Improvements in Heart Health Behaviors and Reduction in Coronary Artery Disease Risk Factors in Urban Teenaged Girls Through a School-Based Intervention: The PATH Program

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Objectives. We sought to assess the effects of a school-based intervention program on cardiovascular disease risk factors in urban girls.

Methods. We compared heart health knowledge, health behaviors, cardiovascular risk factors, and physical fitness among a group of 442 multiethnic teenaged girls (310 experimental participants vs 132 control participants). Testing was conducted before and after a 12-week program of vigorous exercises integrated with lectures and discussions on diet, exercise, stress, and smoking.

Results. Significant differences in body fat, systolic and diastolic blood pressure, heart health knowledge, and whether breakfast was eaten were observed between experimental participants and control participants.

Conclusions. An integrated program of exercise and heart health–related lectures and discussions had a beneficial effect on health knowledge, health behaviors, and onset of risk factors for coronary artery disease among urban girls. (*Am J Public Health.* 2004;94:1538–1543)

With the exception of reproductive studies, research on women's health issues has been largely neglected.[1] Research on heart disease, for example, has focused predominantly on men,[2] even though cardiovascular disease is the leading cause of death in women as well as men in the United States.[3,4]

Studies on cardiovascular disease in young girls and boys in the United States indicate a high prevalence of risk factors, especially obesity and physical inactivity.[5,6] Among urban minority teenaged girls, the prevalence of risk factors is especially alarming.[6] The long-term health implications of this high prevalence are also a matter of concern, because risk factors often track into adulthood[7] and are associated with the early onset of atherosclerosis.[8] Therefore, the increased morbidity and mortality from cardiovascular disease observed among certain minority female populations is a likely consequence of risk factors earlier in life.[8]

The findings of previous risk factor prevalence studies in children and teenagers[6,7,9] demonstrate a need for early intervention. Several important investigations have been undertaken,[10–14] although none has focused on urban teenaged girls, among whom cardiovascular health problems are most prevalent.[6] We sought to assess the effects of a school-based intervention program of vigorous exercise integrated with health and nutrition education promoting behavioral change in cardiovascular disease risk factors, heart health knowledge, and fitness levels among urban, multiethnic teenaged girls.

METHODS

Four hundred forty-two urban, multiethnic teenaged girls, aged 14 to 19 years, were studied between 1994 and 1996 to evaluate the effectiveness of Physical Activity and Teenage Health (PATH), a school-based intervention program established in 3 New York City high schools representative of the demographic and racial/ethnic composition of Queens County. The teenaged girls self-reported their race/ethnicity as White (10%), African American (46%), Hispanic (29%), or Asian American (15%).

In year 1 of the study, individual girls were randomly assigned to experimental classes (PATH) or to traditional physical education control classes (PED) consisting of volleyball, basketball, and other sports activities. Because of scheduling difficulties at the schools after year 1, random assignment thereafter was performed by class. Classes were co-educational and contained students from different grade levels (grades 9 through 12). Time constraints created by scheduling limitations in the schools limited the number of classes that could serve as controls. Although the change in randomization procedures was unfortunate, it was unavoidable. The fact that experimental and control participants were located in the same school was also of concern owing to possible contamination of control classes. However, using separate schools for PATH and PED participants would have created significant logistical problems. In the end, we decided to use same-school groups, because the bias introduced thereby would if anything make significant differences more difficult to demonstrate, not less. The final sample consisted of 310 girls (13% White, 46% African American, 29% Hispanic, and 12% Asian American) in PATH and 132 girls (5% White, 45% African American, 28% Hispanic, and 22% Asian American) in PED.

PATH Intervention

The PATH curriculum was taught as a personal wellness course that integrated vigorous exercise, health and nutrition education, and behavior modification. PATH student manuals[15] were developed to provide students with information about the anatomy and physiology of the heart, cardiovascular risk factors, the heart disease process, proper exercise and nutrition, stress management,

cigarette smoking avoidance and cessation techniques, and strategies for modifying high-risk health behaviors. PATH teacher manuals were provided to physical education teachers containing instructions for teaching the program curriculum and assessing outcomes.[16] Physical education teachers using the PATH curriculum received in-service training from the investigation team before and during the intervention.

