Effect of an After-School Intervention on Increases in Children’s Physical Activity

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ABSTRACT


Purpose: Evaluate the effect of an after-school intervention on physical activity program changes and individual behaviors among children. Methods: A quasi-experimental evaluation of a YMCA–driven environmental change intervention with 16 intervention and 16 control sites in four metropolitan areas in the United States. Intervention sites participated in learning collaboratives designed to promote physical activity and nutrition through environmental change, educational activities, and parent engagement. Behavioral foci included increasing overall physical activity levels as well as combined moderate and vigorous physical activity and vigorous physical activity. Outcomes were assessed longitudinally using preintervention and follow-up surveys of program implementation and accelerometer measures of physical activity. ActiGraph accelerometer data were collected from a sample of 212 children, ages 5–11 yr, attending the programs. On average, 3 d of data were gathered per child. Reliability of the accelerometer counts averaged 0.78. Multivariate regression models were used to control for potential confounding variables and to account for clustering of observations. Results: Data indicate greater physical activity increases in children in intervention versus control sites after modest intervention implementation. Controlling for baseline covariates, children in intervention sites showed greater increases in average physical activity level than in control sites (76 counts per minute, \( P = 0.037, 95\% \) confidence interval (CI) = 8.1–144) and more minutes of moderate and vigorous physical activity (10.5 min d\(^{-1}\), \( P = 0.017, 95\% \) CI = 1.5–18.6), minutes of moderate physical activity (5.6 min d\(^{-1}\), \( P = 0.020, 95\% \) CI = 0.99–10.2), and minutes of vigorous physical activity (5.1 min d\(^{-1}\), \( P = 0.051, 95\% \) CI = 0.21–9.93). Conclusions: Results indicate significant increases in daily physical activity among children in intervention versus control sites. This study documents the effectiveness of an environmental change approach in an applied setting. Key Words: MODERATE AND VIGOROUS PHYSICAL ACTIVITY, INTERVENTION, CHILD, ACCELEROMETER

The prevalence of childhood obesity has rapidly increased during the past two decades in the United States, with higher rates occurring among minority and economically disadvantaged youth (13,19,29). Low levels of childhood physical activity are a risk for obesity and adult chronic disease (35). Current physical activity guidelines recommend that children accumulate ≥60 min of moderate- to vigorous-intensity physical activity everyday (34). However, when measured by accelerometers, fewer than half of US children meet these guidelines, and substantial disparities exist among population groups (30,40).

Intervention strategies to increase physical activity levels are most effective if they are broad-based, including multiple sectors of society (8,23,27). One important setting for promoting physical activity is after-school programs. The After-School Alliance estimates that 8.4 million US children are enrolled in after-school programming (1). The Surgeon General recently pointed to after-school as an important setting for promoting physical activity among youth (35).

There is some empirical evidence to support the potential for increasing physical activity levels in after-school programs, including cross-sectional studies and short-term interventions (32,36). Some interventions targeted overweight children; others were experiments with nonrandomized controls (6,12,16). Two pilot randomized controlled trials showed limited evidence for improved physical activity, and a randomized trial of a 10-month exercise program found an increase in moderate and vigorous physical activity (MVPA) (3,22,28). The randomized Georgia FitKid Project led to
increased fitness levels and decreased body fat percentages among participants with high attendance (10).

These studies indicate that after-school programs can facilitate increases in physical activity among children. However, more attention should be paid to translating research findings into existing programming. The present study evaluates a YMCA–driven environmental change intervention designed to make relatively simple changes in physical activity and nutrition offerings in after-school programs. We evaluated the effect of the intervention on physical activity measured by accelerometers.

**METHODS**

**Design**

The YMCA After-school Food and Fitness Project evaluation was situated in after-school programs operated by the YMCA. Because of nonrandom assignment, we evaluated the effectiveness of the intervention using a quasi-experimental study design (24). Data were collected from 16 sites within four YMCA associations in the Pacific Northwest, Midwest, South, and Eastern US beginning October 2006. Interventions were implemented in 16 sites, and 16 control sites were matched within the same associations based on size, racial/ethnic breakdown (percent white), education (percent high school graduate), and socioeconomic status (median household income and percent of households with children below the poverty level) using zip code areas where the school-based programs were located. Intervention sites were relatively similar to the potential pool of 152 after-school sites from which they were drawn and the control sites based on these characteristics (Table 1).

