COMPARATIVE EFFECTS OF TWO PHYSICAL CONDITIONING PROGRAMS AND EVALUATION OF INSTRUMENTS FOR MEASURING PHYSICAL FITNESS

APPROVED:

Graduate Committee:

C R Teeter
Major Professor

W. C. Bailey
Minor Professor

C. A. Hardy
Committee Member

Fred W. Tanner
Committee Member

Dwane Kingery
Dean of the School of Education

Robert B. Toulouse
Dean of the Graduate School

Montgomery, John R., _Comparative Effects of Two Physical Conditioning Programs and Evaluation of Instruments for Measuring Physical Fitness_. Doctor of Education (College Teaching), August, 1971, 136 pp., 6 tables, bibliography, 106 titles.

The problem of this study is to determine the effects of two physical conditioning programs on the improvement of parameters of physical fitness and to evaluate the existing relationships among test instruments. The two conditioning programs are routines designed to develop (1) strength and agility and (2) cardiovascular-respiratory efficiency. The three test instruments are (1) basal heart rate, (2) AAHPER Youth Fitness Test, and (3) physical work capacity (180).

The purposes are to determine the effects of specific programs on the improvement of physical fitness parameters and to compare the test instruments for interrelationships.

The effects of the two conditioning programs are investigated by analysis of covariance using pre-test basal heart rates, physical work capacities, and the AAHPER Youth Fitness scores as covariables. The three instruments used for testing and as covariables are compared for their interrelationships by product moment correlations. Correlation matrices are developed considering age, height, weight, test instruments, items of the AAHPER battery, and resting heart rate. The confidence level established for each statistic is .05.

Mean gains indicate that the continuous running program designed to bring the cardiovascular-respiratory system under stress exceeded the strength and agility group on seven variables. The seven variables were sit-ups, shuttle run, 50-yard dash, 600-yard run, AAHPER battery score, physical work capacity, and basal heart rate. The program designed to develop strength and agility had better mean gains on pull-ups, broad jump, softball throw, and resting heart rate.

Significant differences were established between the two programs when the 600-yard run scores, pull-ups, and basal heart rates were used as covariables. Significant differences were not established when the other AAHPER items or test instruments were used as covariables. Physical work capacities, basal heart rates, and items of the AAHPER Youth Fitness Test are significantly correlated only when specific pre-test and post-test comparisons are made.

The dissertation is divided into an introduction, review of related literature, procedures of study, presentation and analysis of data, summary, conclusions, implications, and recommendations.

This study concludes that the AAHPER Youth Fitness Test, basal heart rate, and physical work capacity are different tests which emphasize different parameters of physical fitness. However, significant relationships do exist among test items.

Different physical fitness parameters can be developed to a higher degree by specific programs designed to develop those qualities of fitness which are desired. Program planning should develop from specific testing which is essential to find specific variables affecting student fitness levels. The physical work capacity is a comprehensive test comparable to the AAHPER battery score. These general measures will not distinguish a particular variable. They best provide a general analysis of physical proficiency. Basal heart rate is a specific test for cardiovascular-respiratory efficiency.

If strength, agility, flexibility, balance, coordination, and muscular efficiency are some of the specific parameters of physical proficiency, it appears that the most profitable procedures for their development should be incorporated into the physical education programs. The implications of this study are that (1) the most desirable results are achieved from specific programs for the development of desired outcomes, and (2) specific testing should be done to indicate the presence of the desired qualities of physical proficiency. In comprehensive testing, one parameter may compensate for another. A specific parameter deficiency may not be observed from a battery or comprehensive test.

COMPARATIVE EFFECTS OF TWO PHYSICAL CONDITIONING PROGRAMS AND EVALUATION OF INSTRUMENTS FOR MEASURING PHYSICAL FITNESS

DISSERTATION

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF EDUCATION

By

John R. Montgomery, B. A., M. S. E.
Denton, Texas

August, 1971

TABLE OF CONTENTS

TABLE OF CONTENTS--continued

LIST OF TABLES

CHAPTER I

INTRODUCTION

A need for increased attention to the physical fitness of American youth has been the expressed concern of the last four presidents of the United States. President Eisenhower's Council on Youth Fitness, established in 1956, stimulated action on fitness across America. President Kennedy expressed concern for the "soft" American. Charles "Bud" Wilkinson, acting as a consultant for President Kennedy's council considering physical fitness, provided leadership that helped institute a physical fitness program in the schools of this country. Presidents Johnson and Nixon have continued efforts to improve the state of fitness of the American people.

