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## Long-Term Effects of a Physical Activity Intervention in High School Girls

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### Abstract

**Background**—Physical activity decreases during childhood and adolescence, and physical activity levels are significantly lower in females than males, particularly during adolescence. Schools are attractive settings in which to implement interventions designed to promote physical activity in girls and young women, but few studies have tested the sustained effects of such interventions.

**Design**—Cross-sectional. Data were collected in 2002–2003 and analyzed in 2006–2007.

**Setting/Participants**—1594 adolescent girls in 22 high schools.

**Intervention**—The intervention, Lifestyle Education for Activity Program (LEAP), was designed to increase physical activity in 9<sup>th</sup> grade girls through two channels: changes in instructional practices and changes in the school environment. This study (LEAP 2) examined the extent to which effects of the intervention were maintained when the girls were in 12<sup>th</sup> grade.

**Main Outcome Measures**—Number of 30-minute blocks per day of vigorous physical activity.

**Results**—Girls in the intervention schools that most fully implemented and maintained the intervention were more likely than girls in the other schools to participate in an average of one or more blocks of vigorous physical activity per day ( $p=0.04$ ; OR=1.49; 95% CI=1.01, 2.20).

**Conclusions**—A comprehensive physical activity intervention that is fully implemented and maintained can increase participation in vigorous physical activity by high school girls.

### INTRODUCTION

Physical activity decreases steadily during childhood and adolescence,<sup>1</sup> and physical activity levels tend to be lower in girls than boys.<sup>2</sup> Accordingly, there is a great need to understand physical activity behavior in adolescent girls. Few studies have tested interventions designed specifically for girls,<sup>3–7</sup> and very few have shown positive intervention effects on physical activity.<sup>6, 7</sup> The Lifestyle Education for Activity Program (LEAP), a comprehensive school-

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based intervention that promoted physical activity in high school girls, is one of the few controlled intervention trials in which a positive effect on overall physical activity has been demonstrated.<sup>8</sup> LEAP was designed specifically for high school girls, and the intervention was adapted to the characteristics of each intervention high school. In the main LEAP study, 45% of girls in the intervention schools, compared to 36% in the control schools, reported vigorous physical activity during an average of one or more 30-minute blocks per day over 3 days.<sup>8</sup>

The LEAP investigation also provided the opportunity to observe sustained intervention effects. Girls in the intervention schools were exposed to the intervention as 9<sup>th</sup> graders, and many of them attended the intervention high schools through 12<sup>th</sup> grade, with continued exposure to the environmental component of LEAP. Hence, there was an opportunity to determine if the intervention effect observed in 9<sup>th</sup> grade would be sustained in 12<sup>th</sup> grade. The purposes of this study, LEAP 2, were to test the hypothesis that a sustained intervention effect on physical activity would be evident in 12<sup>th</sup> grade girls (continued environmental exposure) who had been exposed to the LEAP intervention as 9<sup>th</sup> graders (instructional and environmental exposure) and to determine whether 12<sup>th</sup> grade girls attending the intervention schools that most fully implemented and maintained the intervention were more physically active than girls attending the other intervention schools.

## METHODS

### Subjects and Setting

Twenty-four schools (12 intervention and 12 control) participated in baseline (8<sup>th</sup> grade) data collection, intervention, and immediate post-intervention (9<sup>th</sup> grade) data collection during the LEAP study. One control school and one intervention school could not participate in the 12<sup>th</sup> grade data collection. Therefore, 22 schools were available to participate in LEAP 2.

A total of 1594 12<sup>th</sup> grade girls participated in the follow-up measurement protocol. Seventy-five percent (1189) of the girls reported attending the same school during 9<sup>th</sup> grade. Girls with missing data for the physical activity measure ( $n=81$ ) or height and weight ( $n=18$ ), and those who reported race other than white or African American ( $n=43$ ) were excluded from the analyses. Thus, data from 1047 girls were available for the analyses. Data were collected in 2002–2003 and analyzed in 2006–2007.

