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School Physical Education: Effect of the Child and Adolescent Trial for Cardiovascular Health

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Background. Physical inactivity is a risk behavior for cardiovascular and other diseases. Schools can promote public health objectives by increasing physical activity among youth.

Methods. The Child and Adolescent Trial for Cardiovascular Health (CATCH) was a multicenter, randomized trial to test the effectiveness of a cardiovascular health promotion program in 96 public schools in four states. A major component of CATCH was an innovative, health-related physical education (PE) program. For 2.5 years, randomly assigned schools received a standardized PE intervention, including curriculum, staff development, and follow-up.

Results. Systematic analysis of 2,096 PE lessons indicated students engaged in more moderate-to-vigorous physical activity (MVPA) in intervention than in control schools ($P = 0.002$). MVPA during lessons in intervention schools increased from 37.4% at baseline to 51.9%, thereby meeting the established Year 2000 objective of 50%. Intervention children reported 12 more min of daily vigorous physical activity ($P = 0.003$) and ran 18.6 yards more than control children on a 9-min run test of fitness ($P = 0.21$).

Conclusions: The implementation of a standardized curriculum and staff development program increased children's MVPA in existing school PE classes in four geographic and ethnically diverse communities. CATCH PE provides a tested model for improving physical education in American schools.

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INTRODUCTION

Regular physical activity is recognized as an important component of a healthful lifestyle for the reduction of cardiovascular disease among adults.[1] As well, physical activity patterns can influence cardiovascular risk factors among youth, adolescents, and young adults.[2-4] Studies have shown that physical activity may benefit adolescents by increasing their aerobic fitness,[5] bone mass,[6] and HDL cholesterol[7] and by reducing their obesity[8] and hypertension.[9] As a result, international guidelines for adolescent physical activity have been established.[10]

There are substantial barriers to children obtaining adequate amounts of physical activity. While they acquire most of their physical activity in nonschool environments,[11] many children have limited or no access to activity settings such as youth sports and movement lessons, and this is particularly evident for girls[12] and the less affluent. Schools are a logical environment for promoting public health through physical activity,[13] but children's time there is spent primarily in sedentary pursuits. Most elementary schools in the United States require physical education (PE) as part of their curriculum, and PE programs have the potential for influencing physical activity by providing activity during class and, indirectly, by making physical activity engagement an enjoyable, desired pursuit.[13, 14] Studies, however, indicate that PE classes may occur infrequently and that children often are relatively inactive in them,[14-16] particularly when compared to the Healthy People 2000 objectives.[17] Increasing the frequency and duration of physical education is difficult

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because all subject matter areas compete for a limited amount of time during the school day. Thus, it is imperative that the time allocated for PE in schools is used efficiently and that it includes a curriculum that promotes ample amounts of physical activity.

There is a need for research examining the effectiveness of the school in promoting the physical activity of youth, and large-scale studies of curriculum and staff development programs in physical education have not been reported. Physical education was a major component of the Child and Adolescent Trial for Cardiovascular Health (CATCH) which was implemented in 96 elementary schools in four geographically and culturally diverse states.[18, 19] The overall results of CATCH, a multicomponent, multicenter trial targeting diet, physical activity, and nonsmoking among third through fifth graders, recently have been reported elsewhere.[18] The protocol called for a standardized intervention to be delivered to randomly assigned schools.

The purpose of this paper is to briefly describe the CATCH PE methods and materials and to present the major results of the study that relate to children's physical activity. Results are presented for the frequency and duration of physical education lessons and for children's physical activity levels during PE time, the primary school-level measure. At the individual level, results are presented for children's performance on the 9-min run, a field-based assessment of cardiorespiratory fitness, and for their self-reported physical activity throughout the entire day. Results of two process measures related to the implementation of the PE intervention are also presented.

METHODS

CATCH Overview

CATCH, supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health, was implemented in four study center locations throughout the United States: San Diego, California; New Orleans, Louisiana; Minneapolis, Minnesota; and Austin, Texas. The New England Research Institutes near Boston, Massachusetts, served as Coordinating Center for the main trial phase. Third grade students in 96 public elementary schools during the fall of 1991 were recruited into the study and followed through the fifth grade. Baseline measurements were conducted from September 1991 to February 1992 when the children were in the third grade. Upon completion of baseline, 24 schools at each study site were randomized into one of two arms of the study: measurement only (10 per site, 40 total) and intervention (14 per site, 56 total). Intervention schools were further randomized into two conditions: school-based intervention (7 per site, 28 total) and school-based plus family intervention (7 per site, 28 total).

