Effects of a Life Skills Intervention for Increasing Physical Activity in Adolescent Girls

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Background: Although adolescence is a time when physical activity levels decline, few interventions have targeted high school–aged girls in the school setting.

Objective: To evaluate the effects of a life skills–oriented physical activity intervention for increasing overall physical activity in high school–aged girls.

Design: Randomized controlled trial.

Setting: Baltimore magnet high school.

Participants: A total of 221 ninth-grade girls, 83.0% of whom were African American.

Intervention: Participants were randomized to an 8-month physical intervention conducted in physical education class or to a standard physical education class (control).

Main Outcome Measures: Self-reported estimated daily energy expenditure (physical activity), self-reported sedentary activities (television viewing and computer or internet use), cardiorespiratory fitness, and selected cardiovascular disease risk factors.

Results: Intervention classes spent 46.9% of physical education class time in moderate to vigorous activity compared with 30.5% of time for control classes (P < .001). There were no significant between-treatment group differences for mean daily energy expenditure (P = .93), moderate-intensity energy expenditure (P = .77), or hard to very hard energy expenditure (P = .69). The proportion of participants who spent 3 or more hours viewing television during school days declined from 22.3% to 17.0% in the intervention group, but remained at 26.7% for the control group (P = .03). Both groups improved their cardiorespiratory fitness (P < .001).

Conclusion: A life skills–oriented physical education curriculum may need to be combined with other approaches to increase the magnitude of effects on physical activity behavior in predominantly African American high school–aged girls.

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is critical to establish health attitudes and behaviors that are likely to be carried into adulthood. Interventions focused at this age group can reduce the burden of physical inactivity–related chronic diseases that begin in adolescence and typically present in adulthood.

This trial tests the effectiveness of a life skills–oriented physical activity intervention, conducted in PE class by a teacher hired by the project, for increasing physical activity and fitness in ninth-grade girls. We hypothesized that participants in the intervention would increase physical activity and fitness compared with control subjects. The trial extends previous work by providing an intervention that targeted all students regardless of risk factor status.

## METHODS

### PARTICIPANTS

Ninth-grade girls enrolled in an all-girl public magnet high school and who were also enrolled in 2 consecutive semesters of required PE were eligible to participate. Of the entering ninth-grade class, approximately two thirds were eligible based on their PE class schedules. Exclusion criteria were as follows: (1) being excused from meeting Maryland state PE requirements, (2) being pregnant or breastfeeding, (3) planning to leave the geographic area, and (4) having a sister enrolled in the trial. Participants were recruited using multiple strategies, such as presentations at parent and student orientation meetings, mass mailings to parents, and classroom presentations to students.

Students were recruited over 3 successive years. Informed consent was obtained from a parent or legal guardian, and child assent was provided. The study was approved by the institutional review boards at The Johns Hopkins University and the University of Maryland.

### MEASURES

Assessments were made by trained study staff over a 4- to 5-week period before randomization in a dedicated classroom that was refitted as a project office. Measurements were obtained primarily during PE class, although assessments were also made before and after school and during lunch. Measurements were obtained in September (baseline) and, for follow-up, during the last 2 months of the spring semester (April and May). Self-report physical activity, clinical assessments, submaximal fitness, and questionnaires composed the measurement protocol. After baseline data collection was completed, participants were randomized into intervention or control PE classes. This required some participants to transfer from their current PE class to the alternate one occurring at the same time.

#### Estimated Daily Energy Expenditure

Daily energy expenditure, the trial’s primary outcome, was determined from the 7-day Physical Activity Recall. The instrument is widely used to determine change in physical activity interventions. The 7-day Physical Activity Recall is an interviewer-administered instrument that estimates daily expenditure by asking participants to estimate the amount of time spent sleeping and doing physical activities of moderate (eg, brisk walk), hard, and very hard (eg, run) intensity over the previous 7 days. The survey was designed for adults, but it has been validated and used with children. Test-retest reliability was 0.59 for a sample of eighth graders and 0.81 for eleventh-grade students, and it correlated with another self-report instrument (r = 0.76 for girls), time spent with a heart rate of at least a moderate intensity, and skinfold thicknesses. The daily time frame in which physical activity was recalled was modified to allow for recall to be prompted by the school-day schedule. Weekend days were separated by meals, as suggested by the instrument developers.

#### Cardiorespiratory Fitness

Cardiorespiratory fitness was assessed with a submaximal 3-stage step test designed for adolescents. The protocol was designed for participants to exercise successively at 50%, 59%, and 70% of estimated maximal heart rate reserve by stepping up and down on 3 steps whose heights were calculated to meet the required energy expenditure. Participants stepped up and down at progressive step heights until the test was completed or until the participant reached the target heart rate (70% of estimated heart rate reserve).