Since 1956, there have been many different physical fitness programs and an increased interest in the measurement of their effectiveness. The physical educators, attempting to develop physical fitness, have varied emphasis from vigorous calisthenics for fifteen minutes duration daily to the lifetime sports approach to physical education. In 1957, the American Association for Health, Physical Education, and Recreation held a conference on fitness in Washington, D. C. The American Association for Health, Physical Education, and Recreation Youth Fitness Test was devised to measure fitness, and procedures were formulated to establish norms (2).

In 1956, Falls conducted a factor analysis on fifty-three fitness variables. Nine factors accounted for seventy-seven per cent of the total variance for physical fitness. The nine variables were athletic fitness, maximum metabolic rate, respiratory capacity, basic height of blood pressure, heart rate to exertion, expiratory capacity, pulse pressure response, force efficiency, and resting heart rate (11). Cardiovascular efficiency of test subjects was involved in seven out of the nine variables. General mortality rates indicate that cardiovascular and renal diseases are the leading cause of death for people over twenty-five years of age in America (22).

The terms strength, power, and muscular endurance have often been used in a confusing and inconsistent manner. Strength means the maximum effective force which a muscle or group of muscles can exert; power implies the maximum strength which can be exerted once at a maximum rate of movement; and muscular endurance denotes a number of repetitions that a given contraction can be performed.

The general topic of muscle function has been a subject of major interest to physical educators. Although muscle function (strength, power, and muscular endurance) has been studied repeatedly over the years, the topic is still not well understood and remains a subject of controversy.

Mastery of the topic of muscle function is yet to be attained due to the extreme complexity of the phenomena involved. Strength, power, and muscular endurance result from close coordinations of complicated mechanical, biochemical, neural, and endocrine functions. Additional perspective of these functions requires intensive study of the underlying physiology (23).

Muscular contraction provides the force necessary for static postures and dynamic movements in man. An understanding of mechanical principles provides information for analysis of the movement of man. Knowledge of the biochemical and neural functions promotes a better understanding of muscular contractions and the energy supply.

Physical educators should be cognizant of the role of strength and muscular endurance in the prevention of postural deformities and injuries. These are deterrents to physical or muscular efficiency. If a force is applied which tends to move the joint into a range of motion in which ligament damage could occur, a stretch reflex is propagated which results in contraction of the opposing musculature in an attempt to stop the movement. If the musculature and attachments are sufficiently strong, the movement will be stopped and injury will be prevented. If the strength of the muscles around these joints is greater, the injuries are less frequent. The primary competencies that all physical educators should have is an expertise in exercise and work, knowledge of the functions of muscle in strength, power, and endurance performances, as well as of the techniques of assessment of such performances (19).

Cooper's (6) aerobics provided one of the most discussed studies of physical fitness. He indicated:

> Muscular fitness is of some value, but it is too limited. It concentrates only on one system in the body, one of the least important ones, and has limited beneficial effects on the essential organs of overall health. . . . Endurance fitness should be your goal. It will assure all the benefits of the training effect, improving not just your muscles, but your heart, and the blood vessels. . . . The key to endurance is oxygen consumption. The body needs it to produce energy. It can't store it so it must bring it in constantly and deliver it to the organ or tissue where the energy is needed. The amount that the body can bring in and deliver--your maximum oxygen consumption--is the best measure of your fitness (6, p. 13).

Physical fitness is one of the variables involved in healthful living. If we desire to provide a physical education program in our schools that will serve the students' best interest, we should know what produces desirable fitness and how to measure accurately our programs.

We need to continuously evaluate what we are doing in our physical education programs. Evaluations of the contributions made to participants and of the effectiveness of the testing instruments should assist in development of the desired physical fitness parameters.

Statement of the Problem

The problem of this study was to determine the effects of (1) a conditioning program designed to develop cardiovascular-respiratory efficiency and (2) a conditioning program designed to develop strength and agility on the improvement of parameters of physical fitness as measured by the AAHPER Youth Fitness Test, basal heart rate, and physical work capacity determined by a progressive work test on the bicycle ergometer.

