Preventive Medicine Reports 22 (2021) 101377

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Impact of a school-level intervention on leisure-time physical activity levels on school grounds in under-resourced school districts

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ARTICLE INFO

Keywords:
Policy, systems, environmental strategies
Physical activity
School districts
Students, chronic disease prevention

ABSTRACT

Even the best school physical education programs fall short of providing enough physical activity (PA) to meet students' PA guidelines thus increasing PA at other times throughout the school day could help students meet recommended PA levels. Unstructured leisure-time periods during the school day represent an opportunity to promote PA, particularly among students in underserved school districts. Between 2014 and 2018, we partnered with 14 elementary and 5 secondary schools in low-income Latino communities to increase students' leisure time moderate to vigorous physical activity (MVPA). Schools received consultation and technical assistance on their wellness policy, and some created wellness committees. Schools selected 1–2 PA/nutrition promotion activities for the academic year. Following the System for Observing Play and Leisure Activity in Youth protocol, we conducted a pre- vs. post- analysis of observations of school time student PA (levels of MVPA, energy expenditure, proportion of areas in which games and sports were prominent) in 4936 pre-intervention play areas and 4404 post-intervention areas before school, during lunch recess, and after school. We utilized linear and logistic regression analyses to test pre/post changes in these dependent variables using school area characteristics, period of observation, and temperature as covariates. Following our intervention, MVPA levels before school, during lunch recess, and after school increased significantly from 19.8% at baseline to 25.6% among elementary girls and from 25.4% to 33.2% among elementary boys. Decomposition of these effects suggested that the benefits were partially mediated by increased adult playground supervision. We did not observe any significant changes in PA levels among secondary school girls or boys. Our school-level intervention aimed at promoting PA was associated with modest but meaningful increases in leisure-time PA among elementary, but not secondary, school students. The effects were attributable in part to increased adult supervision on the playground.

1. Introduction

Childhood obesity is at an all-time high, particularly among children living in low-income communities (Ogden et al., 2016; Frederick et al., 2014; Wang and Beydoun, 2007; Wang et al., 2007). Increasing children's participation in physical activity (PA) may be one approach for countering this trend (McKenzie et al., 2000, 2010). Because children spend a large portion of their day at school, the school setting offers an opportunity to impact health behaviors, including activity levels.

Despite national policy-level efforts to address nutrition and PA during the school day many communities struggle to improve health outcomes for children—especially for those of lower social economic status and minority groups (Local School Wellness Policy Implementation Under the Healthy, 2010; Piekarz-Porter et al., 2017). In the U.S.,

Abbreviations: MVPA, moderate to vigorous physical activity; SOPLAY, System for Observing Play and Leisure Activity in Youth; CDC, Centers for Disease Control and Prevention; REACH, Racial and Ethnic Approaches to Community Health.

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https://doi.org/10.1016/j.pmedr.2021.101377
Received 26 March 2021; Accepted 28 March 2021
Available online 20 April 2021

Latino children ages 6–11 years have among the highest obesity rates (25.0%) compared to non-Latino African American (21.4%) and non-Latino white children (13.6%) (Ogden et al., 2016). Obesity rates for children in grades 5, 7, and 9 living in Southeast Los Angeles (25.7%) have risen above the Los Angeles County average (23.6%), and in 2015 only 19.9% of children 6–17 years old living in the county's Service Planning Area 7—a predominately Latino community—met the recommended amount of PA (Los Angeles County Department of Public Heatlh, 2017, 2013). These findings highlight the urgency of developing approaches for health promotion in this community.

Since the 2006–2007 school year, funding for participation in USDA's Child Nutrition Programs was tied to presence of a district level wellness policy (Piekarz-Porter et al., 2017). Attention has turned to the wellness policy's comprehensiveness (i.e., breadth) and strength (i.e. whether policy language stipulates a strategy be required) which reflect the extent to which district and school staff can dedicate resources to implementing the strategies contained within the document. Through the wellness policy, the district articulates its commitment, through strong (shall, must, etc) or weak language (should, might, etc), to national recommendations regarding physical education, recess, and other opportunities for students to be physically active throughout the school day (Piekarz et al., 2016). As most U.S. children and youth participate in physical education, school based interventions have focused on testing effectiveness of physical education to increase the proportion of time students spend in MVPA finding that students in intervention conditions spent 24% more time in MVPA compared to those in usual practice conditions (Dobbins et al., 2009; Lonsdale et al., 2013). Intervention categories fell into two main categories: 'teaching strategies' with a MVPA focus in which teachers learned strategies to encourage MVPA through effective activity selection, class organization and management, and instruction; and 'fitness infusion' in which teachers supplemented students' participation in sports activity (basketball) with vigorous fitness activities (running, jumping). According to the literature, this body of interventions is ineffective at increasing the percentage of children and adolescents who are physically active during leisure time (Dobbins et al., 2009).

