Effects of School-Based Aerobic Exercise on Blood Pressure in Adolescent Girls at Risk for Hypertension

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ABSTRACT

Objectives. This study evaluated the effects of aerobic exercise physical education on blood pressure in high-risk, predominantly African-American, adolescent girls.

Methods. Ninth-grade girls (n = 99) with blood pressure above the 67th percentile were randomized to 1 semester of aerobic exercise classes or standard physical education classes.

Result. The study was completed by 88 girls. At posttest, only members of the aerobic exercise group increased their estimated cardiorespiratory fitness. The aerobic exercise group had a greater decrease in systolic blood pressure than the standard physical education group ($P < .03$).

Conclusions. Aerobic exercise physical education is a feasible and effective health promotion strategy for high-risk adolescent girls. (*Am J Public Health.* 1998;88:949–951)

Introduction

Children and adolescents with high normal blood pressure, especially Americans of African ancestry, are at significantly increased risk of developing essential hypertension in adulthood.[1,2] One promising primary prevention approach is to increase physical activity.[3] Physically active or fit children often have lower blood pressures than their sedentary counterparts.[4–8] Physical activity interventions have lowered systolic and diastolic blood pressure in hypertensive adults[9] and may be effective in adolescents.[10–12] Considering that blood pressure levels in adolescence may "track" into adulthood, this possibility should be evaluated.[10]

The present study evaluated the effectiveness of a school-based aerobic exercise intervention, Project Heart, in increasing cardiorespiratory fitness and lowering blood pressure in adolescent girls at increased risk for hypertension. The study design and sample characteristics have been described previously.[13] This paper evaluates the impact of the intervention.

Methods

Sample and Study Design

Project Heart was conducted, from 1991 to 1994, in a large, all-female public high school in Baltimore, Md. This magnet school is attended by students from every economic level and every region of the city. Nearly two thirds of the students are African American. After parental consent was obtained, all entering ninth-grade students were invited to participate in health screening. Girls with blood pressures in the top third of the normal distribution for systolic or diastolic pressures[3] were invited to participate.

As we have described previously,[13] girls who met eligibility criteria were randomly assigned to 1 semester of required standard physical education classes or Project Heart aerobics classes. The aerobic intervention consisted of 1 semester of aerobic exercise classes including didactic instruction. Both classes were conducted in 50-minute periods throughout the 18-week semester. Participants assigned to standard physical education were allowed to take aerobics during a subsequent semester.

Measures

All measures were assessed in a quiet laboratory room at the school. Blood pressure, cardiorespiratory fitness, and body mass index were assessed by technicians who were unaware of the girls' experimental status.

Blood pressure was assessed in a sitting position after 15 minutes of rest. The average of 3 readings was used to determine study eligibility. Girls who elected to participate underwent 2 additional blood pressure assessments (1 week apart) prior to randomization. The 3 readings from each assessment (a total of 6 readings) were then averaged to estimate pretreatment resting pressure. Identical procedures were used to estimate posttreatment values.

Cardiorespiratory fitness was estimated from a step test, described in Ewart et al.[13] This submaximal, multistage test required the girls to exercise at 50%, 60%, and 70% of estimated maximal heart rate reserve[14] by stepping up and down on 3 steps whose heights met energy expenditure requirements.[15] Heart rates recorded by a watch monitor at each stage and test duration were used to assess fitness.

Body mass index was obtained by dividing the participant's weight (in kilograms) by the square of height (in meters).

Statistical Analyses

Effects of aerobic exercise on cardiorespiratory fitness, resting blood pressure, resting pulse, and body mass index were evaluated by analyses of covariance

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(ANCOVAs) in which changes in the dependent variables were regressed on the pretest scores and treatment condition. These analyses were performed with the General Linear Models Procedure (PROC GLM) of the Statistical Analysis System (SAS)[16]; in each analysis, the change score (posttreatment mean minus pretreatment mean) was regressed on the pretreatment score, followed by the treatment condition (aerobics vs physical education, coded as a class variable). The program provides tests of planned contrasts for hypothesis testing and computes the adjusted means (change score adjusted by the pretreatment score). The contrasts testing the hypothesized effects of aerobic exercise on the pretreatment-adjusted change scores were evaluated with directional (1-tailed) tests.

Results

Of the 99 participants randomized, 88 completed the study. Two girls (1 from each group) withdrew because of pregnancy. Nine girls in the physical education control group missed the posttest evaluation because of scheduling problems or school absences. Sixty-three (70%) of the girls who completed the study were African American and the remainder were White. The aerobic exercise and physical education groups did not differ significantly with respect to standard behavioral and familial risk factors.