Purposes of the Study

The purposes formulated for this study were to (1) determine the relative effects of (a) a conditioning program designed to develop cardiovascular-respiratory efficiency and (b) a conditioning program designed to develop strength and agility on the improvement of physical fitness; and (2) evaluate the use of (a) physical work capacity, (b) the AAHPER Youth Fitness Test and (c) basal heart rate as instruments for measuring parameters of physical fitness.

Hypotheses

To perform the purposes of this study, the following hypotheses were formulated and tested:

1. There will be no significant difference between the physical fitness means for the cardiovascular-respiratory and strength-agility conditioning programs, as measured by the basal heart rate when the pre-test basal heart rate is used as a control variable.

2. There will be no significant difference between the physical fitness means for the cardiovascular-respiratory and strength-agility conditioning programs as measured by the physiwork capacity when the pre-test physical work capacity as determined by the bicycle ergometer is used as a control variable.

3. There will be no significant difference between the physical fitness means for the cardiovascular-respiratory and strength-agility conditioning programs as measured by the AAHPER Youth Fitness Test when the pre-test AAHPER Youth Fitness Test is used as a control variable.

4. There will be no significant relationship between the physical work capacity test, basal heart rate, or the AAHPER Youth Fitness Test items as evaluative instruments for determining physical fitness. The correlation between the instruments for assessing fitness levels will be zero for the population under study.

Background and Significance of the Study

In the last decade, physical educators have become more concerned with the development and measurement of physical fitness. Consolazio (5) stated in 1963 that the quantitative measurement of physical fitness was one of the most complex and controversial problems in applied physiology. Linde, (16) in an appraisal of exercise fitness tests, reiterated the frequently expressed concern that no single test of physical fitness was completely satisfactory.

Different concepts of growth and development led to numerous attempts to define the relationship of physical and intellectual growth. Over 400 studies have been reviewed in Monroe's Encyclopedia of Education Research attempting to find the relationship of physical variables to psychological data. Some of the physical variables were body measurements, body proportions, records of illness, physical defects, and physical efficiency. Some of the psychological variables, as related to physical development, were intelligence scores, achievement scores, scholarship records, and records of intellectual accomplishments. The hypotheses guiding these studies were classified under two headings as follows:

1. Common factors involved in physical and intellectual developments.

   a. Physiological variables

   b. Environmental or social variables

2. Organic effects of mental changes or mental effects of organic changes.

This provided a partial summary of the inter-relatedness of physical and intellectual development. In general, the conclusions were that gifted students are larger, stronger, and healthier than average or slow learners. We may reasonably conclude that physical fitness is a possible variable related to intellectual growth and effective living.

Regular periods of exercise designed to develop stress are essential for physiological and emotional purposes. Many individuals lack conceptual foundation of their personal needs for exercise. Each individual needs to perform regular exercise routines for maintenance of physical and emotional health (8).

A recent approach to physical fitness for any age is called aerobics. Cooper (6) identified running, walking, swimming and cycling as exercises that contributed the most to development of physical fitness. Two years ago, aerobics was an exercise program under study by the United States Air Force. Now segments of our population are participating in aerobic type programs in America, and several other countries are considering adoption of aerobics for their armed services. The advocates of aerobics have stated that we should change some of our more traditional approaches to include cardiovascular fitness development by the most profitable means. Basically, this would involve changing the emphasis for the development of conditioning in the physical education programs.

Definition of Terms

The following definitions were formulated to provide the specific meaning implied for this study.

Physical Fitness is the development of the body to a state or condition which will permit performance of a given amount of physical work with a minimum of physical effort. The efficiency of physical effort depends upon the mutual development of the muscular, respiratory, and circulatory system integrated and coordinated by the activity of the nervous system. Physical fitness is used to imply a state of physical proficiency.

AAHPER Youth Fitness Test is composed of measurement of seven items. They are: sit-ups, pull-ups, baseball throw for distance, standing broad jump for distance, shuttle run, fifty-yard dash, and the 600-yard run.

Basal heart rate is a test used by athletes to check pulse rates in order to gain an indication of physical condition. It involves counting the pulse rate before getting out of bed in the morning prior to any physical activity.

Parameter is a variable classification for a general component of physical fitness. The test items are specific measures which are used for evaluation of a parameter. Some parameters of physical proficiency are strength, cardiovascular-respiratory efficiency or endurance, flexibility, agility, and coordination.