Participants’ exercise heart rate was recorded at 2:30, 2:45, and 3:00 of each 3-minute stage. If a student’s average heart rate did not exceed the target heart rate, she proceeded to the next stage. If the target heart rate was achieved, the test was terminated.

A decrease in average heart rate from baseline to follow-up at a given stage was used to assess fitness improvement. A 1- to 2-week test-retest reliability of 21 participants indicated that heart rate was 1 to 3 beats/min lower at the end of a stage during the second administration of the test (difference not significant). Thus, a significant decrease in heart rate indicated fitness improvement rather than familiarity with testing procedures.

#### Sedentary Activities

Time spent in sedentary activities was assessed using selected items from a questionnaire. Participants were asked to estimate how much time they spent (1) watching television, movies, or videotapes (ie, television time); and (2) playing video games, surfing the Internet, e-mailing, or participating in chat rooms (ie, computer time). School days and weekends were queried. Response options were 0 minutes, less than 30 minutes, 30 minutes to less than 1 hour, 1 to 3 hours, and more than 3 hours.

#### Anthropometric and Clinical Variables

Height, weight, and waist and hip circumferences were determined using standard methods. Height was measured to the nearest 0.1 cm and weight to the nearest 0.11 kg. Waist circumference was measured from the horizontal plane at 1 cm above the navel. Hip circumference was measured in a horizontal plane at the site of maximum extension of the buttocks. Four waist and hip circumferences were measured in consecutive order and averaged. Body mass index was calculated as weight in kilograms divided by the square of height in meters. Waist-hip ratio was calculated by dividing the mean waist circumference by the mean hip circumference. Adolescent body mass index, waist circumference, and waist-hip ratio are associated with childhood cardiovascular risk factors and adult overweight or obesity and risk factor status.

Resting blood pressure was measured in the nondominant arm using an automated blood pressure monitor (Dinamap) in a seated position after 5 minutes of rest. Three blood pressure measurements were made, with a 1-minute interval between measures. Three 30-second peripheral pulse rates were also obtained. Measures were averaged.

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Plasma total cholesterol, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol levels were obtained from a venous blood sample drawn after a 12-hour fast. Blood samples were analyzed by a local commercial laboratory (Quest Diagnostics, Lyndhurst, NJ).

**ALTERNATIVE PE INTERVENTION**

The intervention was designed to be congruent with the Social Action Theory, which emphasizes social interdependence, environmental factors, and problem-solving skills. It was taught by a teacher hired by the project. Intervention content included information to make an informed decision about the personal benefits of a physically active lifestyle, develop problem-solving skills, and obtain support from others. Specific strategies that were taught and reinforced included goal setting, problem-solving barriers, communication skills, reinforcement of goal achievement through internal and external rewards, and learning from relevant role models. Skills were taught using class lectures and discussions, small-group discussions, and homework activities. Physical activity self-monitoring was given a strong focus. Students were encouraged to keep weekly exercise logs from which the teacher provided feedback on progress toward goal attainment and reward strategies. All students in class received the intervention, irrespective of whether they were trial participants.

The intervention was also designed to maximize physical activity during PE class. The format was congruent with the school’s PE curriculum—1 semester of individual sports and 1 semester of team sports—taught 5 days per week. Classes were optimized for physical activity by teaching units that were active in nature (eg, soccer instead of softball [personal fitness unit]), breaking skills training into small-group activities, and playing games in small groups (eg, 3-on-3 basketball). Skills training was limited to that needed for competency rather than proficiency. Written tests focused on health-related physical activity and fitness concepts and behavioral skills.

The family support component consisted of a family workshop, monthly newsletters, and adult-child homework assignments. A 2-hour family workshop, scheduled shortly after randomization, featured tips on how parents could provide support to their daughters. As an in-class activity, students worked on skits illustrating support strategies that were videotaped and mailed copies. Families also received a 2-page family support newsletter each month that contained an article on ways families can support physical activity with their daughter.

**STANDARD PE (CONTROL)**

Standard PE class was a curriculum in which students were taught skills in individual and team sports. For example, during the basketball unit, students were taught how to dribble, shoot, and pass, and were tested on concepts such as game rules and defense strategies. Similar to the intervention structure, 1 semester focused on individual sports and the other on team sports. Classes were taught by certified PE teachers employed by the school.

Parents of participants in the standard PE class also received monthly newsletters. Topics were of general health interest and included an article about PE class content that month.