### Study Design

A cross-sectional study design, with school as the unit of analysis, was applied in analyzing the physical activity data collected in 12<sup>th</sup> grade girls attending the 22 participating schools. Analyses were conducted with schools categorized in four different ways. First, the 11 schools that had implemented the LEAP intervention were compared with the 11 control schools. Second, three groups of schools were created by dividing the intervention schools into two subgroups, six that had implemented the intervention with high fidelity (high implementers) and five that had implemented the intervention with less fidelity (low implementers). Intervention fidelity was determined on the basis of process evaluation data collected when the girls were in 9<sup>th</sup> grade. High and low implementation groups were compared with the control group (11 schools). Then, two groups of schools were formed on the basis of maintenance of the LEAP intervention as determined at the 12<sup>th</sup> grade follow-up. The third analysis compared these two groups of schools, high intervention maintenance (high maintainer) schools and low intervention maintenance (low maintainer) schools, and control schools. In the fourth analysis the four high maintainer schools were compared with a group consisting of all the other schools (18 schools).

## Intervention

The intervention, known as LEAP (Lifestyle Education for Activity Program), used a facilitative approach to increase support of physical activity for girls.<sup>9</sup> The intervention focused on “essential elements” of the intervention components and operated through two primary channels: changes in instructional practices and changes in the school environment.<sup>8, 9</sup> The instructional channel involved changes in the content and delivery of physical education and health education. LEAP physical education (LEAP PE) was designed to enhance physical activity self-efficacy and enjoyment, to teach the physical and behavioral skills needed to adopt and maintain an active lifestyle, and to involve girls in moderate-to-vigorous physical activity during 50% or more of class time. LEAP PE was guided by seven required “essential elements,” including a (1) physically active and (2) gender-specific (and, in many cases, gender-separate), girl-friendly, choice-based approach characterized by (3) cooperative activities and (4) small group methods that focused on (5) lifelong physical activities and (6) activities that girls and young women enjoy. In addition, girls learned (7) behavioral skills needed to adopt and maintain an active lifestyle.<sup>9</sup> Most girls were exposed to this component of the intervention in 9<sup>th</sup> grade.

The environmental channel was designed to create a school environment that supported physical activity for girls. Three environmental change “essential elements” were required: school principal support of LEAP, a school physical activity team (LEAP Team), and prominent presentation of messages promoting physical activity in the school. Six additional elements were recommended but not required (because of resource limitations in some schools): (1) faculty and staff health promotion program (role modeling by faculty and staff), (2) opportunities for girls to be active outside of PE, (3) promotion of physical activity by the school nurse, (4) reinforcement of physical activity messages in health education classes, (5) family involvement in physical activity, and (6) community agency involvement in school physical activity.

## Process Evaluation, Assessment of Intervention Elements at Follow-up, and Assessment of Secular Trends

**Process Evaluation**—A comprehensive evaluation was conducted during the active LEAP intervention. As reported elsewhere,<sup>10</sup> multiple data sources were used to rate schools on their level of implementation of the LEAP required and recommended essential elements. At the end of the LEAP intervention (participants’ 9<sup>th</sup> grade year), six schools were classified as high implementers and five as low implementers.<sup>10</sup>

**Follow-up Assessment**—During the follow-up phase (participants’ 12<sup>th</sup> grade year), a comprehensive assessment was used to determine the extent to which the key LEAP intervention essential elements had continued. Three data sources (objective PE observation, interviews with PE teachers, and focus groups of current 9<sup>th</sup> grade students) were used to assess instructional practices at follow-up, and three data sources (objective PE observation, interviews with PE teachers, and interviews with former LEAP Team members) were used to assess environmental elements at follow-up. Instructional practice at follow-up was defined as having a minimum of four of the seven instructional essential elements. Environmental practice at follow-up was defined as having at least two of four environmental essential elements; the four included the three required environmental essential elements plus a fourth element (adult modeling of PA through a faculty-staff health promotion program) that has been identified through the process evaluation as a crucial element.<sup>10</sup> Assessment of overall follow-up practice required evidence of activity from a minimum of four out of six possible data sources for LEAP instructional and environmental elements combined. Through this process schools that continued LEAP instructional and environmental practices were identified. Schools were classified as high maintainers if they (1) were classified as high implementers at the end of the

