To the Graduate Council:

I am submitting herewith a dissertation written by Richard Carlton Gayle entitled "The Effects of a Physical Education Endurance Running Program on Coronary Heart Disease Risk Factors in High School Sophomores." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Physical Education.

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THE EFFECTS OF A PHYSICAL EDUCATION ENDURANCE RUNNING PROGRAM ON CORONARY HEART DISEASE RISK FACTORS IN HIGH SCHOOL SOPHOMORES

A Dissertation
Presented for the
Doctor of Education
Degree
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Richard Carlton Gayle
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ABSTRACT

One hundred and twenty-nine randomly selected high school sophomores were tested before and after an 18-week endurance running program to determine the effects of that program on selected measures associated with coronary heart disease--specifically, systolic and diastolic blood pressures, body fatness, heart rate response to submaximal exercise (bench-stepping test), leisure time energy expenditure, and cigarette smoking habits. Fifty-six of those students with complete physiological data were randomly selected to take the Tennessee Self-Concept Scale before and after the running program.

An analysis of variance on post-intervention data revealed no significant differences ($p > .10$) on physiological measures between those students taking no physical education classes during the 18-week program (Group 1), those students taking physical education during the first nine weeks only (Group 2), those students taking physical education during the second nine weeks only (Group 3), and those students taking physical education for the entire 18 weeks (Group 4). Groups 1 and 4 only were compared on the self-concept measures; no significant differences were detected ($p > .10$). The analysis of covariance technique was used instead of the analysis of variance in all comparisons for which treatment groups differed on pre-intervention measures ($p < .30$).

The same comparisons for those students scoring in the upper 50% on heart rate response to bench stepping (highest heart rate response) yielded similar results. There were no significant differences among the physiological measures ($p > .10$), while only the score for personal self was significantly higher for Group 4. When the same comparisons were made for those students scoring in the upper 50% on body fatness (most fat), there were no significant differences among the treatment groups for either physiological or self-concept measures.

A one-sample Chi square test showed no changes in the distribution of smokers and nonsmokers among the treatment groups ($p > .10$) as a result of the running program. The intervention program apparently did not influence students to stop smoking.

Results suggest that the endurance running program employed in this study is not an effective way for school physical educators to produce desirable changes in coronary heart disease risk factors for high school sophomores in 18 weeks.

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CHAPTER I

INTRODUCTION

Causes of death and disability are different today than they were a generation or two ago. Many childhood and infectious diseases which formerly took a heavy toll have gradually come under control through better sanitation, vaccine programs, increased knowledge of nutrition, virus research, and other efforts. However, this does not mean that there are fewer health problems--just different ones. Chronic diseases and disabilities of the middle and old ages are more prevalent than ever before. Coronary heart disease, the leading cause of death in the United States, is the most striking example.

Although heart attacks are most common in the middle-aged and elderly, recent evidence indicates that the "risk factors" associated with a predisposition to coronary heart disease (CHD) are identifiable in adolescence or even early childhood (Drash, 1972; Enos, Holmes, & Beyer, 1952; Friedman, 1972; Gilliam, Katch, Thorland, & Weltman, 1977; Lauer, Connor, Leaverton, Reitter, & Clarke, 1975; McNamara, Malot, & Stremple, 1971; Wilmore & McNamara, 1974). Physical inactivity, permitted or encouraged by modern mechanization, is one of these factors. Although the existence of a direct link between CHD and physical inactivity has not been conclusively demonstrated, evidence is mounting that vigorous physical activity increases cardiovascular fitness and helps to prevent or diminish the effects of other high-risk factors such as obesity, hypertension, emotional stress, cigarette smoking and poor diet (Åstrand, 1952; Fox, 1973; Jokl, Cluver, Goedvolk, & DeJongh, 1941; Keys, 1970; Montoye, 1969; Pollock, 1973; Robinson, 1939).

Since the beginning of this century, public school physical education programs have been responsible for providing physical activities for the young. However, the contribution of these school physical education programs to the maintenance and development of cardiovascular fitness is unclear. In 1957, the American Association for Health, Physical Education and Recreation (AAHPER) sponsored a national survey of the physical fitness of boys and girls 10 to 17 years of age (Hunsicker, 1958), and uncovered some disturbing findings. In circulatory-respiratory fitness (as measured by the 600-yard run-walk), American children were inferior to comparable populations in Great Britain (Campbell & Pohndorf, 1961) and South Africa (Haig, 1960; Johnstone, 1960). Moreover, performance in the 600-yard run-walk did not improve with age for the American girls. American children were inferior on other fitness measures as well.

The findings of the AAHPER study stimulated educational, professional and governmental bodies to action. (A summary of these developments is recorded by Cureton (1964b).). In an unprecedented action, President John F. Kennedy wrote an article, "The Soft American," which appeared in Sports Illustrated on December 26, 1960. In it, he called for a minimum of 15 minutes of continuous exercise to be given daily in every grade school in the nation, and illustrated several types of exercises useful in developing physical fitness. The so-called "physical fitness revolution" which ensued was given its greatest support by the First Family.

The impact of this fitness revolution was something less than overwhelming. In 1966, Saunders, Montoye, Cunningham, and Kozar compared

Tecumseh, Michigan, high school students who elected physical education to those who elected band, chorus or art instead. Participation in physical education appeared to have little effect on physical fitness levels in males. Four years later, Cooper demonstrated that most students in grades 6 through 12 could not jog 1 mile in 12 minutes. Preliminary investigations for the present study, conducted on a nonrandom sample of high school students (N=605) in Knoxville, Tennessee, failed to show fitness differences between those enrolled and those not enrolled in physical education classes.

School physical education programs, at least those that have been evaluated, still do not require enough vigorous physical activity to develop and maintain good cardiovascular fitness. In 1971-72, Art Friedman of the Fort Worth, Texas, Public School System, in cooperation with Dr. Ken Cooper and the Institute for Aerobics Research, demonstrated that an endurance training program <u>can</u> be implemented effectively in an entire school system, in spite of the political and social constraints of contemporary American public education (Cooper, Purdy, Friedman, Bohannon, Harris, & Arends, 1975). Friedman and Cooper found that such a program can significantly improve endurance performance.

Cardiovascular fitness is not work capacity alone; it is freedom from disease. Whether the performance increases realized in the Fort Worth program indicated improvements in mental and physical well-being and/or reductions in the risk factors associated with coronary heart disease is another question, but an important one. If school physical educators cannot give motivation, understanding and skills necessary to provide this vital step in preventive medicine, the responsibility should be elsewhere.

The present study was designed to determine whether the Knoxville, Tennessee, public school physical education endurance running program is sufficient to improve cardiorespiratory fitness (as measured by heart rate response to bench stepping) and self-concept, and to reduce selected CHD risk factors--specifically, obesity, hypertension, cigarette smoking and physical inactivity--in high school sophomores.

CHAPTER II

REVIEW OF THE LITERATURE

Prevalence of CHD Risk Factors in Children and Adolescents

Gilliam, Katch, Thorland, and Weltman (1977) assessed the prevalence of single and multiple CHD risk factors in 47 active boys and girls, ages 7 to 12 years, who were enrolled in the University of Michigan Youth Fitness Program. Twenty-nine of the children (62%) had at least one risk factor. Of these, 17 had two or more risk factors, and one subject had as many as five. It should be noted, however, that the participants were not randomly selected and represented only 44% of the Youth Fitness Program population.

Wilmore and McNamara (1974) did a similar study on 95 boys, 8 to 12 years old, in Davis, California. Of the total group, 36% exhibited no risk factors, 46% had one, and 14% had two or more. The sample was not randomly selected and represented only 44.6% of the total population available.

Lauer, Connor, Leaverton, Reitter, and Clarke (1975) documented the frequency of coronary risk factors in 4,829 school children, ages 6 to 18 years, in Muscatine, Iowa, over a 14-month period. Serum cholesterol levels were found to be similar for children of all ages. Twenty-four percent of the children had levels $\geq$200 mg/dl, 3% had levels $\geq$240 mg/dl, and in 1% percent, levels were $\geq$260 mg/dl. Levels of serum triglyceride increased with age: the mean level was 71 mg/dl (SD ± 36) at six years of age and 108 mg/dl (SD ± 45) at 18 years. Only 15% of the children had serum triglyceride levels of 140 mg/dl or more.

Blood pressure was observed to increase with age. No child between six and nine years of age had blood pressure ≥ 140 mm Hg systolic or ≥ 90 mm Hg diastolic. In the age group 14 to 18 years, 8.9% had systolic blood pressures ≥ 140 mm Hg, 12.2% had diastolic blood pressures ≥ 90 mm Hg, and in 4.4%, both pressures were at or above these levels.

Obesity also increased with age. Of those who were six to nine years old, 20% had weights relative to those of the whole group of ≥ 110%, and 5% were ≥ 130%; in the 14- to 18-year olds, 25% had relative weights of ≥ 110%, and 8% were ≥ 130%. The investigators concluded that a considerable number of school-age children have risk factors which in adults are predictive of coronary heart disease. However, it should be noted that 70% of the total school population was included in the study, suggesting the possibility of some bias.

Enos, Holmes and Beyer (1952) performed autopsies on 300 United States battle casualties in Korea (mean age 22 years) to analyze gross lesions found in the coronary arteries. In 77.3% of the hearts, some gross evidence of coronary atherosclerosis was found. The disease process varied from fibrous thickening to large atheromatous plaques causing complete occlusion of one or more of the major vessels. In a similar study of United States casualties in Vietnam, McNamara, Malot and Stremple (1971) found evidence of some atherosclerotic development in 45% of 114 cases.