All children enrolled within the intervention sites were exposed to the program level intervention. To evaluate intervention effect, baseline data were collected on a subset of children in fall 2006, and children were followed through the 2006–2007 school year. The evaluation response rate at baseline was 53% for intervention sites and 52% for controls. Retention rates (subjects with complete data on all variables were used in this analysis) from fall to spring were 57% in intervention and 49% in control sites. Although implementation varied among sites, we assumed the inter-

**TABLE 1.** Demographic characteristics of households living where intervention, control, and all potential after-school sites in the four YMCA associations are located, based on US Census 2000 data.

<table>
<thead>
<tr>
<th></th>
<th>Intervention Sites (n = 16)</th>
<th>Control Sites (n = 16)</th>
<th>All Potential Sites in Four YMCA Associations (n = 152)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% white</td>
<td>80</td>
<td>84</td>
<td>83</td>
</tr>
<tr>
<td>% high school</td>
<td>87</td>
<td>88</td>
<td>84</td>
</tr>
<tr>
<td>graduate or higher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median household</td>
<td>50,160</td>
<td>52,422</td>
<td>46,531</td>
</tr>
<tr>
<td>income (US$, 1999)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of households</td>
<td>6.9</td>
<td>5.9</td>
<td>7.7</td>
</tr>
<tr>
<td>with families below</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>poverty level</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Intervention

**Physical activity environmental standards.** The intervention focused on program practice changes in the areas of physical activity and nutrition. The target changes were identified as Environmental Standards developed by the YMCA of the USA (YUSA) and Harvard School of Public Health Prevention Research Center (Fig. 1; available at: http://www.hsph.harvard.edu/prc/ymca/resources.html). The present article focuses on evaluating the following program goals related to physical activity: offer daily inclusive physical activity for at least 30 min, offer vigorous activity at least three times per week, and promote high levels of staff participation in physical activity. The primary behavioral outcome for our evaluation of this intervention was change in physical activity levels among children.

**Theoretical framework.** Development and evaluation of the program were guided by a social ecological framework (4,27). The intervention was delivered to programs through a learning collaborative. The conceptual framework of the learning collaborative assumed that staff and management participation leads to environmental changes, enhanced child and adult experiences, and improved participant attitudes, behaviors, and health. The collaborative was designed consistent with the Institute for Healthcare Improvement Breakthrough Series Collaborative model (14,37).

Educational materials included the Food and Fun After School curriculum. Materials were developed using social cognitive theory and an appreciation for children’s maturational stages (2). Activities were developed to capitalize on staff role modeling and practice of healthy behavior. Food and Fun After School is designed to increase knowledge and build self-efficacy in health behavior decision making.

**Learning collaborative delivery.** All participating YMCA associations were involved with a national learning collaborative in 2004 when select branches were designated as early adopters of these change efforts. The present study follows after-school programs participating in local efforts to spread the collaborative process and change strategies to other programs within their association.

Collaboratives included 3 multiday learning sessions for 1 yr. Staff developed skills for successful implementation, set health promotion goals to work on between meetings, and
were trained to implement small experiments to develop local best practices for each environmental standard. Further support was provided by conference calls and in-person coaching. If staffing changed at a program, new staff members participated in the remaining trainings and calls. Costs and time associated with learning sessions were similar to usual yearly trainings, and interventions were implemented by existing personnel.

**Food and Fun After School.** The Food and Fun After School curriculum was designed by researchers at the Harvard School of Public Health Prevention Research Center in collaboration with YUSA and after-school personnel, and is available free of charge at foodandfun.org. The curriculum was designed to help staff operationalize the environmental standards and help children develop healthy habits through healthy snacks, physically active games, and group activities. The curriculum includes 10 units and a family handbook, newsletters, handouts, and e-mail messages. Site directors were trained to implement Food and Fun After School with a train-the-trainer model. Food and Fun After School was available at central childcare offices, but control sites were not notified they were available and did not receive training.