Our intervention aims to fill this gap and focuses on leisure time physical activity at school as it is widely recognized that physical activity accrued at various points throughout the day contribute to meeting daily physical activity guidelines (U.S. Department of Health and Human Services, 2018; Powell et al., 2019). Moreover our intervention leverages federal policy requiring school districts to develop and implement a wellness policy where leisure time physical activity should be addressed (Piekarz et al., 2016). In 2013, the American Academy of Pediatrics released a policy statement highlighting the crucial role that recess plays in the school day for students. At the start of the 2013–14 school year, however, only 21% of district policies required daily recess for elementary school students (Piekarz et al., 2016). Moreover, in a nationally representative sample of elementary schools, higher student-to-PE teacher ratios contributed to students' not receiving adequate instruction suggesting that a school's financial health and capacity-building profoundly determine the effectiveness of state PE regulations (Turner et al., 2017). Research indicates that children and adolescents who are obese tend to become adults who are obese and are at elevated risk for a variety of serious health problems that include but are not limited to heart disease, type 2 diabetes, stroke, several types of cancer, and osteoarthritis (Obesity. Childhood Obesity Factss, 2019). With the impetus of national, state, and district level policies, schools continue to implement wellness policies while juggling pressure to deliver academic performance during state testing (Piekarz-Porter et al., 2017). While there is evidence suggesting that additional financial support from federal and state education agencies would help schools better meet recommendations to redress physical activity disparities, median school PA equipment budgets were $500 and 30% of schools had no budget at all (Turner et al., 2017). Our program provided technical assistance including evaluation of district wellness policies and student physical activity behaviors to complement and inform on going school-level wellness policy committees charged with wellness policy implementation.

In 2015, the Centers for Disease Control and Prevention (CDC) funded our organization, a federally qualified health center (FQHC), to lead a four-year initiative, titled Racial and Ethnic Approaches to Community Health (REACH), to fight childhood obesity by working with schools in Southeast Los Angeles. Specifically, our team was charged with partnering with schools to develop wellness approaches, such as increasing student activity during the school day. From these, we developed our wellness intervention.

The purposes of this study are to report leisure-time PA levels among schoolchildren using the validated System for Observing Play and Leisure Activity in Youth (SOPLAY) instrument, and to test for the presence of changes in PA levels following implementation of our school-level intervention. Consistent with this protocol, student physical activity behaviors were examined over the course of three randomly selected school days within a two week period (McKenzie et al., 2000). We also examined associations between play-area characteristics, such as presence of loose playground equipment and on-site supervision by staff, and PA levels (moderate to vigorous physical activity, rates of games and sports, and energy expenditure). Based on baseline findings and the literature, we hypothesized that implementation of our intervention would be associated with increases in PA, and that these increases would be partly attributable to increases in availability of loose playground equipment (McKenzie et al., 2000, 2010; Escaron et al., 2019).

2. Methods

2.1. Participants

Fourteen elementary schools and 5 middle schools, involving 5 distinct school districts in Los Angeles County's Service Planning Area 7 (the Southeastern region), participated in this study (Table 1). The student population at baseline data collection periods ranged from 97 to 100% Latino and 79–100% qualified for the free and reduced lunch program. School selection and participation criteria have been described previously (Escaron et al., 2019). Briefly, these criteria included: (1) being situated in Service Planning Area 7 with a zip code that was majority low-income Latino, (2) not participating in other obesity-related policy, systems, and environment focused initiatives, and (3) willingness to designate a school-level contact to coordinate efforts and agree to start a school wellness committee or work through an existing one.

2.2. Setting

Los Angeles County is divided into eight Service Planning Areas (SPA), geographic areas, primarily for the planning and delivery of health and social services (LA County Department of Public Health, 2020). The FQHC's catchment area includes Southeast Los Angeles, thus these grant funded efforts were focused on cities within majority Latino (73.5%) SPA 7 with 17.3% of the population with household incomes less than 100% of the Federal Poverty Level. SPA 7 has a total population of 1,322,943 containing 12 public school districts where 31.2% of children ages 6–17 years obtained recommended amount of aerobic exercise weekly (≥60 min daily) (Los Angeles County Department of Public Health, 2017, 2013; Biel Consulting, Inc., 2016; Obesity and Related Mortality in Los Angeles County: A Cities and Communities Health Report, 2011). Only 19.9% of children ages 6–17 years obtained recommended amount of aerobic and muscle-strengthening each week; below the Healthy People 2030 target goal of 24.1% (Wang and Beydoun, 2007; Andersen and Haraldsdottir, 1993; Increase the proportion of adolescents who do enough aerobic and muscle-strengthening activity — PA-08 – Healthy People, 2030; Physical Activity | Healthy People, 2020).

Table 1
Characteristics of Participating Los Angeles School Districts at Baseline and Follow-up.