Endurance Training, Cardiovascular Fitness and CHD Risk Factors in Children and Adolescents

Over the past 50 years, researchers have attempted to provide reasonable answers to critical questions concerning the intensity, duration and frequency of activity necessary to develop and maintain good cardiovascular function in children and adolescents. Cureton (1964a; 1964b) and other investigators (Holmes, 1958; March, 1959; Mas, 1957; Roby, 1954; Rothermel, 1961; Wickstrom, 1953; Wolbers, 1950; Wright, 1954) conducted a series of studies from 1950 to 1961 at the Sports-Fitness Summer Day School, a research program of the University of Illinois at Urbana. They were particularly interested in the influence of different types, intensities and durations of training exercises for cardiovascular fitness in young boys. In one study, Wickstrom (1953) examined the changes associated with an eight-month gymnastics program for 12 boys, five to 11 years of age. The class met once a week for one hour; the first half-hour was devoted to tumbling and the second half-hour to trampoline. The average pulse ratio was chosen as a criterion for cardiovascular fitness. While some individuals improved significantly on some measures, there were no statistically significant group mean differences. Roby (1954) and Wright (1954), studying the same group, found no significant differences in electrocardiograph (ECG) tracings and heartographs, respectively. The investigators concluded that this particular type of gymnastics program was not sufficient to improve cardiovascular fitness.

Holmes (1958) examined the effects of endurance training programs on selected cardiovascular fitness measures in four matched groups of boys, 6 to 14 years of age. There were 19 boys in each group. The programs consisted of circuit training, muscular endurance exercises, interval running, and steeple chase, 30 minutes daily for 8 weeks. The results of pre- and post-training five-minute step tests showed longer running programs, interval running and steeple chase to be more effective in reducing postexercise pulse rates.

March (1959) showed that a program of warmup muscular endurance exercises and one hour of continuous cycling daily for 13 weeks produced improvements in breath-holding ability, heartograph measures, progressive pulse ratio, and heart rate response to exercise. Studies involving programs of the recreational variety (Mas, 1957; Montoye, 1960; Rothermel, 1961; Wolbers, 1950), such as baseball, volleyball and basketball, failed to produce evidence of significant cardiovascular changes. Mas (1957) concluded that reductions in body fat were obtained from programs oriented toward endurance, and not from those centered on basic intervention and skill.

Ekblom (1969) has studied the effects of physical training on maximal oxygen uptake in 11-year-old boys. Six boys were tested on a treadmill before and after six months of interval training (3-4 x 1000 m), dash training (10-20 x 75 m), distance training (4000-5000 m), strength training (circuit and weight training), and ball games (soccer, ice hockey for 45 min). All training programs were supervised by a physical education teacher. A nontraining group of seven boys of the same age was studied at the same time. The maximal oxygen uptake of the training group improved from 2.18 to 2.48 l/min (a 15% increase), and remained the same for the controls.

Massicotte and Macnab (1974) studied the cardiorespiratory adaptation to training at specified intensities in 36 boys, aged 11 to 13 years. Training occurred on a bicycle ergometer for six weeks, three times a week, 12 minutes per session, at heart rates of 170-180 beats/min

(T_1), 150-160 beats/min (T_2), or 130-140 beats/min (T_3). A fourth group served as a control.

Following the training session, there were 11, 9, and 8% decreases in submaximal heart rates for the T_1, T_2, and T_3 groups, respectively, but these decreases were not statistically significant. The VO_2 max increased significantly (11%) in the highest-intensity training group (T_1), but remained substantially unchanged in the T_2 and T_3 training groups and in the control group. The T_1, T_2, and T_3 training groups increased their maximal work loads by 25, 23 and 21%, respectively, while the control group did not improve.

The investigators concluded that, for short training sessions, the threshold necessary to improve cardiorespiratory functions in 11- to 13-year-old children should be above 170 beats/min. This training stimulus corresponds to approximately 75% of the difference between the resting and maximum heart rates, compared to the 60% in adults reported by Sharkey (1970), Sharkey and Holleman (1967), Faria (1970), and Karvonen, Kentala and Mustala (1957).

Brown, Harrower and Deeter (1972) measured maximal oxygen uptake and heart rate response during submaximal work in 12 girls, 8 to 13 years of age, engaged in a 12-week cross-country running program. The training program consisted of one to two hours of continuous running over gradually increasing distances four or five days per week. Days of interval running were interspersed in the schedule. Maximal oxygen uptake increased by 18% after 6 weeks and 26% after 12 weeks. Heart rates at submaximal work showed moderate but consistent declines. Three runners lost weight (0.7 to 2.0 kg), while the others gained an average of 0.6 kg.

In a similar study by Eisenman and Golding (1975), girls (12-13 years) and women (18-21 years) engaged in endurance training (running and bench stepping 3 times a week for 14 weeks). Both groups showed significant increases in maximal oxygen uptake when compared to controls, and nearly equal increases in maximal oxygen uptake when compared to each other.

Many studies relating training to cardiovascular fitness have been conducted in public and private school physical education programs. In 1928, Schwartz, Britten and Thompson conducted a study at George Washington High School in New York City to determine the relationships among muscular tone, good posture, and selected physiological variables. Sixty-eight boys formed the experimental group, and 50 boys in the same school served as the control. The boys volunteered for the experiment and decided for themselves which of the two groups they would be in. It was explained to them that the purpose of the study was to determine the effect, if any, of exercise on physical fitness. The boys in the experimental group were given one hour each day of intensive physical exercise (running, jumping, climbing ropes, swinging on bars, swimming and calisthenics); the boys in the control group were excused from their gymnasium periods and required to sit in study hall during that period.

A complete physical exam was given before and after the training period. At the end of four months, there were no significant differences between exercising students and controls in systolic blood pressure, diastolic blood pressure, pulse pressure, or obesity. The authors suggest that the nonreliability of single readings for blood pressure and pulse rate might partially explain the lack of differences in these measures for the two groups.

Daniels and Oldridge (1971) studied 14 boys, aged 10-15 years, who elected to take distance running instead of the standard physical education class curriculum. The program lasted 22 months. Height, weight, submaximal and maximal oxygen uptake (l/min), recorded semiannually, improved significantly, but maximal oxygen uptake (ml/kg·min) did not. Mean improvement in running performance was 32 seconds for 1 mile and 63 seconds for 2 miles. Oxygen uptake for submaximal work gradually decreased. It should be noted that the sample was not representative of its age group, having an average maximal oxygen uptake of 59.5 ml/kg·min at the beginning of the program.

Cumming, Goulding and Bagley (1969) measured the physical working capacity (PWC 170) and maximal oxygen uptake of boys from three different schools at the beginning and end of the school year. One school offered a full program of physical education, one had no formal physical education, and one had less than 90 minutes of physical education per week. Regardless of program, the boys with high working capacities remained high, and those with low working capacities failed to improve. The investigators concluded that no matter how many hours were allotted or what type of facilities were available for physical education, the work capacity of fairly fit boys was unlikely to change over a school year unless a training program specifically designed to improve endurance fitness was instituted.

Stewart and Gutin (1976) tested 13 boys, aged 10 to 12 years, within 10 days before and one week after eight weeks of training (40 minutes, four times per week). Training was conducted in the regular physical education classes and consisted of one- or three-minute interval runs separated by one-minute walking recovery periods. Some intervals were paced while others were all-out efforts. Training heart rates averaged 90% of the mean maximal heart rate for the entire group. Maximal oxygen uptake, measured on both the bicycle and treadmill, did not change significantly for the trained group as compared to the controls. However, heart rate responses to submaximal work loads decreased significantly with training, leading the investigators to suggest that submaximal physiological and performance measures are more important than maximal ones in the assessment of cardiorespiratory fitness.

Saunders, Montoye, Cunningham and Kozar (1969) studied more than 800 boys and girls at a senior high school (grades 9-12) in Michigan. The sample tested represented 99% of the total school population. The children in the school were required to enroll in five "solid" subjects and select one elective (physical education, band, chorus or art). Boys and girls enrolled in physical education scored highest on the 600-yard walk-run. However, a careful evaluation of the students' histories of elective selection showed that the differences in girls (those taking physical education versus those not) were probably due to enrollment in physical education, whereas the boys in physical education were physically superior as freshmen and did not increase their superiority as a result of participation in physical education.

Kemper, Vershcuur, Ras, Snel, Splinter and Tavecchio (1976) and Johnson (1969), in two independent studies, demonstrated that additional physical education classes (five per week versus two or three per week) do not contribute to cardiorespiratory fitness. Kemper et al. found no differences in W_{170}, percent body fat or physical activity measured by pedometer between 12- to 13-year-old boys taking physical education five times per week and those taking physical education three times per week for one year. Johnson found no difference in the time needed to run 600 yards for eighth grade boys and girls having had physical education, five versus two or three times per week, for two consecutive school years. He did, however, report significantly less subcutaneous adipose tissue for those students taking five classes per week.

A study by Moody, Wilmore, Girandola, and Royce (1972) of 40 normal and obese high school girls following their participation in a 15- or 29-week walking, jogging and running program supports the findings of Johnson. Subcutaneous fat, as assessed by the sum of skinfold measurements, was 16.0% less for normal girls (relative fat $<$ 30% before program) after 15 weeks. After 15 weeks, skinfold measurements for obese girls (relative fat $>$30% before program) was 20.9% less, and after 29 weeks, 23.5% less for the same group. The program started with the girls jogging and walking 1.6 km in equal proportion, and was gradually increased until the daily required distance was 4.8 to 5.6 km, with 75% of the distance jogged.