intervention and (2) were identified as having evidence of the key LEAP instructional and environmental essential elements at follow-up. Four schools met the criteria as high maintainers.

**Baseline Comparisons and Secular Trends**—As reported elsewhere,<sup>10</sup> the Organizational Assessment, which consisted of interviews with school administrators, was conducted annually in the intervention and control schools and was used to assess organizational differences at baseline and the influences of secular trends at follow-up. There were no baseline differences between intervention and control schools on organizational resources that could impact the intervention. To assess secular trends, three items were each rated on a 4-point scale ranging from 0 (lowest level of participation or recognition) to 3 (highest level of participation or recognition); the three items were summed to create a secular trends score for each school. The items were: extent of PE teacher participation in South Carolina PE Institute training, PE program recognition for South Carolina PE Institute Awards, and school recognition for a South Carolina Healthy Schools Award. The 22 schools were rated based on the total score, with 8 schools in the high group (scores 3 to 9) and 14 in the low group (scores 0 to 2).

**Physical Activity**—The 3-Day Physical Activity Recall (3DPAR), which was administered to the girls in the 12<sup>th</sup> grade, is described elsewhere.<sup>8, 11</sup> Briefly, girls reported their activities and the intensities of those activities for three days, using a time grid, lists of activities, and definitions of activity intensities. Trained research assistants administered the 3DPAR. Activities were assigned MET (metabolic equivalent) values obtained from the Compendium of Physical Activities.<sup>12</sup> Vigorous physical activity (VPA) was defined as an average of one or more 30-minute blocks of VPA ( $\geq 6$  METs) per day. As previously reported, the LEAP intervention positively influenced the prevalence of meeting this VPA standard in 9<sup>th</sup> grade girls.<sup>8</sup>

### Statistical Analysis

All statistical analyses were conducted using SAS version 9 (Research Triangle Institute, Research Triangle Park NC, 2002). To evaluate the impact of the intervention on the prevalence of vigorous physical activity, a series of logistic regression analyses were conducted using Proc Mixed and Proc Glimmix; school was treated as a random variable nested within intervention group for all analyses. Models were considered with and without statistical adjustment for potential confounders.

For the first set of analyses, control and intervention schools were compared.<sup>8</sup> In the second set of analyses, schools were classified as control (11 schools), low implementers (5 schools), and high implementers (6 schools). Because it was hypothesized that the sustained impact would be related to maintenance of the intervention elements at follow-up (with maintenance defined as high implementation at the end of the intervention and documented practice at follow-up), a third set of analyses compared the control schools with high maintainer and low maintainer schools. A fourth set of analyses compared the four high maintainer schools to a combined group of control and low maintainer schools. Two additional models were run for this set of analyses. The first adjusted for secular trend, and the second adjusted for secular trend, BMI and race, since secular trends could attenuate the sustained impact of the intervention.

## RESULTS

Fifty-four percent of the 1047 girls were African American, mean age of the girls was 17.7 years, and 63% of the girls had a least one parent with greater than a high school education (Table 1).

Table 2 shows the results from the first two logistic analyses. In Analysis 1, the schools were grouped by assigned control and intervention status. No differences in the percentages of girls who engaged in  $\geq 1$  block of vigorous physical activity per day were found, with or without adjustment for race and BMI. Analysis 2 compared the girls according to school implementation status (control schools, low implementers and high implementers), based on process evaluation data collected at the end of the intervention.<sup>10</sup> No differences were found among the three groups, regardless of adjustment for BMI and race.