Table 1 presents information on the overall numbers of students, classroom teachers, and physical education specialists who participated in CATCH activities by grade level. At baseline, 5,106 third-grade children (mean age 8.76 years) had blood analysis completed for lipid assessment, and these are considered the study cohort for individual student analyses. Table 2 identifies the numbers of children in the defined cohort at baseline by site, ethnicity, and gender.

The total CATCH intervention included a food service intervention, a physical education program (CATCH PE), classroom curricula promoting cardiovascular health, a tobacco curriculum and school policy, and a home/family component.[20] Process measures were obtained throughout the study,[21] and outcomes were assessed during the spring of fifth grade, ending in June 1994. Appropriate institutional, school site, parent, and child consents were obtained for the various intervention and measurement components, and a Data and Safety Monitoring Board provided oversight throughout the entire study.

CATCH PE Goals

While several lessons in the classroom curricula (i.e., *Hearty Heart and Friends*, *GO for Health-4: Taking Off*, and *GO for Health-5: Health Trek*) and some family activities were created to increase motivation, behavioral skills, and attitudes toward physical activity,[20] CATCH PE was an experiential program designed to modify and improve existing required PE classes. The goals of CATCH PE were to promote children's enjoyment of and participation in moderate-to-vigorous physical activity (MVPA) during PE classes and to provide skills to be used out of school and throughout life.[22] As part of the contract to participate, intervention schools agreed to provide at least 90 min of CATCH PE per week spread over a minimum of three sessions per week. While using appropriate teaching methods and modeling enthusiasm for an active lifestyle, teachers were to engage students in MVPA during at least 40% of the physical education class period.

CATCH PE Components and Process

The major intervention components included: (a) CATCH PE curriculum and materials, (b) teacher training, and (c) on-site consultation to teachers. This intervention package was standardized across the four sites, and extensive efforts were taken to ensure that the PE curriculum, training, follow-up visits, materials, and equipment were similar in all intervention schools.[22]

PE curriculum materials, including the *CATCH PE Guidebook*, the *Activity Box*, and supplementary materials, have been described elsewhere.[22] The *PE Guidebook* described the philosophy and goals of the pro-

TABLE 1

Overall Numbers of Students, Classroom Teachers, and Physical Education Specialists Participating in CATCH Activities by Grade Level

		Grade 3	Grade 4	Grade 5
Students	Control	3,743	3,777	3,653
	Intervention	5,352	5,461	5,375
Classroom teachers	Control	160	150	138
	Intervention	216	219	206
Physical education specialists	Control	30	30	37
	Intervention	38	47	44

gram, made recommendations for class structure and management, and provided sample lesson and unit plans. The *Activity Box* consisted of diverse developmentally appropriate activities on color-coded index cards that were organized into instructional units, such as aerobic games, aerobic sports, jump rope, and rhythmic activities. Teachers were encouraged to add their own age-appropriate activities that met CATCH PE objectives. Three videotapes, made to support the aerobic dance and aerobic bench units, were also provided to schools.

Staff development in-service trainings in CATCH PE were offered to all teachers who were responsible for physical education instruction. Classroom teachers were solely responsible for the physical education that their classes received in California schools. In the other three locations various patterns of responsibility emerged, depending upon district and individual school policies, and there was little change during the 3 years of the study. In Texas schools, a physical education specialist typically provided to a class two PE lessons per week while the classroom teacher taught one.

Third-grade teachers responsible for physical education received a full day of training that included instruction and modeling in both PE curriculum content and pedagogical skills. In subsequent years, fourth- and fifth-grade teachers received a full day of training at the beginning of the school year and a half-day booster at midyear. Physical education specialists, most of whom taught CATCH PE for all 3 years, attended 94.3% of training sessions for which they were eligible. Not all classroom teachers were responsible for physical education, and if they taught CATCH PE it was generally for one grade level only. The mean attendance rate for classroom teachers at PE training sessions was 60.5%.