Cooper, Purdy, Friedman, Bohannon, Harris, and Arends (1975) have demonstrated that an endurance training program can be implemented effectively in an entire school system, and that such a program can significantly improve endurance performance. Their control group consisted of five high schools which performed only the regular physical education activities--push-ups, sit-ups, chin-ups, running 300 yards, and various team sports, such as touch football, basketball, and softball. Four experimental schools added a daily aerobic exercise program, which consisted primarily of up to 14 minutes of jogging at the beginning of each class, followed by the regular activities. The intervention lasted 18 weeks. Both groups participated in pre-intervention and post-intervention 12-minute runs (distance run in 12 minutes). The experimental group ran 17.5% farther in 12 minutes, while the control group actually did poorer (0.7% less distance in 12 minutes).

The Relationship of Endurance Training to Self-Concept in Children and Adolescents

While psychological stress has been established as a risk factor associated with CHD (Boyer, 1972; Fletcher & Cantwell, 1971; Holloszy, 1963), many investigators and cardiologists have reserved judgment as to the role of self-concept in that association. There is, however, an indirect association of self-concept to CHD, particularly as it relates to other risk factors. Work capacity and self-image are important to youngsters. These characteristics are in turn related to habits of regular exercise and to certain risk factors and life styles: for example, smoking and obesity are related to poor maximal oxygen uptake capacity and poor work tolerance. Hence, the expectation of improvement in work tolerance and self-concept may be a powerful motivating force to reduce obesity and smoking.

To date, the few studies relating endurance training to self-concept in children and adolescents have been conducted in school physical education classes, perhaps because of convenience. McGowan, Jarman, and Pedersen (1974) used the Tennessee Self-Concept Scale and Cooper's 12-minute run to test for effects of an 18-week physical education program, emphasizing endurance activities, on seventh-grade boys. The students ran three or four days per week, and participated in various competitive activities--floor hockey, basketball, football and volleyball--on nonrunning days. A control group participated in the regular physical education class. The investigators found that the experimental group experienced a significant positive within-group change in cardiovascular fitness and self-concept. No significant differences from the pre- to post-testing were found for the control group.

In a program for five 13- to 16-year-old obese males, which involved jogging and calisthenics in the gymnasium and bobbing, floating, sprints and endurance swimming in the pool one hour per day, five days per week for three weeks, Collingwood and Willett (1971) measured significant increases in positive self-attitude and self-acceptance.

CHAPTER III

METHODS

Intervention

An endurance running program similar to that used by Cooper et al. (1975) in the Fort Worth, Texas, School District Study was incorporated into the curricula of the eight public high schools in the city of Knoxville, Tennessee (see Appendix A). The intervention period consisted of two nine-week sessions with classes meeting daily for 50 minutes. In each session, all physical education students were required to jog-walk for 6 minutes at the beginning of the class during the first week, and to increase jogging time progressively until they were running for 12 minutes continuously during the fifth week. Beginning with the sixth week, students jogged fewer minutes each day, but were required to jog a minimum distance of one mile during the allotted time. By the ninth week, they were jogging at least one mile in nine minutes. After running, the students engaged in selected recreational activities for the remainder of the physical education class. These activities included badminton, baseball, basketball, bowling, dance, touch or flag football, paddleball, ping pong, softball, tennis, tumbling, volleyball, wrestling and weightlifting.

Physical education teachers were given training program guidelines (Appendix A) and instructions for program administration (Appendix B) well in advance of the intervention. The need for proper administration of the program was discussed at physical education in-service meetings, some of which were conducted by the investigator, prior to the intervention and at intervals during the intervention period.

Subjects

The ideal sampling unit for school fitness testing and the one used for AAHPER Fitness Test norms (Hunsicker, 1958) is the homeroom. The homeroom is a cross-section of a particular school population which contains various groups for comparison, such as male and female, black and white, varsity athlete and nonvarsity athlete, students taking physical education and those not taking physical education. Data from a random sample of homerooms can be used to establish norms specific to age and sex, and percentile ranks for the population from which they were drawn. Within each Knoxville City high school, students are assigned to homerooms alphabetically.

One sophomore homeroom was randomly selected from each of the eight city high schools. The total enrollment of the homerooms (N=183) constituted the original sample. A letter (Appendix C) signed by the Assistant Superintendent for Instruction for the Knoxville City Schools was mailed to the parents or legal guardians of each student in the original sample to (1) announce the new physical education curriculum, (2) inform them of their child's selection for participation in the curriculum evaluation, (3) describe the evaluation process, and (4) solicit the names of those students who had been advised to restrict or avoid physical education or physical activity because of illness or physical disability. No students were eliminated from the original sample by this process, nor did any students eliminate themselves by refusing to give written consent to be evaluated (Appendix D).

On each test day, students were not informed that they were to be evaluated until after school had commenced. This "surprise" technique was employed to minimize experimental bias due to absenteeism. Attendance was checked before the test began to insure that all students present at school on that particular day were tested. There were a few cases of students who were present at school but not tested for one reason or another. Most of these students were found and tested not more than one week after their initially scheduled test day.

Data Collection

Students were tested during the week preceding the intervention (January 30-February 2) and during the last week of the second session of school (May 29-June 1).

Interview

Students were interviewed individually by trained personnel. The interviewer, not the student, recorded the information on the data sheet (Appendix E). Information concerning age, sex, race, school and leisure activity habits, enrollment in physical education, activity preferences and cigarette smoking habits was obtained in this manner.

Blood Pressure

Blood pressure was measured by trained nurses using mercury-gravity manometers which had been checked to ensure identical readings for the same pressure. Systolic pressure was recorded at the first audible sound of a continuous beat. Diastolic pressure was recorded at the change from a clear to a muffled sound. Blood pressures were always measured before the student took the bench-stepping test.

Body Fatness

Subcutaneous body fat was assessed by a trained technician using the skinfold technique. The measurements were taken on the right side of the body at four different sites--biceps, triceps, forearm and cheek--with a calibrated Lange skinfold caliper. A student's body fatness was considered the sum of the four skinfold measurements.

Bench-Stepping Test

The bench-stepping protocol and rhythm were recorded on tape to insure uniformity in measurement for all students on all tests. Participants were required to step up and down on a 34.5 cm bench at the rate of 24 steps/min for one minute. They then sat on the bench and a 15-second pulse count was obtained by palpation of the carotid artery 10 seconds after the cessation of stepping. They continued to rest for 35 more seconds, after which the entire procedure was repeated using a bench-stepping rate of 30 steps per minute.

Energy Expenditure Index

An energy expenditure index was calculated for each student by multiplying the number of hours he/she was engaged in physical activity in the seven days before the interview by the average metabolic cost (ml 0_2/kg·min) of the four physical activities engaged in most often. Metabolic cost values were obtained from the literature.

Self-Concept Test

The Tennessee Self-Concept Scale (Appendix G) was administered to students from four homerooms, one from each geographic area of the city, before the first nine-week session began and at the end of the last nine-week session. Test directions were explained carefully to the students, and the test was monitored closely. After the test began, assistance was given only when word meaning was unclear to the student. In cases where the student obviously did not try to respond carefully and honestly (N=7), those data were omitted from the analysis.

Data Analysis

The treatment groups in the analyses of physiological measures were (1) those students taking no physical education classes during the 18-week program, (2) those students taking physical education during the first nine weeks only, (3) those students taking physical education during the second nine weeks only, and (4) those students taking physical education for the entire 18 weeks.

The treatment groups in the analyses of self-concept data were (1) those students taking no physical education classes during the 18-week program, and (2) those students taking physical education for the entire 18 weeks.

Homogeneity of treatment variances for all physiological dependent variables (heart rate response to bench-stepping test, systolic blood pressure, diastolic blood pressure, body fatness and energy expenditure index) and all self-concept dependent variables (self-criticism, self-satisfaction, physical self, personal self, family self, social self and total self) was tested using the Bartlett-Box F test. In those cases in which nonhomogeneity was apparent ($p < .10$), the raw data were transformed by taking the square root of the raw scores, and the transformed scores were used in the analysis of variance (ANOVA) formulas. A one-way ANOVA was then used to test for the effects of treatment for all physiological and psychological dependent variables on pre-intervention scores.

Homogeneity of variance was tested on post-intervention scores for all dependent variables in the same manner as for the pre-intervention scores. Square root transformation of raw scores was performed where the assumption was not tenable.

A one-way ANOVA was used to test for the effects of treatment for those physiological and psychological dependent variables not different at the .30 level on the pre-intervention ANOVA. For those variables showing differences, a one-way analysis of covariance was used instead of the ANOVA if the assumptions of equal slopes could be tested and verified.

A one-sample Chi square test, using pre-intervention smoking habits as expected values, was used to determine whether participation in physical education classes affected smoking habits among the four treatment groups established for analysis of the physiological data.

CHAPTER IV

RESULTS

A total of 183 students was enrolled in the sample homerooms from the eight high schools. Of those, 169 (92%) were tested before the intervention began, 151 of whom had complete data. Reasons for not having complete data were leg and foot injuries, illness and inability to complete the bench-stepping test successfully. One hundred and twenty-nine of those students who had complete data on the pre-intervention test also had complete data on the post-intervention test. This number represents 77% of the pre-intervention sample and 71% of the original homeroom sample. A summary of the number of students tested expressed in percent of original and pre-intervention samples is given in Table 1.