**Measurement**

**Process data to assess dose.** During fall 2007, we obtained meeting agenda and attendance lists for learning sessions. We reviewed all small experiments related to physical activity documented by sites during 2006–2007. Staff reported Food and Fun After School usage and physical activity offerings via bimonthly surveys. Control site directors completed similar surveys in spring 2007. Environmental outcomes and staff turnover were measured by self-assessments completed by a group of staff in spring 2007. All intervention site directors reported their intervention experience in open-ended interviews at the completion of the study.

Changes in the after-school physical activity environment were assessed using five items from the self-assessment asking whether the site made any changes in the number of days, the amount of time physical activity was offered, the intensity of physical activity opportunities, whether children enjoyed the activity, and the participation in the activity between fall 2006 and spring 2007. Items used a five-point Likert scale. Item responses indicating no change from baseline to follow-up were coded as 0, responses indicating small increases (e.g., physical activity on one to two more days or “a little” change in participation) were coded as 1, and responses indicating large increases (e.g., physical activity on three to five more days or “a lot” more participation) were coded as 2. Conversely, small decreases were coded as −1 and large decreases were coded as −2. A factor analysis indicated that the physical activity items could be summarized in a single score. Factor loadings ranged from 0.34 to 0.86. A composite physical activity change score was created by summing items and ranged from −10 to 10, with higher scores indicating more change and positive scores indicating improvement.

**Primary outcome—physical activity.** Physical activity was measured by ActiGraph accelerometer (model 7164; Pensacola, FL). Reports have established the reliability and validity of accelerometers. Studies indicate that 4 d of data result in reliability averaging 0.80 of overall physical activity for children (11,39). Studies have noted strong evidence for validity among children when compared with criterion measures of physical activity. Accelerometer data are systematically related to gold standard measures of fitness, such as $\dot{V}O_{2\text{max}}$, and activity-related energy expenditure, such as doubly labeled water (7,20,31).

Research assistants hired and supervised by staff from Harvard School of Public Health were on-site at each association. On Mondays, assistants assigned and distributed accelerometers to all participants. Accelerometers were fastened with an adjustable belt. Children were instructed to put the accelerometer on upon waking each morning until they went to bed at night and asked to remove it when showering or swimming. Children and parents recorded the time the accelerometer was off in a family workbook. Parents

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**FIGURE 1**—Environmental standards for physical activity, healthy eating, advertising, and screen time in YMCA after-school programs participating in the YMCA learning collaboratives.
received written instructions and automated reminder calls. On Fridays, assistants collected accelerometers on-site.

Accelerometer analyses follow algorithms developed by Troiano et al. (18,30). We used 1-min epochs. Wear time was defined to determine inclusion of valid days. Nonwear time was operationalized as an interval of ≥60 min of zero intensity counts, allowing for 1- to 2-min spans with counts <101 (a very low level of activity). Wear time was calculated by subtracting nonwear time from 24 h. A valid day was defined as any day with ≥10 h of wear time. Mean counts per minute were calculated by dividing the total counts of activity by the minutes of wear time for all valid days. We applied age-specific count thresholds to identify MVPA. The specific criteria for each age are in SAS code (available from: http://riskfactor.cancer.gov/tools/nhanes_pam). MVPA was defined as ≥4 METs in children age 6–17 yr, whereas vigorous physical activity (VPA) was defined as ≥METs for children age 6–17 yr (30). Results are reported for combined MVPA as well as for moderate physical activity (MPA) and VPA.

We calculated the reliability of accelerometer measures using all observations with three complete days of data in fall (n = 170) and spring (n = 148). The estimated reliabilities of accelerometer counts were 0.77 in the fall and 0.79 in the spring (average = 0.78), 0.82 for minutes of MVPA in the fall and 0.85 in the spring (average = 0.84), 0.76 for minutes of VPA in the fall and 0.78 in the spring (average = 0.77).