Resting heart rate is a check of the pulse rate after a rest period of approximately five minutes in a reclining or sitting position. Other variables affecting heart rate which should be controlled are fatigue, emotions, meals, and physical activity.

Endurance is the ability to do prolonged work without fatigue and recovery to pre-exercise state in a shorter period of time. Endurance in this description involves cardiovascular efficiency.

Muscular endurance is the ability to perform repeated muscular activity. An example would be repeated bench presses or repeated grips of the hand dynamometer.

Muscular strength is the ability to lift weight or master resistance without regard to repetitions. Strength means the maximum effective force which a muscle or group of muscles can exert.

Bicycle ergometer is an instrument for measuring physical efficiency of the human body by providing for consistent regulation of exercise work load.

Strength and agility conditioning program was composed of calisthenics, agility, short sprints, and a strength emphasis weight routine. This program was designed to improve strength and agility of the test subjects.

Cardiovascular-respiratory conditioning program was composed of stretching exercises for flexibility and continuous running. This program was designed to increase endurance of the test subjects.

Limitations

This study was limited to those students entering a weight training class and a track class at North Texas State University in the Spring of 1971. The classes were Physical Education 116 activity courses. Student membership in the classes was determined by physical education requirements, the classes being chosen on an elective basis. If a class was closed during registration, the student may be enrolled in a class of secondary interest. There was no reason to assume that students included in this study would differ significantly from those at other institutions where conditions for selection of physical education classes were similar.

Basic Assumptions

It was assumed that the subjects would respond to the endurance and strength conditioning programs because of their election of a course of their choice. It was further assumed that the subjects would respond with a representative effort on the AAHPER battery and the Physical Work Capacity Test to measure their level of fitness parameters.

Instruments

The AAHPER Youth Fitness Test was used as one of the instruments for measuring parameters of physical fitness. It is a battery developed by leaders of physical education in 1958. The test is composed of pull-ups, sit-ups, the shuttle run, 600-yard run, standing broad jump, fifty-yard dash, and the softball throw for distance. It was used nationally by the public schools for evaluation of the physical fitness of American youth. College norms were provided through the leadership of Paul Hunsicker (2).

The President's Council on Youth Fitness concluded that the AAHPER Youth Fitness Test was one recommendation in the total physical fitness program. The AAHPER Test was a comprehensive validated test to determine the physical fitness of those who participate in the physical education programs. The Buros Mental Measurement Yearbook contains a bibliography of studies justifying the use of the AAHPER test battery (3).

The second instrument for gathering data was a progressive work test monitored by the physiograph when used with the bicycle ergometer to measure physical work capacity. The physiograph was used to monitor the heart rate readings as physical work capacity was taken to assess the cardiovascular efficiency of the subjects. The bicycle ergometer and the power-driven treadmill are two of the most frequently used mechanisms for assessing the physical fitness of trained and untrained subjects who made use of the heart rate or cardiovascular variables. Clarke and Clarke (4) indicated that the bicycle ergometer had certain advantages as a tool of research. The most important advantage as an instrument was the ability to set and maintain a constant work load.

The basal heart rate was the third measure to be taken. The instrument used was the stethoscope with a reliability check made by the physiograph. The basal heart rate has been used very little except by track coaches for assessing the effectiveness of training programs on cardiovascular fitness improvement. The basal heart rate was taken after sleep and before getting out of bed in the morning. Fred Wilt (24) suggested that it was a useful and simple test for athletics. Gerald Tharp (20) found that resting heart rate showed a closer correlation with physical work capacity than did tension on period readings of the electrocardiograph. The basal heart rate was usually slower than the resting heart rate, which was influenced by other variables, primarily of a psychological nature.

In view of the wide use of the AAHPER Youth Fitness Test and the bicycle ergometer, it would appear they were appropriate data gathering instruments. The basal heart rate should merit use on the basis that most physical fitness variables that affect the physical fitness state of test subjects, according to H. B. Falls' (11) factor analysis of fitness variables, were related to heart rate or cardiovascular efficiency.

Clarke and Clarke (4) indicated that nothing new or startling was involved in the simple determination of heart rate as this has been one of the time-honored physiological parameters.