A one-sample Chi square test (Table 2), using pre-intervention smoking habits as expected values, was used to determine whether partici-pation in physical education classes affected smoking habits among the four treatment groups. The obtained $\chi^2 = 0.74$, df = 3, was not significant at the .10 level.

The results of the analyses of variance between treatment groups for all comparisons (all students, students in the upper 50% on heart rate response, students in the upper 50% on body fatness) on pre-intervention physiological and self-concept measures are located in Appendix G.

The results of the analysis of variance between treatment groups on post-intervention physiological data for all students is presented in Table 3. The mean differences between groups for heart rate response

TABLE 1

NUMBER OF STUDENTS TESTED EXPRESSED IN PERCENT OF ORIGINAL AND PRE-INTERVENTION SAMPLES

Sample	N	Percent Original Sample	Percent Pre-Intervention Sample
Total Homeroom Sample	183	100	---
Pre-Intervention	169	92	100
Post-Intervention (with pre-intervention data)	129	71	77

TABLE 2

OBSERVED AND EXPECTED PERCENTAGES OF NON-SMOKERS IN EACH OF THE FOUR TREATMENT GROUPS AFTER 18 WEEKS[a]

	Percent	No P.E.	P.E., First 9 Wks.	P.E., Second 9 Wks.	P.E., 18 Wks.	Chi Square
Expected	100	60	11	14	15	0.67
Observed	100	59	12	12	17	

[a] Includes subjects with complete smoking data for pre-intervention and 18-week tests.

TABLE 3

POST-INTERVENTION ANALYSES OF VARIANCE FOR ALL STUDENTS ON PHYSIOLOGICAL MEASURES

	No P.E. (N=75)		P.E., First 9 Weeks Only (N=14)		P.E., Second 9 Weeks Only (N=16)		P.E., 18 Weeks (N=24)		
Test Item	M	S.E.	M	S.E.	M	S.E.	M	S.E.	F
HR Response (beats/min)	33.6	0.62	32.6	1.35	32.4	1.22	31.5	1.11	1.03
Systolic BP (mm Hg)	113.7	1.52	116.4	3.30	117.4	2.77	112.6	1.87	0.67
Diastolic BP (mm Hg)	73.7	0.98	75.0	2.56	69.0	1.78	73.8	0.96	1.94[a]
Body Fat (mm)	43.3	2.52	39.4	8.52	35.7	4.99	40.0	3.59	0.75[b]
Energy Expenditure Index[b]	81.3	8.65	109.7	19.67	113.7	26.73	80.0	11.49	1.35[b]

[a] Transformed raw scores used in computing F value.

[b] Energy Expenditure Index = (hrs/wk of leisure activity) x (mean met cost for activities).

(F = 1.03, df = 3/125), systolic blood pressure (F = 0.67, df = 3/125), diastolic blood pressure (F = 1.94, df = 3/125), body fatness (F = 0.75, df = 3/125), energy expenditure index (F = 1.35, df = 3/125) were not significant ($p > .10$).

When these analyses were repeated for students scoring in the upper 50% on heart rate response (Table 4), the mean differences between groups for heart rate response (F= 1.71, df = 3/58), systolic blood pressure (F = 0.83, df = 3/58), diastolic blood pressure (F = 0.42, df = 3/58), body fatness (F = 0.82, df = 3/58) and energy expenditure index (F = 0.22, df = 3/58) were not significant ($p > .10$).

Similar results were obtained for students scoring in the upper 50% on body fatness (Table 5). The mean differences between groups for heart rate response (F = 1.34, df = 3/61), and body fatness (F = 0.56, df = 3/61) were not significant ($p > .10$). Table 6 contains the results of the analyses of covariance between treatment groups on measures that were different ($p < .30$) in the pre-intervention analyses for the group scoring in the upper 50% on body fatness. Adjusted mean differences for systolic blood pressure (F = 0.23, df = 3/60), diastolic blood pressure (F = 0.49, df = 3/60), and energy expenditure index (F = 0.29, df = 3/60) were not significant ($p > .10$). Prior to using the covariance analysis, a test was made on the assumption of common slopes. The test revealed that the assumption of equal slopes was tenable for all three variables at the .10 level of significance.

The procedures for analyzing the self-concept measures were the same as for the physiological data. For all students, on those measures not significantly different in pre-intervention analyses (Table 7), the

TABLE 4

POST-INTERVENTION ANALYSES OF VARIANCE ON PHYSIOLOGICAL MEASURES FOR STUDENTS SCORING IN THE UPPER 50% ON HEART RATE RESPONSE TO BENCH STEPPING (HIGHEST HR RESPONSE)

	No P.E. (N=39)		P.E., First 9 Weeks Only (N=6)		P.E., Second 9 Weeks Only (N=4)		P.E., 18 Weeks (N=13)		
Test Item	M	S.E.	M	S.E.	M	S.E.	M	S.E.	F
HR Response (beats/min)	37.3	0.57	35.0	1.24	36.7	1.31	34.9	1.22	1.71
Systolic BP (mm Hg)	114.3	2.10	118.7	7.76	116.5	2.75	112.2	2.76	0.83
Diastolic BP (mm Hg)	74.4	1.43	77.3	4.02	71.5	1.50	74.8	1.41	0.42[a]
Body Fat (mm)	53.4	3.45	49.5	19.55	37.2	2.36	49.6	5.03	0.82[a]
Energy Expenditure Index[b]	77.3	11.58	82.0	24.90	52.6	11.05	62.4	9.35	0.22[a]

[a] Transformed raw data scores used in computing F value.

[b] Energy Expenditure Index = (hrs/wk of leisure activity) x (mean met cost for activities).

TABLE 5

POST-INTERVENTION ANALYSES OF VARIANCE ON PHYSIOLOGICAL MEASURES NOT SIGNIFICANTLY DIFFERENT IN THE PRE-INTERVENTION ANALYSES FOR STUDENTS SCORING IN THE UPPER 50% ON BODY FAT (MOST FAT)

	No P.E. (N=42)		P.E., First 9 Weeks Only (N=5)		P.E., Second 9 Weeks Only (N=7)		P.E., 18 Weeks (N=11)		
Test Item	M	S.E.	M	S.E.	M	S.E.	M	S.E.	F
HR Response (beats/min)	35.7	0.75	34.0	1.55	34.4	1.23	32.6	1.49	1.34
Body Fat (mm)	55.3	2.83	63.6	20.16	49.0	9.05	52.8	5.32	0.56[a]

[a] Transformed raw data scores used in computing F value.

TABLE 6

POST-INTERVENTION ANALYSIS OF COVARIANCE ON PHYSIOLOGICAL MEASURES SIGNIFICANTLY DIFFERENT IN THE PRE-INTERVENTION ANALYSES FOR STUDENTS SCORING IN THE UPPER 50% ON BODY FAT (MOST FAT)

	No P.E. (N=42)			P.E., First 9 Wks. (N=5)			P.E., Second 9 Wks. (N=7)			P.E., 18 Weeks (N=11)			
	Obtained		Adjusted	Obtained		Adjusted	Obtained		Adjusted	Obtained		Adjusted	
Test Item	M	S.E.	M	M	S.E.	M	M	S.E.	M	M	S.E.	M	F
Systolic BP (mm Hg)	113.3	1.96	113.8	119.6	6.40	114.31	116.0	5.45	113.1	110.9	2.48	113.2	0.23
Diastolic BP (mm Hg)	74.0	1.20	74.1	76.0	4.24	74.3	72.3	2.48	72.46	71.8	1.09	72.07	0.49[a]
Energy Expenditure Index[b]	92.9	11.79	92.88	98.7	31.20	97.21	72.5	40.01	85.24	76.8	11.72	69.50	0.29[a]

[a] Transformed raw data scores used in computing F value.

[b] Energy Expenditure Index = (hrs/wk of leisure activity) x (mean met cost for activities).

TABLE 7

POST-INTERVENTION ANALYSES OF VARIANCE FOR ALL STUDENTS ON SELF-CONCEPT MEASURES NOT SIGNIFICANTLY DIFFERENT IN PRE-INTERVENTION ANALYSES

	No P.E. (N=45)		P.E., 18 Weeks (N=11)		
Test Item	M	S.E.	M	S.E.	F
Self-Criticism	115.7	6.18	132.4	18.99	1.13[a]
Physical Self	65.8	1.31	69.5	2.60	1.58
Family Self	65.8	1.09	64.7	2.94	0.70
Social Self	65.4	1.10	67.4	2.59	0.57

[a] Transformed raw scores used in computing F value.

mean differences between groups for self-criticism (F = 1.13, df = 1/43), physical self (F = 1.58, df = 1/43), family self (F = 0.70, df = 1/43), and social self (F = 0.57, df = 1/43) were not significant ($p > .10$).

Table 8 contains the results of the analysis of covariance between treatment groups on measures that were different ($p < .30$) in the pre-intervention analyses for all students. Adjusted mean differences for self-satisfaction (F = 0.02, df = 1/43), personal self (F = 1.57, df = 1/43), and total self (F = 0.13, df = 1/43) were not significant ($p > .10$). Tests revealed that the assumption of equal slopes was tenable for all three variables at the .10 level of significance.