Family workbooks. Demographic data, including child gender, age, race/ethnicity, and times accelerometers were worn, were collected via family workbooks. Children and parents were instructed to complete the workbook together each night. We created three categories of race/ethnicity: white non-Hispanic, African American, and other/missing. Because of the small number of Hispanic (n = 7), Asian (n = 8), multiracial (n = 5), and other (n = 5) participants, we merged these categories with cases missing race/ethnicity data (n = 20).

Weight and height measurements. Trained staff from Mathematica Policy Research, Inc., took anthropometry measurements. Child height was measured to the nearest millimeter using a Shorr stadiometer. Weight was measured to the nearest 0.01 kg on a calibrated digital scale. Body mass index (BMI) was calculated as weight per squared height (kg·m⁻²). BMI z-score and overweight (BMI ≥85th percentile for age and sex) were calculated using the Centers for Disease Control and Prevention algorithm (5). Measurements were taken in lightweight clothing with shoes and interfering hair accessories removed.

Statistical Methods

We conducted analyses to determine whether the intervention among after-school sites yielded greater improvements in the primary outcome of physical activity level compared with the control condition. Because intervention and control sites were not randomized, it is possible that differences that existed before intervention assignment accounted for differences in our outcome measures at follow-up. We controlled for confounding variables by accounting for baseline physical activity and other potentially important covariates: YMCA association, age, gender, race/ethnicity, and BMI z-score. Because students were clustered within sites, we used SUDAAN 8.0.0 software (RTI International, Research Triangle Park, NC) to properly account for autocorrelation assessing SEs (25). Intervention and control sites were matched within association, so we included three indicator variables for the East, Pacific Northwest, and Midwest associations. We chose the association in the South as the reference group because it contained the largest proportion of our sample. We controlled for age, gender, race/ethnicity, and baseline BMI z-score because of their relationship with physical activity level (30). Analyses were conducted using an intention-to-treat protocol, with participants analyzed in their original condition (21). We have no evidence that children moved between control and intervention sites. We controlled for average minutes per day the accelerometer was worn during baseline and follow-up periods.

RESULTS

Program implementation. Attendance at learning sessions varied: half of the intervention sites had at least one person at all three sessions. Two of four associations held monthly in-person meetings or calls, while supports in the other associations were limited. No staff from control sites attended learning sessions or support meetings. Site staff turnover between fall 2006 and spring 2007 was substantial, averaging 49% at the intervention site and 78% at the control site. Forty-four percent of intervention site directors and 25% of control site directors left their position during this period. Change scores in site physical activity environment between fall 2006 and spring 2007 ranged from 1 to 10 and averaged 5.4 in the intervention site and 3.7 in the control site (P = 0.06), providing marginal support for greater implementation in intervention sites. These change scores indicate that intervention sites reported more time dedicated to physical activity during the program, increased intensity of the physical activity offered, more opportunities to engage in physical activities that are fun and enjoyable for children, and increased participation levels when physical activity was offered.

During interviews, 8 of 16 intervention site directors reported scheduling daily physical activity as one of the changes they made to their program. Other reported strategies for improving physical activity included getting children’s feedback on new activities to identify physical activities that appeal to the children they serve and coordinating with physical education teachers to reinforce messages being taught at school and share physical activity equipment.