Following initial training, CATCH PE consultants provided on-site follow-up approximately every 2 weeks. During the 2.5 years, consultants made 3,089 documented school visits, averaging 55.3 per school and 51.7 min in length. Consultants performed various roles during visits, including giving feedback to teachers, modeling new lesson segments, team teaching, and providing motivation and technical support.

Measures

School Level

System for observing fitness instruction time (SOFIT). SOFIT was designed to evaluate the amount of time children spend in moderate to vigorous physical activity while simultaneously assessing the lesson context of PE classes. The development and validation of this direct observation instrument have been described previously.[23, 24] SOFIT activity codes correlate highly with accelerometer (Caltrac) readings[25] and have been calibrated through heart rate monitoring, making it possible to estimate caloric expenditure due to physical activity.[22]

SOFIT observations were scheduled in each of the

TABLE 2

Numbers of Children in the Defined CATCH Cohort at Baseline by Race, Gender, and Site

	Caucasian		African-American		Hispanic		Other		
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Total
California	507	458	44	52	107	111	56	44	1,379
Louisiana	510	390	174	188	11	12	10	4	1,299
Minnesota	609	509	18	21	5	13	19	43	1,237
Texas	268	279	77	100	222	227	8	10	1,191
Total	1,894	1,636	313	361	345	363	93	101	5,106

96 schools during two randomly selected weeks each semester of the study (six measurement periods). All assessors were certified in the use of the instrument, and periodically their ability to maintain observer accuracy was assessed through the coding of "gold-standard" videotapes. In the field, approximately 13% of SOFIT lessons during each measurement period were coded simultaneously by two independent observers. Reliability coefficients between independent observers were found to be very high, ranging between 0.94 and 0.99 for all activity and lesson context variables.

Physical activity record of classes (PARC). The frequency and duration of physical education lessons provided for individual classes was completed by homeroom teachers on a PARC form.[22] This instrument was administered in all control and intervention schools over the 3 years of the study during 2 weeks randomly selected each semester (4 weeks per year).

Individual Level

Nine-minute run. Fitness was assessed by a group-administered 9-min distance run, a measure shown to be a reliable field method of estimating cardiorespiratory fitness.[26] The test–retest reliability coefficient of the run was 0.90 for a cohort of third-grade children. The test was administered in the fall of 1991 (third grade) and again in the spring of 1994 (fifth grade). The run was conducted outdoors during favorable weather conditions on a flat 220-yd oval marked by a premeasured nylon rope and orange cones placed every 20 yd. Students received practice and instruction in running skills and tactics on a day prior to testing. Prior to running, children participated in a group warm-up consisting of calisthenics and general stretching. Three assessors (lap counters) each then took from three to seven children to a separate starting point on the oval to wait for the coordinator to start the run. They assigned numbered jerseys to the children, checked for untied shoelaces, and reviewed test procedures and pacing tactics. During the run, lap counters provided encouragement and tallied each lap their children completed. At the end of the run, the number of laps completed by a child plus any additional cones he/she reached in the 9 min were converted to yards.

Self-administered physical activity checklist (SAPAC). Children's self-assessed participation in physical activity throughout the previous day, both in and out of school, was collected during the spring of the fifth grade, the final measurement period. The instrument has been validated on a multiethnic population of fifth-grade boys and girls similar to the CATCH cohort.[27] SAPAC physical activity measures correlated significantly with an interview form of the questionnaire ($r = 0.76$) and with objective heart rate monitoring ($r = 0.60$). Children reported the number of minutes they spent during the previous day in various common physical activities plus selected sedentary pursuits. To obtain a more refined measure of the intensity of activity engagement, MET scores were later assigned to each reported physical activity using values from a compendium.[28]

Process Measures

Throughout the study numerous process measures were used to assess specific aspects of the intervention, including the implementation of program components and teachers' evaluation of staff development and the curriculum and its implementation. The rationale, development, and administration of process measures have been described in detail elsewhere[21, 22] and two measures are briefly reported here. The *Lesson Observation Checklist* assessed the occurrence of 15 important characteristics of a CATCH PE lesson and was completed by trained observers in intervention schools during each of the five intervention semesters and in control schools during both semesters of fifth grade. The *CATCH PE Debriefing Form* assessed teachers' perceptions of and satisfaction with CATCH PE components and was administered to PE specialists and classroom teachers in intervention schools at the end of fifth grade.