	District					
Characteristics	A	B	C	D	E[g]	E[g]
# of Elementary schools	3	1	0	0	4	6
# of Secondary schools[c]	1	0	1	1	2	0
Baseline[a]	Fall 2015	Spring 2016	Spring 2016	Spring 2016	Spring 2016	Fall 2016
AVG daily attendance (# of students)[c]	1544	468	534	428	4209	3895
Sex (% female)	47	47	52	49	48	49
% Latino students [d]	96	100	99	98	96	96
% students qualifying free and reduced lunch[e]	86	79	93	94	90	100
# of OBS	1460	309	275	169	2127	1569
Follow up[b]	Spring 2016	Spring 2017	Spring 2017	Spring 2017	Spring 2017	Spring 2017
AVG daily attendance (# of students)	1532	N/A	N/A	N/A	4025	3689
Sex (% female)	48	N/A	N/A	N/A	47	40
% Latino students	97	N/A	N/A	N/A	96	96
% students qualifying free and reduced lunch[f]	86	N/A	N/A	N/A	44	67
# of OBS	1,551	210	126	87	723	1,707

Abbreviations: AVG, Average; OBS, Observations.

[a] There were 3 periods of baseline date collection The first wave occurred in in Fall 2015 with District A; wave 2 in Spring 2016 with Districts B, C, D, and E; and wave 3 in Fall 2106 with District E.

[b] There were 3 periods of follow-up data collection. The first wave occurred in Spring 2016 with District A; wave 2 in Spring 2017 with Districts B, C, D, and E; and wave 3 in Spring 2017 with District E.

[c] Data on sedentary activities for secondary students were not collected because the SOPLAY tool used to collect secondary student data did not parse out sedentary activity form moderate and vigorous physical activity for this group.

[d] Average daily attendance reported for all participating schools in a district during the season when observations were completed.

[e] Latino/Hispanic as defined by school districts according to California Department of Education codes.

[f] Average student attendance, percentage of Latino students, percentage of female students, and percentage of students eligible for free or reduced lunch at follow up for Districts B, C, D were not obtained due to lack of permissions.

[g] There were two baseline and two follow up data collection periods for district E.

2.3. Intervention

Our intervention's development was guided by a multilevel ecological framework and involved four broad categories of activities that schools selected from: 1) wellness committee formation and maintenance, 2) wellness policy revision; and 3) the development of curricula/materials to support PA during and 4) after school (Sallis et al., 2006, 2001; Profili et al., 2017; Hoffman et al., 2016). Specific activities varied from school to school, and were determined based on guidance from the grant-funded initiative team and input, needs and resources of each school. Further details on uptake by individual schools are provided in Table 2.

Table 2
Intervention Activities by Category.

Category	Activity	# of Schools Participated
Wellness committee formation and maintenance	Wellness committee formed	11
	Action Plan to address PA and nutrition	19
Wellness policy review and revision	Wellness policy assessment	19
	Wellness policy update	4[a]
Curricula/materials to support PA during school	Signage promoting PA and/or healthy eating	19
	Alliance for a Healthier Generation assessment to identify opportunities to improve health and wellbeing	19
	Wellness policy flyer design, e.g. flyers promoting health school celebrations not involving sweets	7
	Health Education resources to teachers	19
Curricula/materials to support PA afterschool	Signage promoting PA and/or healthy eating	19
	Train-the-Trainer Workshops for teachers	17

PA, physical activity.

[a] The study team reviewed all district wellness policies. However, the team was actively involved in revising only one of the district wellness policies. Other districts updated policies without study team involvement.

2.4. Implementation

From 2015 to 2017, regardless of whether or not schools chose to establish formal wellness committees, our project coordinator met with representatives from each school to identify 1 to 2 strategies for increasing childhood PA and healthy nutrition during leisure times during the academic year. The Project Coordinator, in partnership with school representatives, championed these strategies via participation in School Wellness Committee meetings. Teachers were offered professional development sessions designed to increase opportunities for PA throughout the school day with 17 of 19 schools participating in these trainings (Nader et al., 1999, 2018, 2019; Reed et al., 2010).

Through the wellness committees, our aim was to help identify actionable strategies to promote PA. Each school completed a Healthy Schools Program Assessment from Alliance for a Healthier Generation (available for free on-line), which identifies criteria for a healthy school environment and serves as a guide for policy and practice change at the school site level (Healthy Schools Program Assessment Guide). Through this assessment, FQHC staff in collaboration with wellness committee members engaged in an action planning process to identify and prioritize one or two wellness promotion goals that could be achieved within one academic school year- for example, one school pilot tested a designated area of the schoolyard for play with loose playground equipment. Other strategies included staff involvement in physical activity opportunities for students and co-developing a flyer that succinctly explained the importance of the school wellness policy for parents and school staff as a way to raise awareness of the wellness policy. The level of complexity and duration varied by strategy. Several components of these efforts focused on promoting PA during leisure periods, e.g. several schools developed programs and policies to increase adult supervision in the play yard. One of the most common tips FQHC staff shared was for USDA's Smart Snacks providing guidance on nutritious snacks during classroom celebrations (Local School Wellness Policy Implementation Under the Healthy, 2010). Schools were connected with new community partners and community resources that supported their chosen strategies (County Office on Education, California Dairy Council).