Twelve of 16 intervention sites implemented at least one Food and Fun After School physical activity unit and incorporated active games. Intervention sites reported teaching an
TABLE 2. Baseline characteristics of the longitudinal study sample (children in after- school programs in four associations (32 sites) with accelerometer data in fall 2006 and spring 2007) from intervention and control sites.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Intervention (n = 114)</th>
<th>Control (n = 98)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Background characteristics at baseline</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (yr), mean ± SD</td>
<td>7.3 ± 1.66</td>
<td>7.89 ± 1.57</td>
</tr>
<tr>
<td>Female (%)</td>
<td>45</td>
<td>53</td>
</tr>
<tr>
<td>Race/ethnicity (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White non-Hispanic</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Other (Hispanic, Asian, other/missing)</td>
<td>23</td>
<td>19</td>
</tr>
<tr>
<td>YMCA association (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>39</td>
<td>30</td>
</tr>
<tr>
<td>East</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Pacific Northwest</td>
<td>24</td>
<td>11</td>
</tr>
<tr>
<td>Midwest</td>
<td>26</td>
<td>37</td>
</tr>
<tr>
<td>BMI z-score at baseline, mean ± SD</td>
<td>0.59 ± 0.97</td>
<td>0.73 ± 0.93</td>
</tr>
<tr>
<td>BMI at baseline (kg m⁻²), mean ± SD</td>
<td>17.65 ± 2.98</td>
<td>18.53 ± 3.75</td>
</tr>
<tr>
<td>Daily wear time, fall (min), mean ± SD</td>
<td>798 ± 66</td>
<td>797 ± 94</td>
</tr>
<tr>
<td>Daily wear time, spring (min), mean ± SD</td>
<td>823 ± 92</td>
<td>805 ± 904</td>
</tr>
<tr>
<td>Accelerometry counts per minute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>during wear, mean ± SD</td>
<td>807 ± 298</td>
<td>735 ± 264</td>
</tr>
<tr>
<td>Wear time above moderate/vigorous cut point (min), mean ± SD</td>
<td>81.2 ± 43.3</td>
<td>69.1 ± 37.3</td>
</tr>
<tr>
<td>Wear time at moderate cut point (min), mean ± SD</td>
<td>56.1 ± 29.3</td>
<td>48.5 ± 23.4</td>
</tr>
<tr>
<td>Wear time above vigorous cut point (min), mean ± SD</td>
<td>25.1 ± 20.3</td>
<td>20.6 ± 16.6</td>
</tr>
</tbody>
</table>

* 1-min bouts.

average of 3.0 physical activity–themed lessons and 4.4 active games during the school year. One control site reported implementing the physical activity Food and Fun After School lessons, indicating minimal contamination. Nine of 16 intervention sites reported distributing one or more parent material. Intervention sites averaged two distribution attempts with none at control sites. Sites also reported implementing a range of innovative physical activities including walking clubs for parents and children, physical activity education, dance programs, kid-centered aerobics, yoga/stretch classes, and family nights with physical activity.

**Sample inclusion and characteristics.** There were no significant baseline differences between intervention and control samples in gender, racial/ethnic composition, BMI z-score, baseline accelerometer counts, minutes per day of MVPA, minutes per day of MPA, minutes per day of VPA, or average wear time (Table 2). The sample was spread across the YMCA associations, with a lower percentage (11%) in the Eastern area at follow-up compared with baseline (24%) and corresponding change in distribution at other sites.

**Changes in accelerometer measures.** After controlling for baseline covariates, children in intervention sites showed greater increases in physical activity than children in control sites measured in accelerometer counts (76 counts per minute, \( P = 0.037 \), 95% confidence interval (CI) = 8.3–144), minutes of MVPA (10.5 min d⁻¹, \( P = 0.017 \), 95% CI = 1.5–18.6), minutes of MPA (5.6 min d⁻¹, \( P = 0.020 \), 95% CI = 0.99–10.2), and minutes of VPA (5.1 min d⁻¹, \( P = 0.051 \), 95% CI = 0.21–9.93). As expected, physical activity declined significantly with age regardless of the measure of physical activity used (accelerometer counts per minute, minutes of MVPA, minutes of MPA, and minutes of VPA, all \( P < 0.01 \), as indicated by regression coefficients used in the models for Table 3. We tested for an interaction of the intervention and overweight status of the child to determine whether the intervention had a different effect on overweight versus healthy weight children. This interaction term (\( P = 0.054 \)) in the regression predicted change in physical activity counts, indicating a marginally larger effect of the intervention for overweight compared with other children. In the equations predicting change in MVPA, MPA, or VPA, the interaction term was not significant.

We translated observed changes in average accelerometer counts to changes in energy expenditure to put our physical activity estimates into context. We used the Schofield equations to estimate the basal metabolic rate for each child based on their age, weight, and gender (33). We assume that each additional minute of MVPA is equivalent to replacing 1 MET of activity with 3 additional METs. We use the 95% CIs for minutes of MVPA to calculate the range of additional energy expenditure. Under these assumptions, we estimate that, on average, the typical participant in intervention sites expended an additional 25 kcal d⁻¹ (3.6–44.3 kcal d⁻¹) with an increase of 10.5 min of MVPA per day (95% CI = 1.5–18.6).