Assessor Training

All data were collected by paid CATCH staff who completed training, field practice, and certification for each measure in which they participated. Prior to the third- and fifth-grade data collection periods, senior measurement staff from each study center met for several days in one location for measurement training. These senior staff members, in turn, trained and evaluated all data collectors at their local site according to protocols in the *CATCH Physical Activity Measurement Manual*. Coordinating Center staff visited each study center during the main data collection periods to verify compliance to protocols.

Data Analysis

At the school level, the main endpoints were measures of physical activity (MVPA and estimated energy expenditure) during physical education lessons and the secondary endpoint was the minutes of weekly PE reported by teachers on the PARC. These variables were analyzed by mixed model ANOVA, with time (six measures) and intervention arm (control and intervention) as independent variables. CATCH site was included as a fixed effect (3 *df*), and school, nested within site and intervention arm, was included as a random effect (84 *df*). Two randomly selected weeks of observation for each school provided an additional level of nesting.

TABLE 3

Intervention Effects, Relative to Baseline, for Selected SOFIT and PARC Variables

Variable condition	Baseline mean (SD)	Follow-up mean (SE)[a]	Difference[b]	P
SOFIT (n = 2,096 PE Lessons; C = 801, I = 1,295)				
Lesson length (min)				
C	29.84 (8.39)	29.55 (0.68)	0.94 min	0.24
I	29.23 (10.16)	29.62 (0.58)		
MVPA during lesson (% of time)				
C	34.35 (16.62)	42.28 (1.06)	7.1%	0.0016
I	37.38 (16.79)	51.86 (0.91)		
Estimated lesson energy expenditure (kcal/kg)				
C	2.18 (0.70)	2.26 (0.05)	0.2 kcal/kg	0.002
I	2.21 (0.86)	2.49 (0.06)		
Estimated lesson energy expenditure rate (kcal/kg/min)				
C	0.0732 (.011)	0.0779 (.001)	0.005 kcal/kg/min	0.002
I	0.0757 (.013)	0.0848 (.001)		
PARC (n = 3788 weekly reports; C = 1,576; I = 2,212)				
PE lessons per week				
C	3.2 (1.4)	3.1 (0.1)	−0.05 lessons	0.61
I	3.4 (1.4)	3.2 (0.1)		
PE min per week				
C	96.9 (39.1)	94.3 (2.7)	4.4 min	0.19
I	99.8 (41.6)	101.2 (2.3)		

[a] Adjusted follow-up value (average from semesters 2 to 6) in a mixed model with site, teacher type, and class location as covariate and school as random effect.

[b] Adjusted difference of follow-up from baseline, between intervention (I) and control (C), from the same mixed model.

SOFIT measures were controlled for location (indoors and outdoors) and teacher specialty (PE specialist or classroom teacher). Hypotheses were tested by examining data by time interaction and constructing appropriate contrasts between intervention and control school means before and during intervention. All mixed-model analyses were performed with the MIXED procedure of Statistical Analysis System,[29] with REML estimates for contrasts.

Physical activity endpoints at the individual level included the yards children ran on the 9-min test and their SAPAC scores. Nine-minute run data were analyzed using a mixed-model analysis of variance procedure with the follow-up value as a dependent variable and baseline value as a covariate. The principal independent variable was CATCH intervention arm. CATCH site was included as a fixed effect, and school, nested within site and intervention, was a random effect (3 and 84 *df*, respectively). The child's race and gender were included as covariates, as were interactions between CATCH intervention arm and site, sex, and race. An additional covariate was weather condition. SAPAC data, obtained only during fifth grade, were analyzed in a similar manner, without adjusting for baseline. Since differences in the physical activity measures between the two CATCH intervention conditions (school only, school plus family) were not statistically significant, only comparisons between control (n = 40) and combined school and school plus family conditions (n = 56) are presented.

RESULTS

All 96 of the recruited schools remained in the study over the 3-year study period. Of the defined cohort, 5,106 students who had total cholesterol measured at grade 3 baseline, 4,019 (79%) remained for risk-factor measurement during fifth grade.