**INTERVENTION FIDELITY**

The percentage of PE class time spent in physical activity was assessed in intervention and control classes using a modification of the System for Observing Fitness Instruction Time. This was used to determine fidelity to the intervention goal of optimizing physical activity in class. Trained assessors determined physical activity levels of selected students in all quadrants of the activity area at 5-minute intervals. Physical activity level was recorded as (1) lying down, (2) sitting, (3) standing, (4) walking, and (5) active. At the class start time, observers mentally divided the activity area into quadrants, identified a student in the northeast quadrant, observed for 10 seconds, then identified another student in the northwest quadrant, observed for 10 seconds, and so on. The process was repeated every 5 minutes. In a 45-minute class period, there were 36 student observations recorded. Thus, there was an opportunity for each student to be observed. The percentage of time in class spent in physical activity was calculated as the number of observations of the categories “walking” and “active” relative to the total number of observations.

**STATISTICAL ANALYSES**

Means and standard deviations were calculated at baseline and follow-up for continuous physical activity, fitness, and secondary outcome variables. Baseline means were examined for comparability between intervention and control groups using unpaired t tests. Mean change and standard errors from baseline to follow-up were calculated after controlling for baseline values and race (African American vs other). To determine the effects of the intervention, an analysis of covariance was used, with change in physical activity as the dependent variable, intervention group as the independent variable, and baseline physical activity and race as the covariates. The same approach was used for secondary outcome variables. Initial models tested for treatment X race interactions; none were significant, so they were not included in the final models. Race was a significant covariate and, thus, was retained. Within-treatment group change was assessed by paired t tests, after controlling for baseline values and race.

For the sedentary activities variables, the proportion of participants who reported 3 or more hours per day of television viewing or video game or Internet use during school days and weekends was computed. To test for intervention effects, between-group differences in the reduction of high prevalence of sedentary activities (≥3 hours) were tested using the Fisher exact test. Within-intervention group differences were assessed using the McNemar test. Initial analyses indicated no differences by race, so data were not stratified to test for race differences.

All analyses were conducted using SAS statistical software, version 9.1 (SAS Institute Inc, Cary, NC). Significance was set at a 2-tailed α of .05.

**RESULTS**

The study flow is displayed in the Figure. Of the 442 students eligible to participate across 3 successive school years, 221 (50.0%) agreed to participate and were randomized. There was greater than 90% power to detect a 1.7-kcal/kg per day treatment group difference (5% change) in daily energy expenditure at follow-up. Common reasons for nonparticipation were the following: did not want to miss PE class to undergo baseline measurements, did not want to provide a blood sample, and did not want to be randomized and risk moving to the alternate class. The sample was a mean ± SD age of 13.8 ± 0.5 years. Most (83.0%) were African American, with the remainder predominantly white, consistent with the demographics of the school. More than half of the partici-
pants' mothers (56.3%) had greater than a high school education. We report mother's education because of the many participants (29.2%) who did not know their father's educational level. Follow-up data were obtained for 210 (95.0%) of the participants.

Observations occurred in 81 (40 intervention and 41 control) PE classes. Interrater reliability of physical activity level (active [walking or active categories] vs inactive) was κ = 0.83. Intervention PE classes spent significantly more time (46.9%) walking or active than control PE classes (30.5%) (P < .001). Most of this difference was for the walking category (28.1% vs 18.8%, respectively), with less difference for the active category (16.6% vs 13.9%, respectively).

The results of the physical activity and sedentary activity measures are displayed in Table 1 and Table 2. At baseline, groups were comparable for mean daily energy expenditure. Based on the previously established cut point for sedentary behavior of 35 kcal/kg per day,22 most participants were sedentary, although daily energy expenditure ranged from 30.2 to 50.7 kcal/kg per day. Baseline sedentary activity prevalence did not differ between treatment groups.

There were no significant between-treatment group differences for mean daily energy expenditure, moderate energy expenditure, or hard to very hard energy expenditure (Table 1). The results of additional analyses' testing for possible treatment group differences for those who increased (n = 92) or decreased (n = 113) their physical activity also were not statistically significant.

Both treatment groups significantly increased in fitness, as assessed by reduction in submaximal heart rate (Table 1).

The proportion of participants who reported 3 or more hours per day of television viewing or video game or Internet use declined in the intervention group, with minimal change in the control group (Table 2). For high television viewing during school days, the intervention group declined by 5.3%, with no change in the controls (P = .03). The proportion of participants who reported 3 or more hours per day in at least 1 of the sedentary variables of interest declined from 44.1% to 36.0% in the intervention group, but remained at 45.5% in the control group (P = .06).

Mean body mass index, waist-hip ratio, waist circumference, blood pressure, total cholesterol level, or lipoprotein level did not differ from baseline to follow-up by treatment status (Table 3). However, there were improvements in waist-hip ratio, blood pressure, and high-density lipoprotein cholesterol level in both groups that either were statistically significant or approached significance.