The PATH program consisted of 30-minute classes conducted 5 days per week for 12 weeks. Individual classes began with a brief 5- to 10-minute lecture and discussion featuring a topic on cardiovascular health and fitness and suggestions for modifying health behaviors. In addition, students frequently were given homework assignments designed to enhance or clarify lecture material through use of the PATH manuals. The lecture and discussion were followed by 20 to 25 minutes of vigorous physical activity in the form of either resistance exercise to improve muscular strength and endurance or aerobic exercise to improve cardiovascular fitness. Students alternated resistance and aerobic training each day. Resistance exercise consisted of a vigorous program of circuit weight training at a variety of isotonic and isokinetic exercise stations. Students performed 90- to 120-second bouts of weight lifting at 50%–70% of the 1-repetition maximum (the maximum resistance that can be lifted 1 time). Resistance exercises were designed to increase the muscular strength and endurance of major muscle groups in the upper and lower body, including the trunk.

Aerobic training included a variety of vigorous exercises, such as stationary bicycling, stair stepping, rope jumping, fast walking, jogging, step aerobics, and aerobic dance. Students were instructed to exercise continuously at 70%–85% of their age-predicted maximum heart rate. Students were taught how to self-monitor heart rates during or immediately upon cessation of exercise by palpation of the radial or carotid pulse.

The frequency and duration of traditional PED classes were identical to those of PATH classes. Since PED classes did not have lecture and discussion, they had approximately 5 minutes more physical activity per class than PATH classes.

Physical and Physiological Measurements

Selected physical and physiological data, including age, height, weight, body mass index (BMI), percentage body fat, resting systolic and diastolic blood pressure, total serum cholesterol, and estimated maximum oxygen uptake, were recorded at the beginning and end of the study for each participant. Research staff members (Queens College faculty and graduate assistants) were trained in measurement procedures and administered all tests to the participants. To minimize intertester variation, research staff members were assigned to the same testing stations throughout the study.

Pre- and postintervention measurement required a 2-week period before and after the 12-week PATH program. Height and weight were measured on a standard physician's scale with participants dressed in lightweight clothing (e.g., T-shirts, shorts, and sweat socks). BMI, a measure of relative body weight and obesity, was reported as kg/m^2. Percentage body fat was estimated from regression equations developed from skinfold measurements taken at 3 sites (triceps, subscapular, and suprailiac) on the right side of the body[17] with a Lange Skinfold Caliper (Cambridge Scientific Instruments, Cambridge, Md). Systolic blood pressure and diastolic blood pressure were measured after 5 to 15 minutes of rest in a seated position by the auscultatory method from the right arm at heart level. To allay potential anxiety, participants were informed that 2 measurements would be taken. Only the second reading was recorded.

A Reflotron reflectance photometer (Boehringer Mannheim, Indianapolis, Ind) was used to determine total serum cholesterol. A trained technician used an automated minilancet Autoclix (Boehringer Mannheim, Mannheim, Germany) and a tube to draw a 30-mL capillary blood sample after a finger stick. The capillary sample was applied to a reagent tab that was inserted into the Reflotron. Total serum cholesterol was displayed within 3 minutes. Validity (r) of the Reflotron has been reported between 0.96 and 0.98 with less than ±5% error compared with standard clinical techniques.[18] This reported accuracy is within acceptable standards established by the Laboratory Standardization Panel of the National Cholesterol Education Program.[19] Test–retest reliability was determined on 4 occasions in our study and yielded Pearson correlation coefficients between 0.97 and 0.98. In addition, when compared with known samples provided by Boehringer Mannheim, the differences averaged less than ±3% variation.

Maximum oxygen uptake, an indicator of cardiovascular fitness, was estimated from recovery heart rates following the Queens College step test.[20] The step test consisted of stepping up and down for 3 minutes on a 16-inch bench at 22 steps per minute. Heart rates were counted for 15 seconds, beginning at 5 seconds after stepping ended.

Questionnaire Information

Self-administered anonymous questionnaires were completed by participants before and after the intervention.[16] Questionnaires obtained information on age, ethnicity, heart health knowledge, self-perception of health, non–school-related physical activity, dietary habits, breakfast eating habits, socioeconomic status, and family history of cardiovascular disease and risk factors. Family histories were facilitated by student–parent interviews as part of homework assignments.