Self-concept analyses for students in the upper 50% on heart rate response to bench stepping (Table 9) revealed no significant mean differences for self-criticism (F = 0.08, df = 1/28), self-satisfaction (F = 0.80, df = 1/28), physical self (F = 0.10, df = 1/28), family self (F = 0.12, df = 1/28), social self (F = 0.76, df = 1/28) and total self (F = 1.04, df = 1/28). The analysis of covariance technique was used for personal self (Table 10) to adjust for mean group differences ($p < .30$) on the pre-intervention analysis. Adjusted mean differences were significant (F = 3.73, df = 1/28, $p < .10$). The assumption of equal slopes was tenable at the .10 level of significance.

Finally, no significant differences were discovered using the analysis of variance for students scoring in the upper 50% on body fatness (Table 11) on scores for self-criticism (F = 0.00, df = 1/28), self-satisfaction (F = 0.16, df = 1/28), physical self (F = 0.13, df = 1/28), personal self (F = 1.34, df = 1/28), family self (F = 0.00, df =

TABLE 8

POST-INTERVENTION ANALYSES OF COVARIANCE FOR ALL STUDENTS ON SELF-CONCEPT MEASURES SIGNIFICANTLY DIFFERENT IN PRE-INTERVENTION ANALYSES

	No P.E. (N=45)			P.E., 18 Weeks (N=11)			
	Obtained		Adjusted	Obtained		Adjusted	
Test Item	M	S.E.	M	M	S.E.	M	F
Self-Satisfaction	97.2	1.91	97.2	102.5	4.87	102.5	0.02
Personal Self	64.3	1.18	64.8	69.0	1.80	67.1	1.58
Total Self	326.1	4.20	326.1	335.9	11.92	335.9	0.13

TABLE 9

POST-INTERVENTION ANALYSES OF VARIANCE ON SELF-CONCEPT MEASURES NOT SIGNIFICANTLY DIFFERENT IN THE PRE-INTERVENTION ANALYSES FOR STUDENTS SCORING IN THE UPPER 50% ON HR RESPONSE TO BENCH STEPPING (HIGHEST HR RESPONSE)

	No P.E. (N=25)		P.E., 18 Weeks (N=5)		
Test Item	M	S.E.	M	S.E.	F
Self-Criticism	109.4	10.15	116.2	14.01	0.08
Self-Satisfaction	97.8	2.46	103.4	6.64	0.80
Physical Self	65.2	1.52	66.4	4.54	0.10
Family Self	66.2	1.38	65.8	2.97	0.12
Social Self	65.6	1.46	68.8	4.02	0.76
Total Self	326.7	4.73	339.8	16.25	1.04

TABLE 10

POST-INTERVENTION ANALYSIS OF COVARIANCE ON SELF-CONCEPT MEASURE SIGNIFICANTLY DIFFERENT IN PRE-INTERVENTION ANALYSIS FOR STUDENTS SCORING IN THE UPPER 50% ON HR RESPONSE TO BENCH STEPPING (HIGHEST HR RESPONSE)

	No P.E. (N=25)			P.E., 18 Weeks (N=5)			
	Obtained		Adjusted	Obtained		Adjusted	
Test Item	M	S.E.	M	M	S.E.	M	F
Personal Self	64.1	1.52	64.51	71.6	0.10	69.44	3.73*

*$p < .10$

TABLE 11

POST-INTERVENTION ANALYSES OF VARIANCE ON SELF-CONCEPT MEASURES FOR STUDENTS SCORING IN THE UPPER 50% ON BODY FAT (MOST FAT)

	No P.E.			P.E., 18 Weeks			
Test Item	N	M	S.E.	N	M	S.E.	F
Self-Criticism	25	115.3	20.64	5	113.8	13.26	0.00
Self-Satisfaction	25	97.4	3.12	5	99.6	3.44	0.16
Physical Self	25	64.8	3.20	5	66.2	4.43	0.13
Personal Self	25	65.5	3.55	5	69.6	1.89	1.34
Family Self	25	65.6	2.11	5	65.4	2.71	0.00
Social Self	25	66.8	4.19	5	67.2	3.60	0.01
Total Self	25	329.0	14.57	5	336.8	14.75	0.34

1/28), social self (F = 0.01, df = 1/28), or total self (F = 0.34, df = 1/28).

CHAPTER V

DISCUSSION

Methods for determining energy expenditure resulting from physical activity have been available for many years. Early field determinations were made by indirect calorimetry. Recently, pedometers and devices for recording heart rate have been experimented with. Although they do not present the physical problems of earlier apparatus (Douglas bags, masks, and the like), such devices introduce a psychological artificiality that may result in nonrepresentative data. Interview/questionnaire assessment, the method used in the present study, is perhaps least accurate of the available methods. It is, however, the one commonly utilized in studies of large populations where other methods are impractical and/or too expensive.

Despite the problems and inaccuracies associated with the interview/questionnaire method, the results of the present study are what might be expected. For comparisons involving all students, those students enrolled in physical education at the time of the post-intervention interview (physical education, nine weeks only and physical education, 18 weeks) were expending as much or more energy after school as those who were not enrolled in physical education. This was not true, however, for comparisons involving the most fat and least fit students. The ones enrolled in physical education at the time of the post-intervention interview had lower mean energy expenditures than those not enrolled, suggesting that the activity in class could have had a tiring effect which reduced after-school activity.

It is not surprising that the students who participated in the physical education endurance running program implemented in this study showed no significant decreases in body fatness and blood pressures, which are related to body fatness. Body fatness losses have been realized in training programs that require running sessions of longer duration (Brown et al., 1972) and, as a result, much greater energy expenditure.

That students did not exhibit significantly lower heart rate responses to bench stepping does not at first appear to be consistent with results from studies with similar training regimens. For example, Massicotte and Macnab (1974) demonstrated that increases in cardiorespiratory function can result from three 12-minute cycling sessions (heart rates of 170-180 beats/min) for only six weeks. Their subjects, 11- to 13-year old boys, trained on stationary bicycles in a clinical setting, thus allowing the investigators to monitor carefully the intensity of the training (heart rate 170-180 beats/min). Could Massicotte and Macnab duplicate their results using public school physical education classes supervised by a school teacher? Alternatively, would the Knoxville high school sophomores demonstrate the same lack of training response if they trained under close supervision in a clinical setting? The answer to both questions is probably no, and the literature supports that answer.

Non-school-related programs for children and adolescents (Brown et al., 1972; Eisenman & Golding, 1975; Ekblom, 1969; Holmes, 1958; March, 1959; Mas, 1957; Massicotte & Macnab, 1974) have routinely reported significant changes on some cardiovascular fitness measures, while school-related physical education programs, specifically those which are implemented as part of the regular school physical education curriculum (Cumming et al., 1969; Schwartz et al., 1928) have not. This is not to say that successful training programs are not conducted in schools. Those that are, however, usually involve volunteer students who select special fitness classes in lieu of regular physical education classes (Daniels & Oldridge, 1971), or are atypical within the school or school system in that they involve only one class or an otherwise select group of students (McGowan et al., 1974; Moody et al., 1972; Stewart & Gutin, 1976). One system-wide school endurance training program (Cooper et al., 1975) produced significant performance gains (distance run in 12 minutes), but because performance is influenced by motivation, it is not certain what part of those improvements in performance represented improvements in cardiovascular fitness.

On the basis of the foregoing evidence, it is not advisable to use data collected in public school physical education programs to answer clinical questions. The present study is certainly no exception. This investigation cannot and was never designed to answer the question, "Can an endurance running program prevent or reduce coronary heart disease risk factors in high school sophomores?" It answers a different and no less important question: "Is an endurance running program of this type a reasonable and effective program for school physical education teachers to use in an attempt to prevent or reduce coronary heart disease risk factors in their sophomore classes?" In its present form, the Knoxville school endurance running program does not seem to be, at least not on a 9- or 18-weeks' basis.

Finally, some mention should be made about the danger of using group means to draw conclusions about the benefits of physical training programs in the public schools. Physical education classes are made up of different kinds of people with varying interests, motivations, and abilities. Teachers who worked closely with the Knoxville program observed that some students appeared to benefit greatly from daily running, while others showed little or no interest and ran as little as possible. While averaging the gains made by these two particular groups gives information about the average program effect for all students, it does not do justice to the fact that some students may have significantly improved their cardiovascular fitness as a result of the running program.

CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary and Conclusions

One hundred and twenty-nine randomly selected high school sophomores were tested before and after an 18-week endurance running program to determine the effects of that program on systolic and diastolic blood pressures, body fatness, heart rate response to submaximal exercise (bench-stepping test), leisure time energy expenditure, and cigarette smoking habits. Fifty-six of those students with complete physiological data were randomly selected to take the Tennessee Self-Concept Scale before and after the running program.

The running program was incorporated into the physical education curricula of the eight city high schools in Knoxville, Tennessee. The traditional physical education curriculum consisted of two nine-week sessions with students meeting daily for 50 minutes. Under the intervention program, all physical education students in each session were required to jog-walk for six minutes at the beginning of class during the first week, and to increase jogging time progressively until they were running for 12 minutes continuously during the fifth week. Beginning with the sixth week, students jogged fewer minutes each day, but were required to jog a minimum distance of one mile during the allotted time. By the ninth week, they were jogging at least one mile in nine minutes. After running, the students engaged in selected recreational activities for the remainder of the class.