### Table 1. Baseline, Follow-up, and Change in Estimated Daily Energy Expenditure, Its Subcomponents, and Submaximal Heart Rate by Randomized Treatment Group*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intervention Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline†</td>
<td>Follow-up†</td>
</tr>
<tr>
<td>Estimated daily energy expenditure, kcal/kg</td>
<td>Total 34.6 (3.2)</td>
<td>34.2 (2.9)</td>
</tr>
<tr>
<td></td>
<td>Moderate 2.0 (1.9)</td>
<td>1.8 (3.0)</td>
</tr>
<tr>
<td></td>
<td>Hard or very hard 1.9 (3.6)</td>
<td>1.5 (2.7)</td>
</tr>
<tr>
<td>Change in submaximal heart rate (fitness)</td>
<td>NA</td>
<td>−6.2 (16.4)</td>
</tr>
</tbody>
</table>

Abbreviation: NA, data not applicable.
*Values are given for analysis of covariance testing for within-group change and difference of change between treatment groups for a given variable, with baseline physical activity and race as covariates.
†Data are given as unadjusted mean (SD).
‡Data are given as mean change (SE), adjusted for baseline value and race.

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Study results indicate that the life skills physical activity intervention, while successful in increasing physical activity in PE class, did not result in total increased physical activity. That is, there was no change in overall, moderate, or hard to very hard mean energy expenditure in either the intervention or the control group. The intervention did demonstrate, however, a decline in prevalence of sedentary activities among high school girls.

The prevalence of 3 or more hours per day of television viewing on school days declined in the intervention group, but did not change in controls. Although the intervention targeted moderate to vigorous physical activity, it did include inferences as to how sedentary activities could be replaced with more active pursuits. The reduction in television viewing may have resulted in an increase in light physical activity, which the 7-day Physical Activity Recall is not designed to assess. Previous school-based interventions aimed at reducing the prevalence of sedentary activities among elementary and middle school–aged children did not find a concomitant increase in physical activity, while integrating physical activity promotion in PE class enhances reach and generalizability, efforts may need to

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extend beyond PE class for sufficient potency to increase out-of-class physical activity.

To our knowledge, our study is the first to report results of participants who were overwhelmingly minority (83.0%), which may have contributed to our mixed results. While intervention materials and discussions were designed to be appropriate for African American and white students, there may not have been sufficient cultural targeting to result in substantial out-of-class physical activity participation.

We hypothesized that the intervention would result in an increase in physical activity relative to the control group, a hypothesis that was optimistic in retrospect. Cross-sectional and longitudinal studies document a decline in physical activity in girls throughout adolescence. From a recent longitudinal cohort study of black and white girls, Kimm et al. found an annual mean decline of 4.1 metabolic equivalent times per week for black girls and 3.5 metabolic equivalent times per week for white girls at similar ages as our participants. In contrast, the predominantly African American participants reported no change in physical activity over an 8-month period, irrespective of treatment assignment. Although PE class did not result in increased daily energy expenditure, perhaps it provided sufficient stimulus to blunt the age-expected decline.

Fitness, assessed by reduction in submaximal heart rate, improved in both groups. While the intervention PE classes resulted in greater physical activity compared with the control classes, the difference was largely because of more class time spent walking, rather than more active (vigorous), activity. The vigorous physical activity that occurred in PE class may have been sufficient to improve fitness. These results provide additional evidence for national groups that advocate PE requirements for all ages.

We found improvements in waist-hip ratio, blood pressure, and high-density lipoprotein cholesterol level in both groups, without a decline in weight, waist circumference, or body mass index or an improvement in overall physical activity. These improvements are important, given the high risk of hypertension and cardiovascular disease that African American women carry. In another report, we found that, at baseline, almost 20% of our sample met the criteria for metabolic syndrome. Thus, these adolescent girls are at high risk for future cardiovascular and metabolic diseases. Perhaps the combination of vigorous activity in PE class and improved fitness resulted in favorable physiologic variables. Future work should continue to explore public health strategies to improve cardiovascular risk factors in adolescents.

The trial had several limitations, most of which limit generalizability. The study was conducted in 1 high school, although the high school was a magnet that enrolls students from most Baltimore neighborhoods. Only about 50% of eligible participants chose to enroll. The intervention was delivered by a teacher who was hired by the project. While this approach maximizes the intervention fidelity, it is less generalizable than if the school’s PE teachers were the implementers. And finally, our primary outcome, physical activity, was assessed by self-report. Although the instrument used is valid for high school-aged populations, it may not have been sensitive enough to detect the change in physical activity we were able to produce.

In conclusion, a physical activity intervention conducted in PE class targeting ninth-grade girls increased in-class physical activity and reduced high prevalence of school-day television viewing, but did not result in an increase in overall daily energy expenditure. Given the alarming decline in physical activity during adolescence and the associated increase in prevalence of adolescent obesity, future work should continue to identify potentially effective intervention strategies.

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