2.5. Study design

The impact of the intervention activities was assessed using a pre-/post-design in which student activity levels were compared before and after intervention implementation (Cook and Campbell, 1979). Changes in school area characteristics were also recorded, which enabled us to determine if any associations of the intervention with PA were attributable to changes in school area characteristics (Table 3). These activities were reviewed (#1-887808-1) and deemed exempt by Western Institutional Review Board. In addition, the participating school districts reviewed and approved these activities prior to principal outreach.

2.6. Measurements and data collection

We measured the impact of our intervention using the SOPLAY tool, a validated instrument used to assess: school area characteristics (accessibility, usability, supervision, organized PA, and loose playground equipment); PA levels in play areas (sedentary, walking, very active) during leisure-time throughout the school day (before school, lunchtime recess and afterschool); prominence of activities in play areas, such as games/sports participation and sedentary activity participation; with energy expenditure estimated from PA levels (McKenzie et al., 2000; Escaron et al., 2019). During a scan of a target area, the PA of each individual was coded with separate scans being made for girls and boys. Simultaneous entries were made for the observation time and for school area characteristics and prominent type of activity in each area that girls and boys were engaging in using a list of activities (baseball, basketball, dance, etc). Supervision relates to school personnel available to students in case of an emergency while organized PA includes school personnel leading, instructing, or organizing students in PA.

Table 3
Descriptive Statistics on Key Variables at Baseline and Follow-up.

Variable	Baseline	Follow-up	p
Area characteristics			
Loose playground equipment present (%)	31.6	31.6	0.98
Supervision present (%)	81.7	86.4	<0.001
Area accessible (%)	99.0	97.3	<0.001
Area usable (%)	96.7	93.0	<0.001
Organized PA present (%)	1.4	1.6	0.54
Observation Period			0.093[a]
Before School (%)	10.5	11.8	
During lunch (%)	71.4	71.2	
After School (%)	18.1	17.0	
Observation Season			<0.001[a]
Fall (%)	61.5	3.3	
Spring (%)	38.6	96.7	
Mean Temperature F (SD)	76.1 (9.3)	69.3 (7.6)	<0.0001
Dependent Variables			
Girls- Elementary			
Moderate-to-Vigorous Physical Activity (MVPA), mean (SD), %	20.3 (35.5)	25.6 (39.5)	<0.0001
Sedentary Games mean (SD), %	40	2.5	<0.001
Energy Expenditure mean (SD), kcal/kg/min	0.0248 (0.095)	0.046 (0.129)	<0.0001
Participation in games/sports mean (SD), %	27.9	33.8	<0.001
Boys-Elementary			
Moderate-to-Vigorous Physical Activity (MVPA), mean (SD), %	26.2 (38.6)	33.2 (42.6)	<0.0001
Sedentary Games mean (SD), %	4.2	3.5	0.12
Energy Expenditure mean (SD), kcal/kg/min	0.0456 (0.155)	0.077 (0.167)	<0.0001
Participation in games/sports mean (SD), %	34.4	39.1	<0.001

PA, physical activity.
MVPA, moderate-to-vigorous physical activity.
[a] For overall comparisons.

2.7. Main study variables

Trained community health workers made leisure-time observations of student activity in areas of the schoolyard that were identified by the school principals as areas where students would be active and recorded the presence/absence of schoolyard characteristics described above (McKenzie et al., 2000; Escaron et al., 2019). The key independent variable is the pre-post intervention absent/present indicator. Four area-level measures of activity were determined from the SOPLAY data, each of which was a dependent variable in our analysis: 1) moderate-to-vigorous physical activity (MVPA), which was defined as the proportion of students in each area observed while engaged in activity levels categorized either as walking or very active consistent with previous work. The mean proportion of students engaged in MVPA was the aggregate measure of MVPA at pre-and post-intervention time points; 2) whether games/sports participation was the most prominent activity in an area; 3) whether participation in sedentary games was the most prominent activity in an area; and 4) energy expenditure per area, which was measured in kilocalories per kilogram of weight expended per minute (kcal/kg/min) (McKenzie et al., 2010). Energy expenditure was calculated by multiplying the number of children per area recorded as sedentary, walking and very active by published energy expenditure conversion factors (McKenzie et al., 2000, 1991). Unoccupied areas were recorded as having zero-levels of any of the activity outcomes. For each measurement, we also recorded the period of observation (before, during, after school), season of observation (Fall or Spring semester) and outdoor temperature in degrees Fahrenheit. To compute gender- and period-specific daily summaries for each school, daily means of activity counts based on the 3 observation days for each target area at each school were computed.

Data were collected during different periods by school district (Table 1). Data collection in Districts A-E occurred during both the fall and spring semesters from 2015 to 2017. District E did not approve observations of students' after school leisure time PA and therefore we only observed students from this district before school and during lunch recess.