Cooper (6) in his <u>Aerobics</u> concluded that the trained individual had a lower resting heart rate and a greater stroke volume. These findings should help justify the use of basal heart rate as a data gathering device for this study.

Procedures for Collecting Data

Permission was obtained from the physical education department to use two classes from the activity program for subjects. A weight training class and a track class were chosen to provide two intact groups. The basal heart rate was taken manually, with a stethoscope. A reliability check was made on every sixth case with the physiograph. The subjects were housed in the women's gymnasium at North Texas State University the night preceding the taking of the basal heart rate readings.

The bicycle ergometer was used to measure the state of physical fitness by measuring the physical work capacity.

The evaluation was taken before students participated in the conditioning programs.

The American Association of Health, Physical Education, and Recreation Youth Fitness Test was administered after the other two tests were completed and before participation in the conditioning program. The AAHPER battery is composed of seven different physical fitness measures. A possibility of some conditioning or retrogression may occur through the administration of the battery. It was, therefore, administered after the basal heart rate and physical work capacity tests. Physical work capacity was obtained by use of a progressive work test on the bicycle ergometer.

The same procedure was followed after eight weeks of participation in the conditioning programs. At the conclusion of the post-test, the data were compiled for statistical treatment and analysis.

Procedures for Analysis of Data

At the conclusion of testing and collection of data, the relative effectiveness of the two conditioning programs was analyzed statistically. The physical fitness pre-test and post-test measures were used as control variables and dependent variables respectively. The two different approaches to conditioning were the independent variables. The data were analyzed for significant differences in the adjusted means.

The instruments for determining physical fitness were evaluated by product moment correlations to determine the relationships that existed among the three instruments. The three instruments for determining physical fitness were basal heart rate, physical work capacity as measured by a progressive work test on the bicycle ergometer, and the AAHPER Youth Fitness Test. The level of significance was arbitrarily set at five per cent.

Hypothesis one, two, and three were tested using analysis of covariance as the statistic.

H = hypothesis, and M = Greek lower case mu.

$H_1 : M_1 = M_2$ $M_3 : M_1 = M_2$

$H_2 : M_1 = M_2$

Hypothesis number four was tested by use of product moment correlation at the five per cent level of significance. The correlations were computed between physical work capacity and each measure of the AAHPER test battery. The physical work capacity and the basal heart rate were compared by coefficient of correlation. To conclude the statistical treatments, a correlation between basal heart rate and items of the AAHPER Youth Fitness Test were calculated.

Further Organization of the Study

A survey of related literature was presented in Chapter II. The literature review was hypothetically divided into four categories. The categories were related to the meaning physical fitness, the AAHPER Test, cardiovascular variables related to physical fitness, and conditioning methods.

The methods and procedures related to the activity classes, collection of data, and the treatment of data are presented in Chapter III.

The (1) presentation of data and (2) the analysis of data indicating the results of the study, as related to the hypotheses, are developed in Chapter IV.

A summary of the study indicating the findings and implications, as they are related to the hypotheses, is included in Chapter V.

CHAPTER BIBLIOGRAPHY

1. Alexander, J. F. and J. E. Torpey, "Conditioning Improves Cardiovascular Fitness," Minnesota Journal of Education, XXXXVIII (October, 1967), 12-15.

2. American Association for Health, Physical Education and Recreation, Youth Fitness Test Manual, Library of Congress, Washington, D. C., 1961.

3. Buros, O. K. editor, Mental Measurement Year Books, Highland Park, New Jersey, Grython, 1969.

4. Clarke, David H. and H. Harrison Clarke, Research Processes in Physical Education, Recreation and Health, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1970.

5. Consolazio, C. F. and others, Physiological Measurement of Metabolic Functions in Man, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1963.

6. Cooper, Kenneth H. and Kevin Brown, Aerobics, New York, M. Evans and Co., Inc., 1968.

7. Cureton, T. K., "Comparison of Various Factor Analysis of Cardiovascular-Respiratory Test Variables," Research Quarterly, XXXVII (October, 1966), 316-325.

8. Davis, Elwood Craig and others, Quality of Living: Source of Personal Health, William C. Brown Company Publishers, Dubuque, Iowa, 1967.

9. Doolittle, T. L. and R. Bigbee, "Twelve Minutes Run-Walk Test: A Test of Cardio-Respiratory Fitness of Adolescent Boys," Research Quarterly, XXXIX (October, 1966), 491-495.