**DISCUSSION**

This quasi-experimental field trial points to the benefits of intervening in after-school programs to increase physical

TABLE 3. Estimated differences in change in accelerometer measures from baseline to follow-up for children in intervention (I) and control (C) sites, from fall 2006 to spring 2007 (four YMCA associations and 32 after-school sites).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Sample</th>
<th>Baseline</th>
<th>Follow-Up</th>
<th>Crude Change</th>
<th>Adjusted Difference</th>
<th>95% CI</th>
<th>( P )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean accelerometer counts per minute</td>
<td>C</td>
<td>98</td>
<td>735</td>
<td>767</td>
<td>+32</td>
<td>—</td>
<td>0.037</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>114</td>
<td>807</td>
<td>904</td>
<td>+97</td>
<td>+76</td>
<td>8.1–144</td>
<td></td>
</tr>
<tr>
<td>Mean monitored minutes of MVPA</td>
<td>C</td>
<td>98</td>
<td>69.2</td>
<td>70.4</td>
<td>+1.3</td>
<td>—</td>
<td>—</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>114</td>
<td>81.2</td>
<td>94.2</td>
<td>+13.0</td>
<td>+10.5</td>
<td>1.5–18.6</td>
<td></td>
</tr>
<tr>
<td>Mean monitored minutes of MPA</td>
<td>C</td>
<td>98</td>
<td>48.5</td>
<td>48.2</td>
<td>−0.3</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>114</td>
<td>56.1</td>
<td>61.5</td>
<td>+5.4</td>
<td>+5.6</td>
<td>0.99–10.2</td>
<td>0.56</td>
</tr>
<tr>
<td>Mean monitored minutes of VPA</td>
<td>C</td>
<td>98</td>
<td>29.6</td>
<td>22.2</td>
<td>+1.6</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>I</td>
<td>114</td>
<td>25.1</td>
<td>32.7</td>
<td>+7.6</td>
<td>+5.1</td>
<td>0.21–9.93</td>
<td>0.051</td>
</tr>
</tbody>
</table>

* Restricted to cohort students with paired data.
** Baseline and follow-up values are the unadjusted means.
\( d \) Adjusted change represents the difference in change in scores in the intervention group compared with the control group students, after adjusting for baseline value of the dependent variable, intervention status, baseline age, female gender, indicators for African American and other racial ethnic group, BMI z-score, and indicator variables for YMCA association (three indicators), and baseline and follow-up number of minutes monitored. Regression estimates were calculated using SUDDAN to account for the clustered sampling design.
activity among youth. Children in intervention sites showed an extra 76 counts per minute on average, an additional 10.5 min d\(^{-1}\) of moderate and vigorous, and an additional 5.1 min d\(^{-1}\) of vigorous physical activity than children in control sites.

To our knowledge, these findings are the first to demonstrate increases in physical activity as a result of a sustained multisite after-school intervention in a continuing program. The intervention sought to increase physical activity both during program time and at home, through changes in program practices and parent engagement. These results make a significant addition to the small amount of evidence in the field.

Results can be interpreted in the context of estimates of the energy gap in children responsible for recent increases in the relative weight of children in the United States—a deficit of about 100–165 kcal d\(^{-1}\) (38). The current intervention produced an energy expenditure difference of about 25 kcal d\(^{-1}\). While we can safely say that children’s activity-related energy expenditure increased in intervention children more than controls, the actual increment would depend on each child’s baseline level and would be influenced by lean body mass and other factors. Nonetheless, an average change of 25 kcal d\(^{-1}\) represents a substantial fraction of this energy gap.

Furthermore, adding 10.5 min of MVPA per day, particularly for children that were relatively sedentary at baseline, is a significant improvement toward meeting current recommendations for at least 60 min of MVPA per day. Children obtaining at least 60 min of MVPA per day can expect to have better outcomes related to body composition, risk factors for cardiometabolic disorders, and mood improvement (34). Paired with effective dietary changes, interventions in after-school could meaningfully contribute to efforts to curb the childhood obesity epidemic (17).