2.8. Interrater reliability

To assess the interrater reliability of playground activity observations, interrater reliability scans were conducted in 521 observed areas, representing 11% of total areas observed. Cohen's kappa coefficients were calculated to measure agreement between the two independent observers in their assessments as part of the reliability scans. Agreement between observers was high for all area characteristics: accessibility ($k = 1.00$), usability ($k = 0.92$), supervision ($k = 0.87$), organized PA ($k = 0.85$), loose playground equipment availability ($k = 0.89$). Kappa coefficients for observer agreement on most prominent PA (i.e. the primary PA in which children were engaged in an observed area) among elementary and secondary school boys and girls were also determined: prominent activity among elementary school girls ($k = 0.89$), secondary school girls ($k = 0.99$), elementary school boys ($k = 0.89$). The following Pearson correlation coefficients were obtained for student activity levels: sedentary girls ($r = 0.94$), walking girls ($r = 0.89$), very active girls ($r = 0.80$), sedentary boys ($r = 0.98$), walking boys ($r = 0.94$), and very active boys ($r = 0.73$). A Kappa Coefficient for most prominent activity among secondary school boys could not be obtained due to low participation counts across various activity categories.

2.9. Statistical analysis

Four area-level measures of activity were calculated from the SOPLAY data, each of which was a dependent variable in our analysis. The associations of our intervention with MVPA and energy expenditure (kcal/kg/min; continuous dependent variables) was assessed with linear regression; the associations with prominence of games/sports

participation and sedentary games (categorical dependent variables) was assessed with logistic regression; MVPA is defined as the proportion of students in each area observed while engaged in activity levels categorized either as walking or very active. Consistent with the SOPLAY protocol, all area-level measures were collected over the course of three randomly selected school days within a two week period (McKenzie et al., 2000). For these analyses, covariates included loose playground equipment availability, presence of supervisors, period of observation (before school, lunch time, after school), semester (fall or spring), temperature and school. We accounted for clustering by school which should simultaneously account for district-related clustering. Estimates stratified by student sex are presented, which was collected at the time of the observation per the SOPLAY protocol. In order to provide insights on the observed intervention effects, all significant intervention effects were decomposed, or parsed into intervention effect components attributable to changes in SOPLAY area characteristics such as availability of loose playground equipment and supervision from baseline to follow-up. The Blinder-Oaxaca effect decomposition method was used to decompose overall intervention effects with those area characteristics that showed increases from pre- to post-intervention (Jann, 2008). This is a method that is used to decompose, or parse, associations of interest into components that are attributable to explanatory variables. In this study, we used it to parse associations of our intervention with PA into components attributable to area characteristics such as availability of loose playground equipment and the presence of supervisors.

We also performed a supplemental analysis in which we categorized schools as implementing one of two types of interventions: those whose district-level wellness policy revisions were implemented in collaboration with our intervention team, or those whose policy changes were not implemented with our team. We subsequently compared these categories of schools in order to assess whether the intervention effects were attributable to formal changes in district wellness plans that occurred during the study period. Since there were no differences in our dependent variables between these two intervention categories, we have not included these results in this manuscript. Importantly, however, there was no indication that the overall intervention effects that we observed were attributable to wellness policy changes, i.e. there was no suggestion that these independent wellness policy revisions confounded our main findings.

3. Results

3.1. Sample

Demographics for the study sample at baseline and follow up are summarized in Table 1.

At baseline, we completed 4936 leisure-time observations of PA in areas from 19 schools in 5 districts. The number of observations ranged from 169 to 2127 by district at baseline. At follow up, we conducted 4404 leisure-time area observations for the same schools. The number of observations ranged from 132 to 1653 per district during follow up. At baseline, 10.5% of observations were conducted before school, 71.4% were conducted during lunch, and 18.1% of observations were collected after school. At follow up, 11.8% of observations were conducted before school, 71.2% were conducted during lunch recess, and 17% were conducted during the after school program period.

Descriptive statistics on SOPLAY school area characteristics, covariates (period, season, temperature) and dependent variables are presented in Table 3. At baseline, temperatures ranged between 55 and 100 degrees Fahrenheit. The average temperature at baseline was 76 degrees Fahrenheit. Temperatures during follow-up ranged from 44 to 88 degrees Fahrenheit. The average temperature at follow up was 69 degrees Fahrenheit. The only SOPLAY area characteristic that was found to increase from baseline to follow-up was the proportion of areas with supervision present. Consequently, supervision was the only SOPLAY area characteristic used to decompose all intervention effects presented below.

3.2. Intervention associations with PA among elementary school girls

The analyses conducted on elementary school girls yielded significant beneficial intervention associations with all four dependent variables. The mean proportion of girls engaged in MVPA increased significantly from 20.3% at baseline to 25.6% at follow-up (absolute difference 5.7%, 95% CI, 4.2% −7.7%). Decomposition of this increase indicated that a significant 0.6 percentage-point component of this increase was attributable to increased supervision (see Table 4). In addition, the proportion of areas in which games/sports participation was prominent increased significantly from 27.3% at baseline to 33.7% at follow-up (absolute difference 6.5%, 95% CI, 4.3%–8.6%). Decomposition of this increase indicated that increases in supervision were responsible for a 1.2 percentage-point component of the overall increase (see Table 4). Furthermore, a significant association of the intervention with energy expenditure was found, where energy expenditure increased by an average of 0.017 kcal per kilogram of weight per minute (kCal/Kg/minute) from baseline to follow-up (95% CI, 0.012–0.023). Decomposition of this increase indicated that a 0.001 kCal/Kg/minute component of this increase was attributable to increases in supervision (see Table 4). And a significant association of the intervention with prominence of participation in sedentary games was found, where prominence decreased by 1.8 percentage points from baseline to follow-up (95% CI, −2.7% to −1.0%). Decomposition of this decrease indicated that increases in supervision did not explain the reduction in prominence of sedentary games (see Table 4).