SOFIT

A total of 2,096 physical education lessons were observed systematically over 3 years, 801 in control schools and 1,295 in intervention schools. Per measurement period, the number ranged from 292 to 378, with an average of 3.34 and 3.85 lessons being observed in each control and intervention school, respectively. The results for the school effects of CATCH PE on SOFIT measures are shown in Table 3. Relative to the baseline period, intervention lessons during the subsequent five semesters were 0.9 min longer than control lessons, a nonsignificant difference. After staff development, however, children in intervention schools engaged in more MVPA during lessons than those in control schools (51.9% vs 42.3% of lesson time, P = 0.002). This represents a 39% increase in lesson MVPA from baseline for intervention schools, while control schools

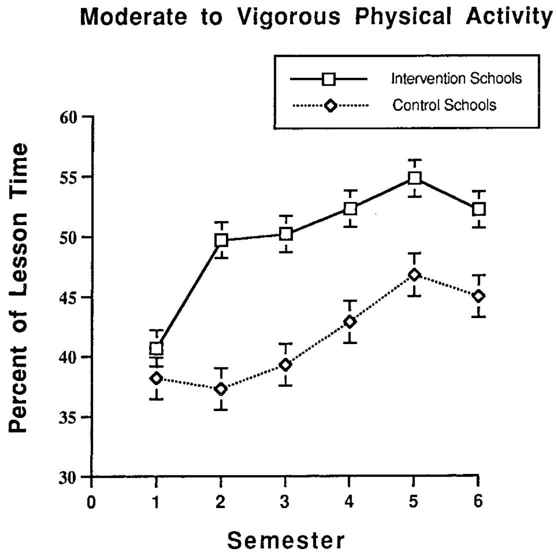

FIG. 1. Moderate-to-vigorous physical activity observed during physical education lessons in intervention and control schools over six semesters. (Adjusted mean ± SE).

increased by 23%. Compared to controls, children in intervention schools also had a higher estimated energy expenditure (2.49 kcal/kg vs 2.26 kcal/kg, P = 0.002) and a higher energy expenditure rate (0.0085 kcal/kg/min vs 0.0078 kcal/kg/min, P = 0.002) per lesson. The percentages of lesson time children were engaged in MVPA and vigorous physical activity are displayed by semester in Fig. 1.

PARC

Based on data from 3,788 PARC reports submitted by homeroom teachers over the 3 years, weekly PE frequency, weekly total PE minutes, and PE minutes by teacher type were assessed as dependent variables in separate mixed-model analyses. The number of PARC reports per measurement period ranged from 580 to 670, with an average of 6.57 and 6.58 coming from each control and intervention school, respectively.

The frequency and duration of physical education lessons by intervention arm are displayed in Table 3. Both control and intervention schools offered slightly fewer PE lessons per week during the follow-up period than at baseline; however, the reduction was not significantly influenced by intervention arm. During follow-up intervention schools provided 6.9 min more of PE per week than controls, but within approximately the same number of lessons. Further analysis, not illustrated in the table, indicated that this change resulted primarily from classroom teachers in intervention schools teaching approximately 10 more min of PE per week during the intervention than they did at baseline (P = 0.037).

Nine-Minute Run

Table 4 displays, relative to baseline, the number of yards completed on the 9-min run by children in control and intervention schools. Children increased the distance they ran in 9 min from third to fifth grade, with those in intervention schools increasing 18.6 yards more than those in control schools. This difference was not statistically significant.

Gender-by-intervention arm interactions and race-by-intervention arm interactions were not significant, indicating no differential effects of the intervention by gender and race. There was, however, a significant gender difference in yards increased from baseline, with boys gaining approximately 66 yd more than girls (P = 0.0001). Site differences were apparent, with children in California and Minnesota having greater increases than those in Louisiana and Texas.

SAPAC (Daily Physical Activity)

SAPAC was completed only during spring of grade 5 (measurement period 6), and 3,239 cohort children reported. Four separate dependent variables were analyzed: physical activity minutes, MET-weighted physical activity minutes, vigorous physical activity minutes (minutes during which students reported "breathing hard most of the time"), and MET-weighted vigorous physical activity minutes. Results for these variables are presented in Table 5. MET-weighted values were computed by multiplying the minutes spent in a physical activity by its MET value obtained from an established compendium.[28]

Children in intervention schools reported engaging in significantly more vigorous physical activity minutes (58.6 vs 46.5; P = 0.003) and MET-weighted vigorous minutes (339.5 vs 270.3; P = 0.003) per day than controls. Meanwhile, children in control schools reported approximately 9 min of physical activity and 43 MET-weighted physical activity min more per day than children in intervention schools; these differences were not statistically significant.

