	Yes	No
2. How many minutes did each block of physical activity during instruction time usually last?	Fill in, numeric	

Open-ended question

1. What are your suggestions for removing or limiting the major barriers that exist to implementing physical activity during instruction time?
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