Ethnicity (White, African American, Hispanic, or Asian American) was determined from a self-reporting questionnaire asking participants to indicate the ethnic group with which they most identified. Heart health knowledge represented the percentage of correct responses on a 50-item, multiple-choice test developed for the PATH program and based on information presented in the student manual. Self-perception of health was determined by having participants rate their health compared with that of their peers on a scale of 1–9: below average (1–3), average (4–6), or above average (7–9). This scale was used successfully in a previously reported study of adult health and fitness.[21] Level of non–school-related physical activity was defined as the number of such activities engaged in for a minimum of 15 minutes per session per week. The questionnaire used to determine level of non–school-related physical activity was similar to procedures used previously and shown to be reliable.[22] We used a food frequency checklist of 35 common foods that are high in cholesterol, saturated fat, sugar, and salt to assess dietary hab-

its. The dietary score represented the sum of the frequencies with which foods reported as consumed were consumed in a typical week. Higher scores represented poorer eating habits. The food frequency inventory has been shown to be a reliable and valid measure of dietary habits.[23] Girls were asked to indicate how often they ate breakfast. Assessing the frequency of eating breakfast is important in adolescents, because a healthy breakfast helps to stabilize blood sugar levels until lunchtime, thereby allowing students to stay energetic. In addition, it has been previously observed that young girls tend to avoid eating breakfast as a weight control technique.[24] Lifestyle questionnaires and student–parent interview homework assignments were used to provide family histories of cardiovascular disease and risk factors. Socioeconomic status was assessed according to the total combined years of parents' education. Test–retest reliabilities were calculated for the specific items in the PATH questionnaire and ranged from $r=.83$ to $r=.90$.[24]

Statistical Analyses

Mean differences between experimental and control participants at baseline were compared by independent t tests and χ^2 analysis. Independent t tests were used to compare the preintervention and postintervention differences (Δ or change in scores) between experimental and control participants on physical, physiological, and health knowledge measures. Because of pervasive problems with student transfers and absences, the sample sizes varied among tests. Chi-square analysis was used to test the intervention program's effect on lifestyle measures. A P value of .05 was chosen for significance and was used for all statistical comparisons in the study. All statistical tests were conducted with SPSS version 10 (SPSS Inc, Chicago, Ill).

TABLE 1—Baseline Physical Characteristics, Physiological Measures, and Questionnaire Information for Experimental (Physical Activity and Teenage Health [PATH]) and Control (Physical Education [PED]) Female High-School Participants: New York City, 1994–1996

	Mean (SD)	
	PATH Participants (n = 310)	PED Participants (n = 132)
Baseline physical characteristics		
Age, y*	16.2 (1.3)	15.9 (1.2)
Height, in	62.8 (2.3)	62.7 (2.8)
Weight, lb	127.9 (26.0)	132.4 (34.4)
Ethnicity, %		
White	13.0	5.0
African American	46.0	45.0
Hispanic	29.0	28.0
Asian American	12.0	22.0
Baseline physiological measures		
BMI, kg/m^2	22.8 (4.1) (n = 310)	23.6 (5.0) (n = 132)
BF, %*	29.7 (5.5) (n = 292)	31.1 (5.2) (n = 123)
SBP, mm Hg	110.7 (8.8) (n = 310)	111.2 (10.3) (n = 129)
DBP, mm Hg	71.0 (7.1) (n = 310)	70.1 (8.6) (n = 129)
TSC, mg/dL	159.6 (28.2) (n = 234)	153.8 (26.8) (n = 86)
VO_2max, mL/kg per minute	34.5 (2.9) (n = 285)	34.4 (4.0) (n = 102)
Baseline questionnaire information		
HHK, % correct	51.6 (15.9) (n = 281)	54.4 (19.1) (n = 94)
SPH, 1–9*	6.2 (1.5) (n = 262)	5.8 (1.5) (n = 95)
PA, no. sessions per week	4.5 (2.8) (n = 273)	4.9 (3.2) (n = 118)
DH, no. foods per week	45.8 (21.6) (n = 286)	43.8 (20.7) (n = 114)
SES*	25.0 (6.2) (n = 180)	26.7 (6.7) (n = 72)

Note. BMI = body mass index; BF = body fat; SBP = systolic blood pressure; DBP = diastolic blood pressure; TSC = total serum cholesterol; VO_2max = maximum oxygen uptake; HHK = heart health knowledge; SPH = self-perception of health; PA = physical activity = number of non–school-related activities of 15 minutes per session per week or greater in duration); DH = dietary habits; SES = socioeconomic status, defined as parents' combined education in years.
*P < .05.