All ANCOVAs assessing treatment effects initially included race as a potential main effect and interaction effect. As these proved nonsignificant, the results were analyzed by treatment condition only.

TABLE 1—Pretest and Posttest Step-Test Exercise Duration, in Seconds, in the Experimental Aerobic Exercise (AE) Group and the Physical Education (PE) Control Group: Ninth-Grade Girls, Baltimore, Md, 1994

Group	Pretreatment Mean (SD)	Posttreatment Mean (SD)	Change[b]	Significance[a] AE	Significance[a] AE – PE
AE	515.5 (153.3)	572.7 (170.4)	62.9	$P < .01$	$P < .0003$
PE	486.8 (132.1)	441.8 (166.8)	–50.6	...	...

Note. n = 44 in each group.
[a]*P* values are one-tailed.
[b]Change score (posttreatment mean minus pretreatment mean) adjusted by the pretreatment (baseline) mean.

Cardiorespiratory Fitness

The ANCOVA assessing group changes in duration of step-test exercise disclosed that the aerobics group exercised an average of 1 minute longer at posttest than at pretest, whereas the mean duration of step-test exercise in the physical education group did not increase (Table 1) (t [df = 86] = 3.65, $P < .0003$).

Analysis of exercise heart rate changes among those girls who completed a particular step-test stage both at pretest and at posttest showed that participants in the aerobics group exhibited larger reductions in mean exercise heart rate levels than did physical education participants during all test stages ($P < .05$). Compared with those in the aerobics group, fewer girls in the physical education condition who completed stage 2 or 3 at pretest completed the same stage at posttest.

Cardiovascular Risk

Effects of training on resting blood pressure, resting pulse, and body mass index are presented in Table 2. The ANCOVA on change scores revealed that although average resting systolic blood pressure decreased significantly from pretest to posttest in both groups, a significantly greater drop in average resting systolic pressure was observed in the aerobics group than in physical education participants (t [df = 86] = 2.00, $P < .03$). There were no other significant group differences.

Discussion

Girls participating in the aerobic exercise group exhibited improvements in aerobic fitness and a modest reduction in resting systolic blood pressure compared with girls in standard physical education classes. Although the mean reduction in blood pressure seen in the aerobics participants was not large, it is notable, considering that the

TABLE 2—Pretest and Posttest Resting Systolic and Diastolic Blood Pressure, Pulse, and Body Mass Index in the Experimental Aerobic Exercise (AE) Group and the Physical Education (PE) Control Group: Ninth-Grade Girls, Baltimore, Md, 1994

Measure	Pretreatment Mean (SD)	Posttreatment Mean (SD)	Change[b]	Significance[a] Change[b]	Significance[a] AE – PE
Systolic blood pressure, mm Hg					
AE group	120.0 (6.1)	114.0 (6.3)	–6.0	$P < .001$	$P < .05$
PE group	119.9(7.7)	116.2 (7.9)	–3.7	$P < .001$	...
Diastolic blood pressure, mm Hg					
AE group	58.2(6.9)	57.1 (6.7)	–1.3	$P < .06$	NS
PE group	60.4(5.9)	58.8 (6.9)	–1.4	$P < .05$	...
Pulse rate, beats/min					
AE group	79.7(10.8)	79.2 (10.3)	–1.3	NS	NS
PE group	83.8(9.6)	83.8 (9.9)	0.0	NS	...
Body mass index, kg/m^2					
AE group	24.8(5.8)	25.1 (5.7)	0.3	NS	NS
PE group	24.1(5.0)	24.1 (5.1)	0.0	NS	...

Note. n = 44 in each group. NS = not significant.
[a]*P* values are 1-tailed.
[b]Change score (posttreatment mean minus pretreatment mean) adjusted by the pretreatment (baseline) mean.

girls were not hypertensive, and it is comparable to reductions found in other studies of adolescents.[10,12] Changes of this magnitude, if widely achieved, could have important public health benefits.

We do not know if the aerobics program increased girls' physical activity outside the school setting during or after the course. However, as previously reported,[13] 81% of the aerobic exercisers expressed interest in taking an aerobic exercise maintenance program if one were offered for academic credit, indicating the acceptability of longer-term exercise behavior. Considering that increased physical activity and fitness may lower cardiovascular risk independently of their effects on blood pressure,[17] a multiyear high school program of aerobics would seem desirable. A program teaching skills to maintain physical activity across the life span would be of greatest benefit, although effective ways to do this have yet to be developed. □

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