3.3. Intervention associations with PA among elementary school boys

Our analyses indicated significant favorable associations of our intervention with three of the four dependent variables among elementary school boys. The average proportion of boys engaged in MVPA increased significantly from 25.4% at baseline to 33.2% at follow-up (absolute difference 7.8%, 95% CI, 5.9%–9.7%). Decomposition of this increase indicated that a significant 0.7 percentage-point component was attributable to increased supervision (see Table 4). In addition, the proportion of areas in which games/sports participation was prominent increased from 33.6% at baseline to 39.1% at follow-up (absolute difference 5.5%, 95% CI, 3.3%–7.7%), while a significant 1.3 percentage-point component of this increase was attributable to increases in supervision (see Table 4). Furthermore, energy expenditure was found to increase significantly from baseline to follow-up by an average of 0.021 kCal/Kg/minute (95% CI, 0.014–0.029). And, a significant 0.001 kCal/Kg/minute component of this overall increase was attributable to increases in supervision (see Table 4). There was no evidence of intervention associations with prominence of participation in sedentary games.

3.4. Intervention associations with PA among secondary school girls and boys

Among secondary students, we found evidence of an association of our intervention only with prominence of games/sports participation, where prominence decreased from 16.4% at baseline to 9.5% at follow-up (absolute difference −6.9%, 95% CI, −10.1%, −3.8%) among girls and from 31.5% at baseline to 24.8% at follow-up (absolute difference −6.7%, 95% CI, −10.5%, −3.0%) among boys. Decomposition of these decreases indicated that increases in supervision did not explain the observed reduction in prominence of games/sports participation (see Supplemental Table 1). There was no evidence of intervention associations with any of the other dependent variables, for either girls or boys.

Table 4
Adjusted Estimates of Intervention Effects for Elementary School Students and Decomposition of these Effects.

	Intervention Effect Estimates			Intervention Effect Decomposition
	Baseline[a]	Follow-up[a]	Total Intervention Effect (Follow up – Baseline)	Intervention Effect Due to Increased Supervision
Girls				
Moderate-to-Vigorous Physical Activity (MVPA)	19.8%	25.6%	**5.9% (4.2%, 7.7%)**	**0.6% (0.3%, 0.8%)**
Sedentary Games	4.2%	2.5%	**−1.8% (-2.7%, −1.0%)**	–
Energy Expenditure	0.028 kcal/kg/min	0.046 kcal/kg/min	**0.017** kcal/kg/min **(0.012, 0.023)**	**0.001** kcal/kg/min **(0.0005, 0.0013)**
Participation in games/sports	27.3%	33.7%	**6.5% (4.3%, 8.6%)**	**1.2% (0.5%, 1.9%)**
Boys				
Moderate-to-Vigorous Physical Activity (MVPA)	25.4%	33.2%	**7.8% (5.9%, 9.7%)**	**0.7% (0.4%, 1.0%)**
Sedentary Games	4.0%	3.4%	−0.6% (-1.5%, 0.3%)	–
Energy Expenditure	0.055 kcal/kg/min	0.077 kcal/kg/min	**0.021** kcal/kg/min **(0.014, 0.029)**	**–**
Participation in games/sports	33.6%	39.1%	**5.5% (3.3%, 7.7%)**	**–**

–, not applicable.
[a] Adjusted for period (i.e. before school, lunch, after school), season (i.e. fall or spring) and temperature.

4. Discussion

Our intervention, in which we partnered with local school districts to promote student PA during the school day, was associated with modest but meaningful improvements in activity levels and energy expenditure among elementary age boys and girls. Specifically, the mean proportion of elementary girls engaged in MVPA increased by 6 percentage points following implementation of the intervention, while the mean proportion of elementary boys engaged in MVPA increased by 8 percentage points. Similarly, following our intervention mean energy expenditure increased from baseline to follow-up by an average of 0.017 KCal/KG/minute and 0.021 kCal/Kg/minute among girls and boys, respectively.