The treatment groups in the analysis of physiological measures were (1) those students taking no physical education classes during the 18-week program (Group 1), (2) those students taking physical education during the first nine weeks only (Group 2), (3) those students taking physical education during the second nine weeks only (Group 3), and (4) those students taking physical education for the entire 18 weeks (Group 4). Only Groups 1 and 4 were compared on self-concept measures. The physical education program was elective, so students placed themselves in one of the four groups by their class enrollment preferences. They were not, however, aware that their preferences were in any way connected with the program evaluation.

An analysis of variance on post-intervention data revealed no significant differences between treatment groups on physiological and self-concept measures ($p > .10$).

The same comparisons for those students scoring in the upper 50% on heart rate response to bench stepping (highest heart rate response) yielded similar results. There were no significant differences among the physiological measures ($p > .10$), while only the score for personal self was significantly higher for those who took physical education for 18 weeks.

When the same comparisons were made for those students scoring in the upper 50% on body fatness (most fat), there were no significant differences among the treatment groups for either physiological or self-concept measures.

A one-sample Chi square test showed no changes in the distribution of smokers and nonsmokers among the treatment groups ($p > .10$) as a result of the running program. The invervention program apparently did not influence students to stop smoking.

Recommendations

1. Although the endurance running in this particular study was not sufficient to effect significant changes in coronary heart disease risk factors (except for Personal Self-Concept), it appears to have caused small changes in preferred directions for some of the risk factors. This suggests that an endurance running program requiring more activity per session over a longer period of time might produce significant, desirable changes in risk factors.

2. More precise methods of measurement are needed in field studies of this type, expecially for determining the amounts of physical activity and energy expenditure.

3. The sample size in a study of this type should be large enough to ensure a minimum of 20 to 25 students in all treatments for all comparisons, including those comparisons made for most fat and least fit students.

4. Blood analyses should be done to measure the effects of endurance running programs on high- and low-density lipoproteins, both of which are strongly implicated in the etiology of heart disease. While these analyses may be impractical for the entire sample, a percentage of the original sample should be selected for this purpose.

5. Daily records of distance covered by each student should be kept by the physical education teachers. This would enable the researcher to eliminate those students not sufficiently involved in the intervention from the statistical analyses, or to treat them as a separate group.

6. High school sophomores may already be "locked into" a sedentary life style that minimizes the benefits of endurance activity. Other investigations similar to the present one need to be directed toward younger school children who may be more eager and more impressionable.

7. Public school officials, administrators and teachers appear too content to provide expensive physical education programs without evaluating the effects of these programs on physical and mental well-being. A change in such attitudes would encourage and facilitate further research in this area.

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APPENDICES

APPENDIX A

KNOXVILLE CITY SCHOOLS CARDIOVASCULAR FITNESS PROGRAM

Week	Stretching* (min)	Jog/Walk (min)	Minimum Distance (mi)	Cool down (min)	Total time (min)
1	1	6	—	1	8
2	1	8	—	1	10
3	1	10	—	1	12
4	1	11	—	1	13
5	1	12	—	1	14
6	1	12	1	2	15
7	1	11	1	2	15
8	1	10	1	2	14
9	1	9	1	2	13
10**	1	6	—	1	8
11	1	8	—	1	10
12	1	10	—	1	12
13	1	11	—	1	13
14	1	12	—	1	14
15	1	12	1	2	15
16	1	11	1	2	15
17	1	10	1	2	14
18	1	9	1	2	13

*Arm circles, trunk rotations and toe touches

**New nine-week session begins.

APPENDIX B

KNOXVILLE CITY SCHOOLS NOTE TO PHYSICAL EDUCATION TEACHERS ON THE CARDIOVASCULAR CONDITIONING PROGRAM*

The Training Effect

This program is an attempt to increase the cardiovascular physical fitness of the students in the Knoxville public schools. Cardiovascular conditioning increases the body's ability to transport oxygen from the lungs into the blood, through the heart and blood vessels, and finally into the body tissue. The change in the body resulting from cardiovascular conditioning is known as the "training effect." The bodily systems affected and the results of cardiovascular conditioning include:

1. THE HEART—develops it into a strong, healthy muscle that works more effortlessly, either during moments of relaxation or moments of peak physical exertion, and by doing so maintains large reserves of power to handle whatever physical or emotional stress is imposed upon it. As a result, the resting heart rate will decrease, sometimes up to 20 beats per minute or more.
2. THE LUNGS—exercises the muscles surrounding the lungs, increasing their strength and efficiency, and helping to open up more usable lung space. Increases the vital capacity and reduces residual volume.
3. THE BLOOD—produces more blood, specifically more hemoglobin, which carries the oxygen; more red blood cells, which carry the hemoglobin; more blood plasma, which carries the red blood cells; and consequently, more total blood volume. A man of average size may increase his blood volume by nearly a quart in response to aerobic conditioning.

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*Adapted from notes developed by Dr. J. Gerry Purdy, Institute for Aerobics Research, for physical education teachers in the Fort Worth, Texas School District (Report No. IAR-1972-002, November, 1972).

4. THE BLOOD VESSELS—— enlarges the blood vessels and makes them more pliable to pressure, increases their number for saturation coverage, and helps keep their linings clear of corrosive material for speedier routes.
5. THE DIGESTIVE SYSTEM—has a relaxing effect on the digestive system. For example, conditioned men generally produce less acid in their stomachs. Exercise is a natural cathartic.
6. THE MUSCULAR SYSTEM——produces muscle fitness as a by-product. On the other hand, training for muscular strength does not produce cardiovascular fitness as a by-product.
7. LIPID LEVELS————lowers the cholesterol and triglyceride levels, making it less likely that fatty deposits will form on vessel walls (arteriosclerosis).

Habits in the maintenance of good physical fitness must be developed early in life, and it is essential that students be made aware of long-term benefits of maintaining a high level of physical fitness and the proper diet, and eliminating smoking habits. It is very important that you, as physical education teachers, tell the students what the training effect is and what changes occur: knowledge of the training effect will help motivate the students in their conditioning program.

Administration of the Conditioning Program

You will be given a Daily Training Program guide and a Class Record form to record test results. The Daily Program Guide was designed with the intention of having the student cover a particular distance each day. The student should be told that the sooner he/she finishes the required distance, the sooner he/she can go to other activities.

The "Maximum Time" is given as a cutoff, so that those in very poor physical fitness will not have to run/jog/walk for the whole period. You can call out the elapsed time as the students reach the required distance.

When the maximum time is reached, blow a whistle and tell all those remaining to stop.

An 18-week program has been outlined. If a class does not meet on a given day, simply ignore the workout for that day.

We ask that you time your students for a one-mile run during the first and ninth weeks of each nine-week session. Be as precise as possible in your testing and motivate your students to do their best each time.

APPENDIX C

LETTER TO PARENTS

KNOXVILLE CITY SCHOOLS
Division of Instruction

101 East Fifth Avenue - Knoxville, Tennessee 37917 - Telephone (615) 546-2251

JAMES A. NEWMAN, Superintendent
PAUL KELLEY, ED.d., Assistant Superintendent for Instruction
THOMAS R. UNDERWOOD, Director of Elementary Education
EARL W. HENRY, ED.d., Director of Secondary Education

January, 1979

Dear Parents:

Certain Knoxville City Schools are now using an innovative physical education program that is designed to improve the health and physical fitness of our children.

The program is similar to the "aerobics" program devised by U.S. Air Force doctors, now used by many public schools and universities throughout the United States. It is designed to supplement, not replace, the existing physical education program.

Your child, along with the other students in his/her homeroom, has been selected to help us evaluate the effects of our new program. In the near future, the following tests will be administered by school nurses and teachers:

1. Blood pressure test,
2. A nutrition interview,
3. A short, written self-concept test, and
4. Other measures of cardiovascular fitness.

The information which is obtained will be treated as privileged and confidential. If, however, you prefer that the information collected on your child not be used in the program evaluation, or if you have any questions concerning the program, please call Vic Taylor, Director of Physical Education and Athletics, at 546-2251.

Your child's cooperation is greatly appreciated.

Paul Kelley

Dr. Paul Kelley
Assistant Superintendent for Instruction

If your child has been advised by a physician not to participate in school physical education classes because of illness or physical disability, or to restrict his/her physical activity for said reasons, please sign and return this form to the school. There will be no penalty for the non-participant.

____
Signature of Parent or Legal Guardian

APPENDIX D

STUDENT CONSENT FORM

I have been informed orally of the procedures for the physical fitness testing for Knoxville City Schools. The information which is obtained will be treated as privileged and confidential and will not be released or revealed to any person without my written consent. The information obtained, however, may be used for a statistical or scientific purpose with my right of privacy retained.

I have read the foregoing and I understand it. Any questions which may have occurred to me have been answered to my satisfaction.

Signed:

______________________________ ____________________
Student Date

______________________________ ____________________
Witness Date

APPENDIX E

KNOXVILLE CITY SCHOOLS FITNESS DATA CARD

Column

1-2 ______________________ SCHOOL

3-5 ________ ID #

6 _____ CARD #

7-8 _____ AGE

9 _____ SEX 1=male 2=female

10 _____ RACE 1=white 2=black 3=other

11-12 ______________________ DID YOU TAKE P.E. DURING THE PAST NINE-WEEK SESSION? IF SO, WHAT?