RESULTS

Experimental and control participants' age, height, weight, and ethnicity at baseline were compared (Table 1). There were no significant differences in height or weight, although girls in the PATH group were significantly older than girls in the PED group (16.2 vs 15.9 years). Nevertheless, correlation analysis was conducted between age and systolic blood pressure and diastolic blood pressure. The respective r values were –.069 and –.111, neither of which was significant. Therefore, the slight age difference was not an important factor. Although there were small differences in ethnicity between the 2 groups, they were not significant. The differences in percentage body fat between PATH and control participants (29.7 vs 31.1, $P<.05$) were small but significant. There were no significant differences in BMI, systolic blood pressure, diastolic blood pressure, total serum cholesterol, and maximum oxygen uptake. Compared with control participants, PATH participants had slightly higher self-perceptions of health (6.2 vs 5.8, $P<.05$) and slightly lower socioeconomic status (25.0 vs 26.7 years of parental schooling, $P<.05$); the differences were statistically significant. There were no significant differences in heart health knowledge, non–school-related physical activity, or dietary habits.

Effects of the school-based PATH intervention program on physical, physiological, heart health knowledge, and lifestyle data are presented in Tables 2 and 3. Mean changes in PATH versus PED physiological measures were significant for percentage body fat, systolic blood pressure, and diastolic blood pressure (Table 2). Mean differences in BMI, total serum cholesterol, and estimated maximum oxygen uptake were not significant. Significant differences in heart health knowledge (Table 3) and eating breakfast (Figure 1) were observed between PATH and PED participants, as demonstrated by χ^2 test ($\chi^2=14.8$,

TABLE 2—Pre- and Postintervention Mean Differences in Physiological Measures of Experimental (Physical Activity and Teenage Health [PATH]) and Control (Physical Education [PED]) Female High-School Participants: New York City, 1994–1996

	PATH, Mean (SD)			PED, Mean (SD)			Mean Difference ($\Delta_1 - \Delta_2$)	SE Mean Difference
	Pre	Post	Post – Pre Δ_1	Pre	Post	Post – Pre Δ_2		
BMI, kg/m^2	22.8 (4.1)	22.8 (4.2)	0.0 (1.0) (n = 310)	23.6 (5.0)	23.7 (5.1)	0.1 (1.6) (n = 132)	0.1	0.1
BF, %**	29.7 (5.5)	28.5 (5.3)	–1.2 (1.9) (n = 310)	31.1 (5.2)	30.7 (5.2)	–0.4 (2.2) (n = 123)	–0.8	0.2
SBP, mm Hg*	110.7 (8.8)	105.4 (8.8)	–5.3 (0.6) (n = 310)	111.2 (10.3)	108.2 (10.1)	–3.0 (9.8) (n = 129)	–2.3	0.9
DBP, mm Hg**	71.0 (7.2)	67.8 (7.0)	–3.2 (7.7) (n = 310)	70.1 (8.6)	70.3 (7.5)	0.2 (8.3) (n = 129)	–3.4	0.8
TSC, mg/dL	159.6 (28.2)	151.2 (26.3)	–8.4 (19.6) (n = 234)	153.8 (26.8)	149.6 (27.1)	–4.2 (19.3) (n = 86)	–4.2	2.5
VO_2max, mL/kg per minute	34.5 (2.9)	36.5 (3.2)	2.0 (3.3) (n = 285)	34.4 (4.0)	35.9 (4.0)	1.5 (3.8) (n = 102)	0.5	0.4

Note. BMI = body mass index; BF = body fat; SBP = systolic blood pressure; DBP = diastolic blood pressure; TSC = total serum cholesterol; VO_2max = maximum oxygen uptake.
*P < .05; **P < .001.