Although not presented in the table, boys reported being significantly more physically active than girls on all four variables. For example, they engaged in more physical activity minutes (159 vs 140; P = 0.0001) and more vigorous physical activity minutes (60 vs 46; P = 0.0001). Child gender-by-intervention arm interactions were nonsignificant, indicating there were no differential effects for boys and girls by the intervention. Significant site differences were evidenced, with children from California and Minnesota typically reporting both more physical activity and more vigorous activity than those from Louisiana and Texas.

Lesson Observation Checklist

The checklist was completed during 1,180 lessons in intervention schools over the 3 years. Observations

TABLE 4

Number of Yards Completed in 9 Min by Children in Intervention and Control Schools

School condition	N[a]	Baseline mean ± SD[b]	Follow-up mean ± SE[c]	Difference	P
C	1,294	1,428.5 ± 240.45	1,503.2 ± 11.42	18.6 yd	0.21
I	1,920	1,432.3 ± 239.05	1,521.9 ± 9.70		

[a] Number of paired observations between baseline and follow-up.
[b] Unadjusted means and standard deviation.
[c] Adjusted means controlling for baseline values, weather conditions, site, gender, and race.

indicated that teachers implemented lessons that highly conformed to CATCH objectives. Relatively low frequencies, however, were noted for teachers conducting a cool-down during lessons (mean = 52.0% of lessons) and for children being prompted or rewarded for out-of-school physical activity (mean = 6.1% of lessons).

The checklist was also completed in 275 additional lessons in control schools during grade 5, allowing for a comparison between intervention and control lessons during this period. A mixed-model analysis was performed while controlling for site, semester, class location (indoor or outdoor), teacher type (PE specialist or classroom teacher), and school. Results indicated lessons in intervention schools were significantly higher on the following five characteristics: (a) students were encouraged to be physically active ($P = 0.0001$), (b) half or more of the class was engaged in MVPA for at least 40% of class time ($P = 0.0001$), (c) lessons had an adequate child-to-equipment ratio ($P = 0.005$), (d) the lesson included a warm-up ($P = 0.0001$), and (e) the lesson included a cool-down ($P = 0.0001$).

Teacher Satisfaction with CATCH PE

Debriefing questionnaires were completed by 138 teachers who taught CATCH PE during fifth grade. Ratings on a 7-point Likert-type scale (1, lowest; 7, highest) indicated teachers were highly satisfied with various CATCH PE intervention components and they would recommend the program to other elementary school teachers. Mean ratings included: (a) overall impression, 6.07; (b) beneficial to students, 6.06; (c) quality of in-service training, 6.29; (d) *Guidebook*, 6.37; (e) *Activity Box*, 6.53; (f) CATCH PE consultant helpfulness, 6.65; and (g) would recommend CATCH PE to others, 6.07. PE specialists found it easier to prepare for ($P = 0.006$) and teach ($P = 0.003$) CATCH PE lessons than classroom teachers.

DISCUSSION

With few exceptions,[24, 30] the random assignment of schools to treatment conditions has not been possible in previous studies that examined the effects of PE curriculum and staff development programs on the physical activity of children, and this was the first randomized trial to be implemented in diverse geographical and cultural regions. Using direct observation to study physical education was a major strength of this study, and the results confirm that an intervention in the existing school environment can promote an in-

TABLE 5

Reported Daily Minutes and MET-Weighted Minutes in Vigorous Physical Activity and in General Physical Activity by Fifth-Grade Children in Intervention and Control Schools

Condition	N	Mean ± SE[a]	Difference (SE)	P[b]
Vigorous physical activity minutes (time spent breathing hard)				
C	1,309	46.5 ± 3.1		
I	1,930	58.6 ± 2.6	12 (4)	0.003
MET-weighted vigorous physical activity minutes				
C	1,309	270.3 ± 18.1		
I	1,930	339.5 ± 15.1	69 (23)	0.003
General physical activity minutes				
C	1,309	154.8 ± 4.9		
I	1,930	145.5 ± 4.1	−9 (6)	0.15
General MET-weighted physical activity minutes				
C	1,309	845.7 ± 27.4		
I	1,930	801.8 ± 22.8	−43 (0.21)	0.22