10. Encyclopedia of Educational Research, 2nd Edition, New York, The Macmillan Company, 1960.

11. Falls, H. B., "Development of Physical Fitness Test Batteries by Factor Analysis Techniques," Journal of Sports Medicine, V (December, 1965), 185-197.

12. Franks, B. D., "Smoking and Selected Cardiovascular-Respiratory Measures," Research Quarterly, XXXXI (May, 1970), 140-144.

13. Harper, D. D. and others, "Comparative Effects of Two Physical Fitness Programs on Cardiovascular Fitness in Man," Research Quarterly, XXXX (May, 1969), 293-298.

14. Henderson, John, Emergency Medical Guide, New Brunswick, McGraw-Hill Book Company, 1969.

15. Hickman, Cleveland P., Health for College Students, Englewood Cliffs, Prentice-Hall, Inc., 1968.

16. Linde, L. M., "An Appraisal of Exercise Fitness Tests," Pediatrics, XXXII (October, 1963), 656-659.

17. Lovell, J. A., "Prior for Fitness," Journal of Health, Physical Education and Recreation, XXXIX (June, 1968), 26.

18. Metz, K. F. and J. F. Alexander, "Investigation of the Relationship Between Maximum Aerobic Work Capacity on Physical Fitness in 12 to 15-Year Old Boys," Research Quarterly, XXXXI (March, 1970), 75-81.

19. Rhodes, E. and others, "The Effects of a Pre-Season Ankle Exercise Program on the Prevention of Ankle Injuries in High School Basketball Players," Journal of Physical and Mental Rehabilitation, XIV (1960), 78-79.

20. Tharp, Gerald, "Cardiac Function Test as Indexes of Fitness," Research Quarterly, XXXX (December, 1969), 818-822.

21. Thompson, J. C., "Physical Fitness for the 1970's," Physical Educator, XXVI (December, 1969), 146.

22. Smolensky, Jack and Franklin B. Haar, Principles of Community Health, Philadelphia: W. B. Sanders Co., 1967.

23. Van Huss, Wayne and others, An Introduction to Measurement in Physical Education: Physical Fitness, Phi Epsilon Kappa Fraternity, Indianapolis, 1970.

24. Wilt, Fred, Run Run Run, Los Altos, California, Track and Field News, Inc., 1964.

CHAPTER II

REVIEW OF RELATED LITERATURE

Two of the oldest and most basic techniques used by the physical educator for assessing physical fitness are muscular strength and heart rate (18). Muscular strength is usually taken as the subject is performing a maximal task or, in some instances as repeated strength tasks are done to assess the loss of strength with each repeated measure. Heart rate has been evaluated in a resting state, submaximal work state, maximal work state, and by recovery to a resting state following physical activity. Many different attempts have been made to assess physical fitness parameters by use of the subject's heart rate. The conditioning methods have been just as varied in an attempt to develop parameters of physical fitness as has been the physical educators' attempt to measure physical fitness.

The review of related literature, is divided into four categories related to the development and measurement of physical fitness parameters. The categories are studies within the general area which are related to the (1) meaning of physical fitness, (2) AAHPER Youth Fitness Test, (3) cardiovascular efficiency as an index of physical fitness and testing, and (4) conditioning methods and development of physical fitness.

The Meaning of Physical Fitness

One of the problems of attempting to develop physical fitness through the physical education programs is that physical fitness connotes a diversity of meaning. Some people have definite beliefs about what physical fitness is, or what it should be, while others suggest that we re-examine that which is called physical fitness. No single definition of physical fitness seems to be acceptable to all physical educators. Presently, the physical educator is more prone to discuss parameters of physical fitness rather than the overall state of physical fitness.

Strength, power, and muscular endurance have been used as parameters related to development and maintenance of physical fitness. These topics have been of major interest to the physical educators. Van Huss and others (76), in a discussion of exercise science or physical fitness, emphasized the inclusion of strength, power, muscular endurance, endurance, circulatory-respiratory fitness, and flexibility as parameters affecting a state of fitness. Each item in test batteries is considered to measure a particular characteristic or ability. Being exceptionally fit in one area and exceptionally unfit in another does not add up to an acceptable state of fitness. The individual items are important and should be treated specifically.