Our intervention did not appear to be effective in promoting PA levels among secondary school students: there were no favorable changes in activity levels following implementation of our intervention among either secondary school girls or boys. We may have been underpowered to observe small intervention effects among secondary students due to the fact that we only were able to include 5 secondary schools in our analysis. Still, these findings are consistent with other studies that indicate that secondary students tend to be less receptive to PA interventions compared to elementary age children (Salmon et al., 2007; Brown et al., 2019; Kahn et al., 2002). The differences in effects between elementary and secondary school may be due to interest in different types of equipment and activities (U.S. Department of Health and Human Services, 2018; Powell et al., 2019; Willenberg et al., 2010; Garcia et al., 1998). Middle school students are seeking increased autonomy and closer relationships with peers, rather than adults, and may partly explain why supervision was not associated with PA in older students. A more dramatic decline in students' total PA has been reported in the transition between fifth and sixth grade compared to that between sixth and seventh grade with the bulk of this reduction occurring during the school day (Lau et al., 2017). Thus in addition to biological and psychosocial factors, reduction in school PA opportunities in middle schools may be another potential factor. Indeed, in 2014 90% of U.S. elementary schools offered regular physical activity breaks, such as recess, outside of physical education during the school day, but only 66% of middle schools offered such breaks (National Center for HIV/AIDSs, 2014). Furthermore, multiple studies have identified a consistent decline in energy expenditure as children reach adolescence (Lau et al., 2017; Caspersen et al., 2000; Sallis et al., 2003; Aaron et al., 2002; Dovey et al., 1998; Telama and Yang, 2000; Andersen and Haraldsdottir, 1993). In one U.S. adolescent sample, the decrease in total amount of PA observed seemed to be primarily a function of a decrease in the number of activities rather than a decrease in the time spent on specific activities (Aaron et al., 2002). In our study, elementary schools provided balls, jump ropes, and hula hoops while middle schools provided balls.

Also consistent with previous literature, our analysis revealed that boys were more active than girls during both the baseline and follow up analysis periods (McKenzie et al., 2010; Frost et al., 2018). In addition, our intervention was associated with greater increases in PA rates among elementary age boys vs. girls, though notably the observed increase in participation in games or sports was larger among elementary girls vs. boys. Previous studies have suggested more pronounced benefits from playground interventions in boys vs. girls (McKenzie et al., 2010; Willenberg et al., 2010). Some studies have also indicated that girls may be more responsive to the particular loose playground equipment provided during recess time or staff presence, which may explain why the observed increase in participation in games or sports was larger among girls vs. boys (McKenzie et al., 2000).

Though the increases in energy expenditure we observed appear modest (0.017 and 0.021 kcal/kg/minute, respectively, in girls and boys), they are approximately three times higher than the 0.006 kcal/kg/minute increase observed in one prior neighborhood playground intervention (Flaes et al., 2016). Furthermore, even modest increases in energy expenditure may be clinically meaningful. An imbalance between energy intake and energy expenditure (3500 kcal/year) will lead to approximately one pound of weight change in boys and girls aged 2 to 7, it has been proposed that an increase in energy expenditure of 110–165 kcal/d can mitigate the average 0.43 kg/year excess weight gain that 2–7 year olds commonly experience over a 10-year period (Wang et al., 2006). Therefore, a rise in the energy expenditure rate similar to that observed in our study – approximately 0.020 kcal/kg/min for a 25 kg elementary school student for 90 min per day – would translate to an increase in energy expenditure of approximately 45 kcal/day, one third the amount needed to mitigate this unhealthy weight gain.

Our analyses suggest that increased playground supervision was responsible for a modest portion of the increase in PA rates we observed among elementary students following implementation of our intervention. Prior research on the impact of adult supervision on activity rates among children has been mixed. Several studies have suggested a favorable impact of adult supervision on activity rates of children, while others have found that playground supervision may have a chilling effect on activity rates, perhaps because playground supervisors may prioritize student behavior management and safety over activity (i.e. "walk don't run") (McKenzie et al., 2010; Escaron et al., 2019; Willenberg et al., 2010; Sallis et al., 2003; Frost et al., 2018; Janssen et al., 2015; Verstraete et al., 2006). Overall, our findings add support to the hypothesis that promoting playground supervision may be an effective approach for fostering PA among elementary students, though further research is needed.

Aside from the modest component of intervention associations attributable to supervision, it is unclear which elements of our intervention led to the observed benefits. Since the specific wellness

interventions varied considerably across school sites, yet the observed activity increases were widespread, it is possible that increased staff focus on student PA – which resulted from our intervention – was responsible for the observed benefits. For example, the meetings and discussions our team organized may have caused staff to be more mindful of the importance of student activity, leading to favorable effects on students. However, more research is needed to further elucidate the explanation. Such information would provide insights for other schools hoping to increase student activity levels.

5. Limitations

Though our study is a prospective analysis with a large sample size using validated measurement tools offering schools flexibility in intervention selection, there are important limitations. First- and most importantly, this was a pre-/post- analysis without a control group, and thus it is possible that confounding explain our findings. Moreover with this study design only correlation, not causation, can be concluded. Objective physical activity (accelerometer) data was not collected, however, the direct observation protocol utilized in the current study has shown to be reliable within the same environment over time (McKenzie et al., 2000, 2010). This study does not observe/track individual students, so only group/setting level increased amount of PA can be determined, rather than at the individual level. Intervention fidelity was not measured thus we have little information regarding how well/to what extent each school implemented their intervention activities. Nevertheless, our findings raise important hypotheses for future research.