[a] Adjusted mean and standard error from analyses of variance.
[b] From analyses of variance, controlling for site and gender.

crease in the amount of moderate-to-vigorous physical activity children engage in during class time. Active PE time increased from baseline by 39% in the intervention schools (and 23% in controls), while maintaining the CATCH goals of three PE lessons per week (3.2 achieved) and 90 min per week of PE time (101 min achieved). By surpassing the 50% of PE class time spent in MVPA, the intervention schools met the Year 2000 goal[17] set for school PE, whereas the control schools did not. Thus, CATCH provides a curriculum and staff development model for increasing physical activity in PE programs around the nation.

The increase, relative to control children, in the amount of time intervention children spent in physical activity during PE classes was accompanied by a nonsignificant increase in the distance (18.6 yd) they ran in 9 min. Given that the PE intervention emphasized activity engagement rather than fitness and fitness training, this is an interesting but unclear finding. The small magnitude of effects in the 9-min run performance could be due to several factors, most notably that physical activity is only partially correlated with fitness. Therefore, the significant difference in vigorous activity observed at fifth grade would not necessarily be reflected in improved 9-min run performance.

Similar to other studies using timed distance runs,[31] boys performed better than girls and gender differences increased with age (by 66 yd in 9 min). It is believed that most gender differences in distance runs before puberty are environmentally induced (e.g., physical activity engagement levels, practice, societal expectations), and after puberty biological influences (e.g., adiposity, muscle mass, leg length) add to these differences. The CATCH PE curriculum and staff development were designed to modify some environmental conditions that might affect equity, but were not sufficiently powerful to significantly modify the increasing gender difference in the distance completed on the fitness test.

A study limitation is that the SAPAC was administered only once, during spring of fifth grade, so changes in the overall daily activity patterns by children in the intervention arms cannot be compared over time. During this one measure, intervention children reported engaging in significantly more daily minutes of vigorous physical activity (in which they "breathed hard most of the time"), while control children reported slightly more daily minutes of general physical activity. The reasons for this are not clear. One could postulate that intervention children expended their theoretical daily expenditure of energy more quickly by engaging in more vigorous activity or perhaps they had a better understanding of what was included in vigorous activity and this was reflected in their reports. The current analysis did not identify precisely where activity occurred. There is, however, a strong likelihood that the increased daily vigorous physical activity reported by intervention students came from out-of-school engagement, because their schools did not significantly increase the frequency or length of in-school offerings of either physical education or recess.

The finding that fifth-grade boys were more physically active than girls is consistent with the literature, with most studies reporting males to be more active than females at all ages.[4, 32] In addition to boys typically having more opportunities to engage in youth sports outside school,[12] gender differences in physical activity engagement may be influenced by sociocultural beliefs and expectations.[31] School physical education programs may play an important role in reducing gender differences in physical activity engagement, such as by providing more equitable opportunities for engagement in health-related physical activity at school and promoting the development of skills and attitudes that encourage both males and females to make physical activity a regular part of their lifestyle. The CATCH PE curriculum and staff development program were designed to promote equitable opportunities within physical education lessons; however, additional analyses of the SOFIT data will be needed to determine whether this in-class goal was reached.

The effect of CATCH was accomplished through the implementation of a developmentally appropriate activity-based program and improved instruction and class management. This is in contrast to increasing the length or frequency of PE classes, since the school day cannot easily be modified. Systematic observations revealed lessons in intervention schools were not only more physically active, but differed from those in control schools on a number of important features. Nearly half of the lessons in this study were taught by classroom teachers, so the intervention was effective for the regular classroom teacher as well as the PE specialist. These findings have implications for both the educational preparation and the in-service staff development of all teachers who will be teaching physical education at the elementary level.

In summary, schools play an important role in helping to meet the nation's objectives for health-related physical activity. The CATCH PE program demonstrated that it is possible to implement, using existing time and staff for school PE classes in four geographic and ethnically diverse communities, a standardized intervention to increase the amount of moderate-to-vigorous physical activity engaged in by children during physical education. This is the first multisite trial to show this school-level effect. Since the results showed the program can be implemented effectively by both PE specialists and classroom teachers, CATCH PE provides a model for dissemination among the schools across the nation.

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