13 _____ HAVE YOU COMPLETED YOUR REQUIRED P.E. FOR HIGH SCHOOL? 1=yes 2=no

14-15 _____ VARSITY SPORTS:

16-17 _____

18-19 _____

20-21 _____

1. __ None
2. __ Baseball
3. __ Basketball
4. __ Cross Country
5. __ Football
6. __ Golf
7. __ Swimming
8. __ Tennis
9. __ Track
10. __ Volleyball
11. __ Wrestling
12. __ Other

22-23 _____ WHAT ARE YOUR FAVORITE P.E. ACTIVITIES? (3)

24-25 _____

26-27 _____

1. __ Badminton
2. __ Baseball
3. __ Basketball
4. __ Bowling
5. __ Dance
6. __ Fitness
7. __ Football
8. __ Paddleball
9. __ Ping Pong
10. __ Softball
11. __ Tennis
12. __ Track
13. __ Tumbling
14. __ Volleyball
15. __ Wrestling
16. __ Other

28-29 _____ HOW MANY HOURS LAST WEEK (Monday-Sunday) IN YOUR FREE TIME DID YOU SPEND ON PHYSICAL ACTIVITY?

30-31 _____ HOW MANY HOURS/WEEK IN YOUR FREE TIME DID YOU NORMALLY SPEND ON PHYSICAL ACTIVITY DURING THIS PAST YEAR?

Column

32-33 ______ WHAT SPORTS OR OTHER FORMS OF PHYSICAL ACTIVITY DO YOU DO MOST OFTEN IN YOUR FREE TIME? (4)

34-35 ______

36-37 ______

38-39 ______

1. __ Badminton
2. __ Baseball
3. __ Basketball
4. __ Bowling
5. __ Calisthenics
6. __ Canoeing
7. __ Cycling
8. __ Dancing
9. __ Fishing
10. __ Football
11. __ Gardening
12. __ Golf
13. __ Gymnastics
14. __ Handball
15. __ Horse Riding
16. __ House Work
17. __ Hunting
18. __ Ice Hockey
19. __ Ice Skating
20. __ Jogging
21. __ Judo
22. __ Lawn Work
23. __ Mountain Hike
24. __ Paddleball
25. __ Ping Pong
26. __ Racquetball
27. __ Sailing
28. __ Scuba Diving
29. __ Shopping
30. __ Skateboarding
31. __ Skiing (Water)
32. __ Skiing (Snow)
33. __ Soccer
34. __ Softball
35. __ Squash
36. __ Swimming
37. __ Tennis
38. __ Volleyball
39. __ Walking
40. __ Weightlifting
41. __ Wrestling
42. __ Other

40-41 ______ DO YOU SMOKE CIGARETTES? IF SO, HOW MANY PER DAY?

42-44 ______ SYSTOLIC BLOOD PRESSURE

45-47 ______ DIASTOLIC BLOOD PRESSURE

48-49 ______ BICEPS SKINFOLD

50-51 ______ TRICEPS SKINFOLD

52-53 ______ CHEEK SKINFOLD

54-55 ______ FOREARM SKINFOLD

56-58 ______ HEIGHT

59-61 ______ WEIGHT

62-63 ______ HEART RATE, 24 STEPS/MINUTE

64-65 ______ HEART RATE, 30 STEPS/MINUTE

NAME ________________________________

APPENDIX F

TENNESSEE
SELF-CONCEPT SCALE

COMPUTER SCORED EDITION

by

William H. Fitts, PhD

Published by
Counselor Recordings and Tests
Box 6184 - Acklen Station Nashville, Tennessee 37212

NCS/NOF -491:54321 DC 33-283 [illegible]

WRITE YOUR NAME, LAST NAME FIRST, IN THE BOXES BELOW AND THEN MARK OUT THE CORRESPONDING LETTERS.

INK CANNOT BE SCORED
USE PENCIL ONLY
COMPLETELY FILL IN THE AREA BETWEEN THE LINES
THOROUGHLY ERASE ANY ANSWER YOU WISH TO CHANGE

ID NUMBER

NAME ______________ (last name first please) DATE ______

STUDENT NUMBER ______________

INDICATE YOUR SEX HERE: MALE ☐ FEMALE ☐

	CF	MF	P	MT	CT
1	1	2	3	4	5
2	1	2	3	4	5
3	1	2	3	4	5
4	1	2	3	4	5
5	1	2	3	4	5
6	1	2	3	4	5
7	1	2	3	4	5
8	1	2	3	4	5
9	1	2	3	4	5
10	1	2	3	4	5
11	1	2	3	4	5
12	1	2	3	4	5
13	1	2	3	4	5
14	1	2	3	4	5
15	1	2	3	4	5
16	1	2	3	4	5
17	1	2	3	4	5
18	1	2	3	4	5
19	1	2	3	4	5
20	1	2	3	4	5
21	1	2	3	4	5
22	1	2	3	4	5
23	1	2	3	4	5
24	1	2	3	4	5
25	1	2	3	4	5
26	1	2	3	4	5
27	1	2	3	4	5
28	1	2	3	4	5
29	1	2	3	4	5
30	1	2	3	4	5
31	1	2	3	4	5
32	1	2	3	4	5
33	1	2	3	4	5
34	1	2	3	4	5
35	1	2	3	4	5
36	1	2	3	4	5
37	1	2	3	4	5
38	1	2	3	4	5
39	1	2	3	4	5
40	1	2	3	4	5
41	1	2	3	4	5
42	1	2	3	4	5
43	1	2	3	4	5
44	1	2	3	4	5
45	1	2	3	4	5
46	1	2	3	4	5
47	1	2	3	4	5
48	1	2	3	4	5
49	1	2	3	4	5
50	1	2	3	4	5
51	1	2	3	4	5
52	1	2	3	4	5
53	1	2	3	4	5
54	1	2	3	4	5
55	1	2	3	4	5
56	1	2	3	4	5
57	1	2	3	4	5
58	1	2	3	4	5
59	1	2	3	4	5
60	1	2	3	4	5
61	1	2	3	4	5
62	1	2	3	4	5
63	1	2	3	4	5
64	1	2	3	4	5
65	1	2	3	4	5
66	1	2	3	4	5
67	1	2	3	4	5
68	1	2	3	4	5
69	1	2	3	4	5
70	1	2	3	4	5
71	1	2	3	4	5
72	1	2	3	4	5
73	1	2	3	4	5
74	1	2	3	4	5
75	1	2	3	4	5
76	1	2	3	4	5
77	1	2	3	4	5
78	1	2	3	4	5
79	1	2	3	4	5
80	1	2	3	4	5
81	1	2	3	4	5
82	1	2	3	4	5
83	1	2	3	4	5
84	1	2	3	4	5
85	1	2	3	4	5
86	1	2	3	4	5
87	1	2	3	4	5
88	1	2	3	4	5
89	1	2	3	4	5
90	1	2	3	4	5
91	1	2	3	4	5
92	1	2	3	4	5
93	1	2	3	4	5
94	1	2	3	4	5
95	1	2	3	4	5
96	1	2	3	4	5
97	1	2	3	4	5
98	1	2	3	4	5
99	1	2	3	4	5
100	1	2	3	4	5

THE TENNESSEE SELF CONCEPT SCALE

DC 33-284

DIRECTIONS: Fill in your name and other information on the separate answer sheet.

The statements in this inventory are to help you describe yourself as you see yourself. Please answer them as if you were describing yourself to yourself. Read each item carefully; then select one of the five responses below and fill in the answer space on the separate answer sheet.

Don't skip any items. Answer each one. Use a soft lead pencil. Pens won't work. If you change an answer, you must erase the old answer completely and enter the new one.

RESPONSES	Completely False	Mostly False	Partly False and Partly True	Mostly True	Completely True
	C	M		M	C
	F	F	PF - PT	T	T
	1	2	3	4	5

TENNESSEE SELF CONCEPT SCALE

1. I have a healthy body 1
2. I am an attractive person 2
3. I consider myself a sloppy person 3
4. I am a decent sort of person 4
5. I am an honest person 5
6. I am a bad person 6
7. I am a cheerful person 7
8. I am a calm and easy going person 8
9. I am a nobody 9
10. I have a family that would always help me in any kind of trouble 10
11. I am a member of a happy family 11
12. My friends have no confidence in me 12
13. I am a friendly person 13
14. I am popular with men 14
15. I am not interested in what other people do 15
16. I do not always tell the truth 16
17. I get angry sometimes 17
18. I like to look nice and neat all the time 18
19. I am full of aches and pains 19
20. I am a sick person 20
21. I am a religious person 21
22. I am a moral failure 22
23. I am a morally weak person 23
24. I have a lot of self-control 24
25. I am a hateful person 25
26. I am losing my mind 26
27. I am an important person to my friends and family 27
28. I am not loved by my family 28
29. I feel that my family doesn't trust me 29
30. I am popular with women 30
31. I am mad at the whole world 31
32. I am hard to be friendly with 32
33. Once in a while I think of things too bad to talk about 33
34. Sometimes when I am not feeling well, I am cross 34
35. I am neither too fat nor too thin 35
36. I like my looks just the way they are 36
37. I would like to change some parts of my body 37
38. I am satisfied with my moral behavior 38
39. I am satisfied with my relationship to God 39
40. I ought to go to church more 40

DC 33-288 [illegible]