6. Conclusions

Overall, our findings demonstrate that school-based wellness interventions may be associated with meaningful increases in PA among school children, particularly elementary age children, in low-income Latino communities. Although the explanation for the benefits of our intervention are not completely clear, we did find that greater playground supervision may have partially mediated the benefits. We hypothesize that the simple process of increasing staff focus on student PA may have led to some of these observed benefits. Moreover, since our intervention appeared to be ineffective among secondary students, our findings highlight the challenges of promoting PA in this population. Additionally, our data confirmed prior research showing that there is a PA gap between boys and girls, with boys being more active than girls are.

Future research should focus on elucidating which specific interventions are effective in promoting leisure-time PA rates among schoolchildren, as well as identifying specific strategies for promoting activity among girls and secondary students. Based on prior research, we also believe future studies should assess whether interventions aimed at increasing loose playground equipment availability might promote student activity since this is a simple, inexpensive and scalable approach with the potential to produce substantial benefits (Escaron et al., 2019; Martinez et al., 2017).

Funding

This project was supported by the Grant Number 5U58DP00-5740-03, funded by the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the Department of Health and Human Services.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

The authors acknowledge the support of the districts' administration, teachers, and staff.

Appendix A. Categories of intervention activity

Wellness committee formation

As part of our initiative, we offered technical assistance to intervention school sites, advising these schools on strategies for promoting physical activity among their students. As part of these efforts, we suggested that each school form a wellness committee to address priority physical activity related initiatives. Eleven of the 19 participant schools established such committees. Although the remaining schools did not establish formal committees, their leadership engaged in physical activity promotion planning with our technical advisers.

Technical assistance was offered over a period of 3 academic years to form wellness committees and implement strategies for promoting physical activity. Five schools received technical assistance during all 3 academic years, 4 schools received technical assistance during 2 academic years and 2 schools received technical assistance during 1 academic year to form a wellness committee. Other schools (8) opted not to form formal wellness committees for a variety of logistical reasons, however these schools still received support for individual health-related strategies.

From 2015 to 2017, regardless of whether or not schools chose to establish formal wellness committees, our project coordinator met with representatives from each school to identify 1 to 2 strategies for increasing childhood physical activity and healthy nutrition during leisure times during the academic year. The Project Coordinator in partnership with school representatives championed these strategies via participation in School Wellness Committee meetings. The level of complexity and duration varied by strategy.

Wellness policy revision

A large focus of intervention activities was the assessment of School District Wellness policies. All school districts received a formal review of their school district's wellness policies. Two of five school districts, encompassing 16 of 19 evaluation schools, made formal changes to their wellness policies based on the review findings (Hoffman et al., 2016). The project coordinator helped support the formal revisions to the district wellness policies. Wellness policies were assessed for strength (directness of language used) and comprehensiveness (level of content covered).Results of the assessment were then shared with school employees representing all 19 evaluation schoosl (e.g., District Superintendent, teachers, coordinators, and parents) to highlight opportunities for improvement. Two school districts completed a revision of their wellness policy. Program staff was able to work closely with one of the school districts on the revision process. It was difficult to revise and update the wellness policy of other school districts because of their district size and leadership structure.

Curricula and materials to support PA during school

Through the wellness committees our aim was to help identify actionable strategies to promote physical activity, among other healthy changes on campus such as healthy food and beverages. Each school completed a Healthy Schools Program Assessment from Alliance for a Healthier Generation (available for free on-line), which identifies criteria for a healthy school environment and serves as a guide for policy and practice change at the school site level (Healthy Schools Program Assessment Guide)[28]. Through this assessment, AltaMed staff in

collaboration with wellness committee members engaged in an action planning process to identify and prioritize one or two wellness promotion goals that could be achieved within one academic school year. As one example, one school pilot tested a designated area of the schoolyard for play with loose equipment. Interpersonal-level activities included staff involvement in physical activity opportunities for students.

Long-term action plans were also discussed so that school wellness committees could build on progress from year one, and further advance their wellness goals. All 19 schools also received healthy signage (i.e. Posters, Banners, Murals, Flyers) to promote physical activity and seven of the participating schools (covering 3 of the participating school districts) co-developed a flyer that succinctly explained the importance of the school wellness policy for parents and school staff.

Type and number of intervention activities varied by school: schools were given the freedom to identify goals based on their perceived needs, and identified strategies that could be realistically achieved within the school year. Schools were connected with new community partners and community resources that supported their chosen strategies.

Curricula and materials to support PA after school

Another objective of this project was to help enhance opportunities for physical activity during the after-school period. AltaMed staff offered capacity-building workshops to school staff to equip them with the tools and resources to host their own wellness promotion activities (i.e., health fairs, healthy back-to-school nights, etc.). Additionally, 17 after-school program leads were invited by AltaMed staff to participate in physical activity workshops hosted by third party subject matter experts (i.e., County Office of Education).

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2021.101377.

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