TABLE 3—Pre- and Postintervention Mean Differences in Knowledge and Behavioral Variables of Experimental (Physical Activity and Teenage Health [PATH]) and Control (Physical Education [PED]) Female High-School Participants: New York City, 1994–1996

	PATH, Mean (SD)			PED, Mean (SD)			Mean Difference ($\Delta_1 - \Delta_2$)	SE Mean Difference
	Pre	Post	Post – Pre Δ_1	Pre	Post	Post – Pre Δ_2		
HHK, % correct*	51.6 (15.9)	56.1 (19.6)	4.5 (12.7) (n = 281)	54.4 (19.1)	51.2 (23.0)	–3.2 (15.9) (n = 94)	7.7	2.2
SPH, 1–9	6.2 (1.5)	6.4 (1.5)	0.2 (1.5) (n = 262)	5.8 (1.5)	5.9 (1.6)	0.1 (1.7) (n = 95)	0.1	0.2
PA, no. sessions per week	4.5 (2.8)	5.3 (2.9)	0.8 (2.6) (n = 273)	4.9 (3.2)	5.5 (3.7)	0.6 (3.2) (n = 118)	0.2	0.3
DH, no. foods per week	45.8 (21.6)	41.7 (21.2)	–4.1 (17.4) (n = 286)	43.8 (20.7)	42.6 (19.5)	–1.2 (16.2) (n = 114)	2.9	1.9

Note. HHK = heart health knowledge; SPH = self-perception of health (9 = good); PA = physical activity = number of non–school-related activities of 15 minutes per session per week or greater in duration; DH = dietary habits.
*P < .001.

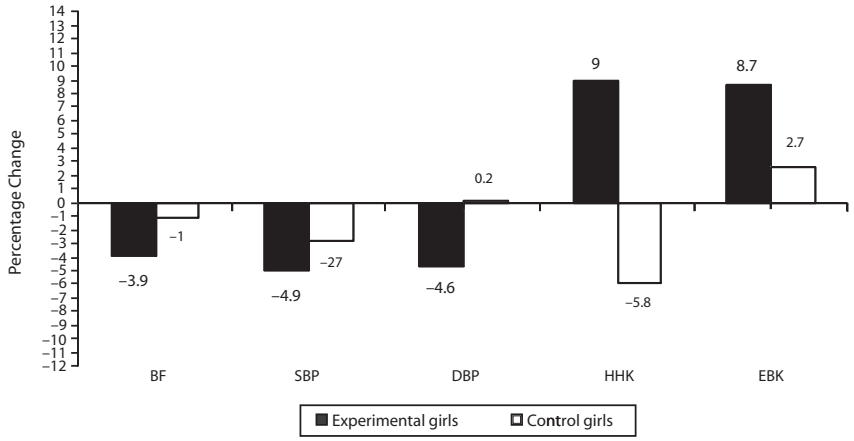
df = 1, P < .05). Analysis of other lifestyle measures revealed no significant differences between mean change scores for self-perception of health, out-of-school physical activity, and dietary habits. Figure 1 illustrates the relative percentage change of physical, physiological, knowledge, and behavior measures among PATH and PED participants.

DISCUSSION

Our study examined the ability of a unique school-based program of personal wellness to modify heart health behaviors in urban teenage girls compared with a traditional school physical education program. The mixed racial/ethnic composition of the teenagers in this study represents a population who are known to be at increased risk for coronary disease as adults.[4]

The PATH program has been described in greater detail elsewhere.[25] Because the PATH curriculum is adaptable, flexible, and inexpensive, it has been well received by students and teachers and implemented in numerous high school and middle school programs. Currently the program has been introduced in approximately 50 schools. The greatest challenge is introducing the unique aspects of the program (e.g., using a textbook and providing lecture material to both physical education teachers and students).