41. I am satisfied to be just what I am 41
42. I am just as nice as I should be 42
43. I despise myself 43
44. I am satisfied with my family relationships 44
45. I understand my family as well as I should 45
46. I should trust my family more 46
47. I am as sociable as I want to be 47
48. I try to please others, but I don't overdo it 48
49. I am no good at all from a social standpoint 49
50. I do not like everyone I know 50
51. Once in a while, I laugh at a dirty joke 51
52. I am neither too tall nor too short 52
53. I don't feel as well as I should 53
54. I should have more sex appeal 54
55. I am as religious as I want to be 55
56. I wish I could be more trustworthy 56
57. I shouldn't tell so many lies 57
58. I am as smart as I want to be 58
59. I am not the person I would like to be 59
60. I wish I didn't give up as easily as I do 60
61. I treat my parents as well as I should (Use past tense if parents are not living) 61
62. I am too sensitive to things my family say 62
63. I should love my family more 63
64. I am satisfied with the way I treat other people 64
65. I should be more polite to others 65
66. I ought to get along better with other people 66
67. I gossip a little at times 67
68. At times I feel like swearing 68
69. I take good care of myself physically 69
70. I try to be careful about my appearance 70
71. I often act like I am "all thumbs" 71
72. I am true to my religion in my everyday life 72
73. I try to change when I know I'm doing things that are wrong 73
74. I sometimes do very bad things 74
75. I can always take care of myself in any situation 75
76. I take the blame for things without getting mad 76
77. I do things without thinking about them first 77
78. I try to play fair with my friends and family 78
79. I take a real interest in my family 79
80. I give in to my parents.(Use past tense if parents are not living) 80
81. I try to understand the other fellow's point of view 81
82. I get along well with other people 82
83. I do not forgive others easily 83
84. I would rather win than lose in a game 84
85. I feel good most of the time 85
86. I do poorly in sports and games 86
87. I am a poor sleeper 87
88. I do what is right most of the time 88
89. I sometimes use unfair means to get ahead 89
90. I have trouble doing the things that are right 90
91. I solve my problems quite easily 91
92. I change my mind a lot 92
93. I try to run away from my problems 93
94. I do my share of work at home 94
95. I quarrel with my family 95
96. I do not act like my family thinks I should 96
97. I see good points in all the people I meet 97
98. I do not feel at ease with other people 98
99. I find it hard to talk with strangers 99
100. Once in a while I put off until tomorrow what I ought to do today 100

OC 33-280 [illegible]

APPENDIX G

PRE-INTERVENTION MEASURES: TABLES G-1 THROUGH G-6

TABLE G-1

PRE-INTERVENTION ANALYSES OF VARIANCE FOR ALL STUDENTS ON SELF-CONCEPT MEASURES

	No P.E. (N=45)		P.E., 18 Weeks (N=11)		
Test Item	M	S.E.	M	S.E.	F
Self-Criticism	119.8	6.10	124.8	11.06	0.13
Self-Satisfaction	96.2	1.57	103.4	3.89	3.82*
Physical Self	65.7	1.08	67.2	2.92	0.32
Personal Self	62.1	1.16	65.4	2.16	1.71
Family Self	65.2	1.23	65.4	2.10	0.01
Social Self	66.4	1.08	67.5	2.49	0.19
Total Self	321.4	4.24	331.9	9.96	1.17

*$p < .30$

TABLE G-2

PRE-INTERVENTION ANALYSES OF VARIANCE ON SELF-CONCEPT MEASURES FOR STUDENTS SCORING IN THE UPPER 50% ON HEART RATE RESPONSE TO BENCH STEPPING (HIGHEST HR RESPONSE)

	No P.E. (N=25)		P.E., 18 Weeks (N=5)		
Test Item	M	S.E.	M	S.E.	F
Self-Criticism	110.5	8.63	116.6	21.27	0.08
Self-Satisfaction	97.0	2.19	100.6	3.57	0.48
Physical Self	64.8	1.46	62.0	4.35	0.55
Personal Self	61.1	1.50	65.2	3.55	1.23^{*}
Family Self	64.9	1.94	67.2	2.18	0.26
Social Self	66.8	1.19	68.6	4.67	0.29
Total Self	321.6	5.43	331.8	14.56	0.55

$^{*}p < .30$

TABLE G–3

PRE–INTERVENTION ANALYSES OF VARIANCE ON SELF–CONCEPT MEASURES FOR STUDENTS SCORING IN THE UPPER 50% ON BODY FAT (MOST FAT)

	No P.E.			P.E., 18 Weeks			
Test Item	N	M	S.E.	N	M	S.E.	F
Self–Criticism	25	115.4	7.64	5	115.0	9.67	0.00
Self–Satisfaction	25	95.3	1.73	5	99.4	2.32	0.95
Physical Self	25	62.9	1.12	5	65.6	1.42	0.86
Personal Self	25	62.5	1.39	5	65.2	1.49	0.57
Family Self	25	64.3	1.70	5	67.4	1.45	0.59
Social Self	25	67.4	1.18	5	66.2	1.50	0.14
Total Self	25	321.4	4.76	5	332.0	5.07	0.73

TABLE G-4

PRE-INTERVENTION ANALYSES OF VARIANCE FOR ALL STUDENTS ON PHYSIOLOGICAL MEASURES

	No P.E. (N=75)		P.E., First 9 Weeks Only (N=14)		P.E., Second 9 Weeks Only (N=16)		P.E., 18 Weeks (N=24)		
Test Item	M	S.E.	M	S.E.	M	S.E.	M	S.E.	F
HR Response (beats/min)	35.1	0.76	34.2	1.46	32.4	1.56	34.3	1.42	0.79
Systolic BP (mm Hg)	118.1	1.42	123.9	3.39	122.0	3.86	118.0	1.92	1.20
Diastolic BP (mm Hg)	77.8	1.05	81.1	2.99	75.4	2.78	77.1	1.44	0.99
Body Fat (mm)	43.9	2.45	38.3	6.69	40.4	6.16	39.7	3.95	0.44
Energy Expenditure Index[b]	64.6	8.15	77.1	25.03	72.4	34.03	68.0	12.55	0.25[a]

[a] Transformed raw scores used in computing F value.

[b] Energy Expenditure Index = (hrs/wk of leisure activity) x (mean met cost for activities).

TABLE G-5

PRE-INTERVENTION ANALYSES OF VARIANCE ON PHYSIOLOGICAL MEASURES FOR STUDENTS SCORING IN THE UPPER 50% ON HEART RATE RESPONSE TO BENCH STEPPING (HIGHEST HR RESPONSE)

	No P.E. (N=39)		P.E., First 9 Weeks Only (N=6)		P.E., Second 9 Weeks Only (N=4)		P.E., 18 Weeks (N=13)		
Test Item	M	S.E.	M	S.E.	M	S.E.	M	S.E.	F
HR Response (beats/min)	40.23	0.59	39.5	0.85	40.2	1.75	39.8	1.06	0.11
Systolic BP (mm Hg)	119.9	1.45	124.3	5.50	126.5	4.03	116.8	2.65	1.01
Diastolic BP (mm Hg)	79.0	1.41	84.0	5.29	81.0	5.00	77.3	1.55	0.86
Body Fat (mm)	55.4	3.40	45.2	15.19	53.5	14.78	46.1	6.47	0.70
Energy Expenditure Index[a]	52.4	8.06	47.5	12.96	24.5	8.51	55.3	16.79	0.40

[a] Energy Expenditure Index = (hrs/wk of leisure activity) x (mean met cost for activities).

TABLE G–6

PRE-INTERVENTION ANALYSES OF VARIANCE ON PHYSIOLOGICAL MEASURES FOR STUDENTS SCORING IN THE UPPER 50% ON BODY FAT (MOST FAT)

Test Item	No P.E. (N=42)		P.E., First 9 Weeks Only (N=5)		P.E., Second 9 Weeks Only (N=7)		P.E., 18 Weeks (N=11)		
	M	S.E.	M	S.E.	M	S.E.	M	S.E.	F
HR Response (beats/min)	38.2	0.73	35.4	2.01	36.0	2.14	35.5	2.07	1.19
Systolic BP (mm Hg)	118.3	1.73	127.6	4.71	123.7	6.81	115.4	2.80	1.63
Diastolic BP (mm Hg)	77.3	1.26	89.6	4.21	76.6	4.42	76.0	1.59	3.61
Body Fat (mm)	57.9	2.73	59.8	14.26	60.6	9.55	54.2	6.11	0.19
Energy Expenditure Index[a]	53.1	7.25	56.8	21.64	20.1	7.29	71.8	19.63	1.68[*,b]

[a] Energy Expenditure Index = (hrs/wk of leisure activity) x (mean met cost for activities).

[*] $p < .30$

[b] Transformed raw data scores used in computing F value.

VITA

Richard Carlton Gayle was born in Suffolk, Virginia, on October 26, 1946. His family moved to Sandston, Virginia in 1950. He attended elementary schools in that town and was graduated from Highland Springs High School in 1965. The following September he entered the College of William and Mary, and in March 1968, withdrew from the College to fulfill his military obligation. He returned to William and Mary in January 1972, and in August 1973, received a Bachelor of Arts degree in Physical Education.

In September 1973, he entered the University of Tennessee and began study toward a Master of Science degree in Physical Education. He received this degree in June 1975, and was accepted into the doctoral program in September of that same year.

After a year of study at the University, Gayle applied for and was awarded a Fulbright Scholarship for study in Finland. He spent 1976-77 in Jyväskylä, Finland, collaborating in research with the Department of Public Health at the University of Jyväskylä and investigating the relationship of physical fitness and coronary heart disease. He resumed his studies at the University of Tennessee in 1977 and received the Doctor of Education degree with a major in Physical Education in August 1979.

He is a member of the American College of Sports Medicine and the Honor Society of Phi Kappa Phi.