Table 3 shows the results of Analyses 3 and 4. No differences were found among the three groups in Analysis 3. Analysis 4 compared low maintainer intervention schools plus control schools to the high maintainer schools. In the unadjusted model, girls in the high maintainer schools were more likely (OR=1.49; 95% Confidence Interval=1.01, 2.20) to report  $\geq 1$  block of vigorous physical activity per day than girls in the combined group (low maintainer and control schools). These differences bordered on statistical significance after controlling for secular trends ( $p=0.06$ ) and after controlling for BMI and race ( $p=0.07$ ).

## DISCUSSION

The major finding of LEAP 2 was that girls attending high schools that fully implemented a comprehensive physical activity intervention and maintained the key elements of that intervention were more physically active than girls attending other schools in the study. Girls in intervention schools were exposed to the LEAP intervention as 9<sup>th</sup> graders, and active implementation of the intervention was terminated at the end of 9<sup>th</sup> grade. However, personnel in the intervention schools were encouraged to implement the intervention on a permanent basis, and the follow-up assessment indicated that four of the schools that fully implemented the intervention successfully sustained the key elements three years later. The intervention had been conceptualized as an environmental intervention designed to encourage physical activity in female students. The findings of this study suggest that sustained modification of the school environment and instructional practices to encourage and support physical activity can exert a positive influence on girls' physical activity across their entire high school careers. This sustained intervention effect would be expected to provide health benefits for girls during the critical adolescent developmental period. Further, sustained participation in higher levels of physical activity should increase the likelihood that girls will carry a physically active lifestyle into adulthood.<sup>13</sup>

LEAP 2 was unique in a number of ways. It was a large-scale study that initially involved 31 middle schools, 24 high schools, and more than 4000 adolescent girls. Approximately equal numbers of white and African American girls participated, and the participants were diverse in terms of BMI, socioeconomic status, and urban/suburban/rural location. The study used a facilitative approach and "standardized process," rather than "standardized curriculum,"<sup>14</sup> to implement the intervention. Teachers and school staff used a framework of "essential elements" to develop and implement an intervention that fit the environment of their school, and university-based research staff supported them with training, materials, and consultation, an approach consistent with developing school organizational capacity and enhancing sustainability of program efforts.<sup>15</sup> The study involved post-intervention and follow-up measures, the first at the end of the intervention period (the spring of participants' 9<sup>th</sup> grade

year) and the second three years after the active intervention had ended (the spring of the participants' 12<sup>th</sup> grade year).

LEAP was unique in its comprehensive, systematic, and quantitative approach to measuring intervention implementation and secular trends, as well as to examining organizational change in both intervention and control schools at baseline, post-intervention, and follow-up.<sup>10</sup> The “essential elements” of LEAP, defined prior to intervention implementation, served as the framework for the process evaluation and organizational assessments. The investigators also identified at the outset of the study activities and events that could affect implementation or outcomes of the intervention or related factors in the control schools (i.e., secular trends). These assessments allowed for identification of intervention schools that fully implemented and maintained the intervention and control schools that incorporated “LEAP-like” elements into their educational program and environment and to control for outside factors that might influence girls’ physical activity levels.

Few school-based physical activity studies have conducted follow-up assessments to examine maintenance of the intervention or intervention effects. The notable exception is CATCH, which conducted the CATCH-ON study to examine the extent of institutionalization of the CATCH program five years after the original trial ended.<sup>16</sup> In the follow-up of CATCH-PE, students in former intervention schools had maintained the amount of PE time spent in MVPA but time spent in VPA had declined sharply, and because MVPA had increased in the former control schools there were no differences between the intervention and control schools at follow-up.<sup>17</sup> The LEAP follow-up and CATCH-ON differed in several ways, including target group (high school vs. elementary school students), intervention focus (organizational change vs. curriculum), and follow-up measurement (individual PA and organizational measures which included a secular trend assessment vs. individual PA in PE and teacher-reported use of CATCH materials).