These findings can be interpreted as even more promising if we take account of the relatively low dose of intervention documented by our process measures and the potential reach of the intervention across 10,000 US YMCA childcare and after-school sites. We found variable levels of program support and staff attendance at trainings and modest curriculum usage. Programs experienced high staff turnover, which may have contributed to a low level of program change. Staff turnover is a significant barrier to program implementation and remains a challenge to promoting health in after-school programs.

Despite the limited dose, our results suggest promise for the use of environmental standards and support materials in a large network of after-school programs. To date, more than 21,000 children in 530 youth programs have been exposed to Food and Fun After School, and recently, YUSA has focused efforts in communities that are disproportionately affected by obesity through their African American and Hispanic-Latino collaboratives.

Several limitations should be noted. Because we worked with YUSA to evaluate a program ongoing in the field, we had to choose a quasi-experimental design rather than a randomized trial. The lack of randomization could be accompanied by residual confounding. We worked with YMCA leadership to identify similar intervention and control sites within each area and controlled for confounding using multivariable regression. However, limited control variables were available. The response and follow-up rates for the evaluation were similar for intervention and control sites but were also relatively low (52% response rate at baseline; 53% fall to spring follow-up) because of the turnover among children and because we needed to obtain separate parent consent and child assent both in fall and in spring. Therefore, there could be uncontrolled selection bias. It should be noted that these response rates reflect participation in data collection and not for the intervention itself. High turnover among after-school staff led to difficulty in accurately assessing change at the program level. The self-report nature of the program-level physical activity measure and relatively small number of after-school programs likely limited our power to detect significant differences at the program level. Finally, although the intervention ultimately seeks to address the health burden of childhood obesity, this study was not powered with a sample large enough to detect changes in BMI z-score or relative weight. We can only show changes in physical activity levels with hopes that sustained efforts like this intervention will lead to changes in weight status over time.

Despite these limitations, this study has many strengths. First, use of the accelerometers provides objective estimates of physical activity that are both reliable and valid. We used consistent wear time definitions and age-specific cut points to determine moderate and vigorous activity using software, so results are comparable to the National Health and Nutrition Examination Survey analyses (30). Average levels of physical activity found in this sample of 5- to 11-yr-olds at baseline (average 774 counts per minute, 76 min of MVPA, 53 min of MPA, and 23 min of VPA) compare reasonably well to national averages among 6- to 11-yr-olds (608 counts per minute, 85 min of MVPA, 72 min of MPA, and 13 min of VPA) (30). The national sample is, on average, a year older and thus would be expected to have lower levels of physical activity.

The accelerometer may underestimate physical activity from water sports and upper body exercise, although these contribute little to children’s overall activity. There is little threat of differential bias because any error should be similar in intervention and control samples. Similar comments can be made regarding the 1-min epochs used. While evidence indicates young children engage in vigorous physical activity in small bouts, we expect little bias in estimating intervention effects because we expect similar patterns in intervention and control participants (26).

Another major strength is the longitudinal sample. We assessed physical activity change in the same children across the school year, which allows clear specification for change after the intervention. There was limited evidence for contamination across sites: no staff reported attending trainings or support sessions, and only one control site reported curriculum use. Our outcome was physical activity during

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the entire day. This approach allowed us to account for any compensation that may have occurred in physical activity outside the after-school setting. Others have hypothesized, for example, that children who increase physical activity at school may then be less active out of school (15).

This study shows evidence for the effect of environmental changes in an applied setting. The results are not limited to a controlled (and difficult to replicate) trial. Rather, the intervention was delivered in the field by after-school staff. Intervention changes can be seen not only as an indication of program efficacy but also as an actual effectiveness in the real world (9).

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REFERENCES


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This work is solely the responsibility of the authors and does not represent official views of the Centers for Disease Control and Prevention. Intervention materials are available at http://www.hsph.harvard.edu/prc/ymca/resources.html.

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The results of the present study do not constitute endorsement by the American College of Sports Medicine.