Our investigation increased the size of both the subject and data pool from a previous study of PATH,[26] which found significant improvements in total serum cholesterol, dietary habits, cardiovascular health knowledge, and percentage body fat in a small sample of teenage boys and girls. In our study, urban high school girls were provided daily lectures of 5- to 10-minute duration, emphasizing heart health and cardiovascular fitness combined with vigorous physical activity including circuit weight training and aerobic exercise lasting 20 to 25 minutes. Even though the amount of lecture time allotted was short, the information provided was beneficial, as demonstrated by significant improvements in heart health knowledge and an increase in frequency of eating breakfast. Significant improvements in percentage body fat, systolic blood pressure, and diastolic blood pressure suggest that the intensity, duration, and frequency of the vigorous exercise portion of PATH were sufficient to change physical measures in teenage girls. These improvements are all the more remarkable if one considers that the time allotted for physical activity in PATH classes was 20% less than that in PED classes. PATH participants tended to have



Note. BF = body fat; SBP = systolic blood pressure; DBP = diastolic blood pressure; HHK = heart health knowledge; EBK = percentage eating breakfast.

FIGURE 1—Relative change (%) in significantly improved physical, physiological, knowledge, and behavior measures in Physical Activity and Teenage Health (PATH) vs physical education control (PED) female high-school participants: New York City, 1994–1996.

slightly greater improvements in aerobic fitness and dietary habits, which perhaps could become significant with continued intervention. Although it was difficult to explain improvements in percentage body fat and blood pressure, we speculate that improved aerobic fitness and diet habits in PATH participants, while not individually statistically significant, may be beneficial owing to their cumulative effect

Another positive outcome of PATH is that students appeared to enjoy this nontraditional approach to wellness, as reflected by personal observation and a 10% better attendance compared with students in traditional physical education classes.[27] For the most part, students responded favorably to receiving individualized training and instruction, progressing at their own rates, and not being required to compete with students who were more fit and athletic, as is the case in traditional, sports-based physical education classes. Within this individualized framework, and because of facility, equipment, personnel, and schedule differences, it was not possible to provide identical sequences of the program at each study site. However, the general types of training (e.g., circuit, intermittent, aerobic, resistance) were very similar, and all sites used identical workbooks covering the lecture and discussion component of the program. Although the lack of identical PATH interventions, owing to the difficulty of recommending a "specific" intervention protocol in all cases, is a potential limitation, it is also a benefit that the program is adaptable to different schedules, facility, and equipment resources. In reality, the programs were almost identical at each school.

In general, urban teenaged girls are not enthusiastic about vigorous physical activity in or out of school. Urban schoolgirls are reluctant to exercise outside of school for reasons of safety and privacy,[6] a finding that strongly supports use of school-based physical education; urban teenage girls who do not engage in physical activity in school will not engage in physical activity at all.

Various comparisons can be made between the PATH program findings and results of studies with similar interventions. Compared with participants in similar studies,[14,28,29] PATH students attained higher posttest scores, indicating improvement in heart health knowledge, a finding similar to the increased pre- to posttest scores on nutrition knowledge for preschoolers in the Healthy Start Project.[30] In addition, the PATH intervention was associated with a reduction in blood pressure and BMI, as was also observed in similar, previous studies of interventions that emphasized intense physical activity and resistance training.[31,32]

CONCLUSIONS

Results from our study suggest that a school-based program of health promotion and personal wellness significantly improves heart health knowledge, eating habits, percentage body fat, and blood pressure in urban multiethnic teenaged girls. These results are particularly encouraging for African American and Hispanic girls, who constituted the majority of the participants in this study, and who, as adults, are part of a racial/ethnic group that is historically at increased risk for hypertension and obesity. Over time, school-based intervention programs may lower the prevalence of cardiovascular disease risk factors that track into adulthood, thereby favorably altering morbidity and mortality patterns in African American and Hispanic women. For this reason, programs such as PATH, which teach and promote healthy lifestyle habits that can persist into adulthood, should be made part of the required physical education curriculum. ■

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Contributors

M. Bayne-Smith conceived the study's focus on girls, and assisted with data analysis and writing. P. Fardy collected data and assisted with data analysis and writing. J. Magel assisted with data analysis and writing. A. Azzollini assisted with data collection and data analysis. K.H. Schmitz assisted with data collection and analysis. D. Agin assisted with data collection and analysis.

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Human Participant Protection

The study was approved by the New York City Board of Education and the Queens College internal review board, committee for the protection of human subjects. In addition, parental consents were obtained for all participating students.

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