This study had a number of strengths and some weaknesses. Strengths included the large number of schools and participants, the nearly equal numbers of African American and white girls, the extensive process evaluation, and the long-term follow-up, which covered the period from 8<sup>th</sup> through 12<sup>th</sup> grades. Weaknesses included the use of a self-report measure of physical activity and the fact that only four of the intervention schools met the criteria for high maintainer schools. In addition, we cannot preclude that baseline characteristics of the four schools influenced their ability to implement and maintain the intervention, although our data indicate that they did not.

In conclusion, this study provides evidence that a multi-component school-based intervention that is maintained can exert a long-term, positive influence on students’ physical activity. While the present study was conducted in high schools and was targeted at girls, the core findings should apply to both boys and girls at all school levels. The findings suggest that an appropriately modified school environment can increase overall physical activity in youth.

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**Table 1**  
Characteristics of 12th grade girls (N=1047) from 22 high schools

Variable	Mean (SD)
Age, years	17.7 (0.6)
Body mass index, kg/m <sup>2</sup>	25.0 (6.4)
	Percent
African American	54.4
Parent education, >high school	63.5
Intervention schools	55.4

Prevalence (SE) of participation in  $\geq 1$  block of vigorous physical activity in girls attending schools grouped as control and intervention (Analysis 1) and as control, low intervention implementation, and high intervention implementation (Analysis 2)

**Table 2**

<b>Analysis 1</b>	<b>Control (11 schools) n=467</b>	<b>Intervention (11 schools) n=580</b>	<b>p value</b>		
Unadjusted	36.2(2.9) %	35.4 (2.7) %	0.84		
Adjusting for race and BMI	35.8(2.7) %	36.7 (2.5) %	0.81		
<b>Analysis 2</b>	<b>Control (11 schools) n=467</b>	<b>Low Intervention Implementation (5 schools) n=254</b>	<b>High Intervention Implementation (6 schools) n=326</b>	<b>p value group</b>	<b>p-value trend</b>
Unadjusted	36.2 (2.9) %	33.4 (4.1) %	37.0 (3.7) %	0.80	0.80
Adjusting for race, BMI	35.8 (2.8) %	36.3 (3.9) %	37.0 (3.5) %	0.97	0.79

BMI, body mass index

School was treated as a random variable.

Table 3

Prevalence (SE) of participation in  $\geq 1$  block of vigorous physical activity in girls attending control, low intervention maintenance, and high intervention maintenance schools

Analysis 3	Control 11 schools (n=467)	Low intervention maintenance 7 schools (n=368)	High intervention maintenance 4 schools (n=212)	p value group	p value trend
Unadjusted	36.1 (2.7) %	31.0 (3.0) %	43.4 (3.9) %	0.06	0.13
Adjusting for race and BMI	35.7 (2.6) %	33.2 (3.0) %	42.6 (3.8) %	0.18	0.15
Adjusting for high vs. low secular trend	36.9 (2.6) %	32.0 (3.0) %	43.5 (3.8) %	0.08	0.17
Adjusting for secular trend, BMI and race	36.6 (2.6) %	34.4 (3.0) %	42.7 (3.7) %	0.24	0.19

  

Analysis 4	Control and low intervention maintenance 18 schools (n=835)	High intervention maintenance 4 schools (n=212)	p value
Unadjusted	33.9 (2.0) %	43.4 (3.9) %	0.04
Adjusting for race and BMI	34.7 (1.9) %	42.6 (3.8) %	0.07
Adjusting for high vs. low secular trend	34.8 (2.1) %	43.4 (3.9) %	0.06
Adjusting for secular trend, BMI and race	35.7 (2.0) %	42.7 (3.6) %	0.10

BMI, body mass index

School was treated as a random variable.