Studies related to strength parameters have been investigated using test batteries classified as motor ability items (17, 35, 46, 54, and 55). This type of emphasis attempts to establish a relationship between the general motor ability and the parameters of physical proficiency. These studies considered strength, power, and muscular endurance as specific parameters in the measurement of physical fitness. This particular type of emphasis attempts to study the specific variable as it contributes to a general physical proficiency.

The structure and measurement of physical fitness as determined by the available physical fitness tests are better understood since Fleishman's (35) study of physical fitness testing. These results suggest that physical proficiency or physical fitness is not a single general ability; rather physical fitness can best be described in terms of broad, relative independent factors. The same individual may score high in some factors and low on others. The more physically fit person will score higher on more factors of the test battery. Some specific needs exist in physical fitness testing. Some of the needs are (1) to improve testing, (2) to determine if coordination and agility are separate abilities, (3) to determine how much of a test score is related to individual skill and how much is related to physical fitness of the individual, and (4) to determine the relationship of performance capacities to specific physiological parameters and to organic and functional health. Fleishman concluded by indicating that more research is needed in the above areas to determine the relationship between functional capacity and performance capacity. Such research will lead to a broader concept of physical fitness, its components, and their inter-relationships.

A statement on the role of exercise and fitness by a joint committee of the American Medical Association and the American Association for Health, Physical Education, and Recreation (4) indicated fitness for effective living has many independent components depending upon varying individual roles and responsibilities.

Updyke and Johnson (74) made a distinction between physical fitness and motor ability. Their assessment of physical fitness appears to agree with Fleishman in the more recent evaluations of testing and the components of physical fitness. They offered the following points in summary:

> 1. Only qualities essential to health and/or work capacity should be classified as components of physical fitness.
> 2. Qualities primarily essential to skill and motor performance, and not to health, should not be classified as physical fitness components but, rather as motor performance or motor ability qualities.
> 3. Physical fitness components, then, are circulatory-respiratory capacity, muscular endurance, flexibility, and strength.
> 4. Motor performance components are coordination (their common denominator), ability, speed, power, balance, and reaction time.
> 5. For a given individual, the above categorization may not hold true (74, p. 99).

Morehouse and Miller (64) contended fitness implies a relationship between the task to be performed and the individual's capability to perform it. The task may either be specific or non-specific. On a specific measure such as flexibility, measured by the toe touch, the individual either fails or passes the test by the ability to perform the task. It does not reveal an individual's capacity to perform, nor does it make evident the reason for failure. A non-specific task, such as effective and enjoyable living, implies a relative degree of efficiency without undue fatigue and ability to recover for the next task. When fitness is assessed by such specific test items, it does not describe a state of health; it relates to the task to be performed.

Herbert deVries (31) was reluctant to define physical fitness in specific terms and advocated that the term be operationally defined. Test batteries have been developed by physical educators which include running, throwing, jumping, pull-ups, and push-ups. These test batteries are considered as tests of motor fitness which attempt to measure parameters of physical fitness. Some of the parameters are coordination, speed, agility, endurance, power, strength, balance, flexibility, and body control.

One of the most read physical education authors, Charles Bucher (14), wrote that physical fitness refers primarily to bodily aspects of fitness which represents the individual's capacity to live most vigorously and effectively with his own resources. Not only does it imply effectiveness but also the ability to resist fatigue with a relative degree of motor performance and the ability to adapt to muscular stress.

Karpovich (50) implied that physical fitness measures merely the ability to pass physical fitness tests; therefore, the so-called degree of fitness possessed by an individual depends upon the nature of the test item to be performed and the individual's performance of the task.

A combination of investigations made by physical educators found in a review of dissertation abstracts indicated that physical educators have emphasized physical fitness concepts which have determined the (1) planning and (2) evaluation of the physical education programs. Strength and endurance were investigated as parameters of physical fitness by Mullins (65). Bentley (7) emphasized speed, power, strength, and general endurance as parameters affecting fitness change.

Brooker (12), Girardin (37), Hayes (43), and McNair (59), in unpublished studies, emphasized that the criteria for selection of activities were the amount of stress, the intensity of the activity, and strenuousness of the exercise. The intensity should be sufficient to bring about physiological changes in the participants.- The particular activity was considered secondary in importance to the amount of stress brought about by the game or the activity. These studies imply through emphasis, particular interests in specific parameters and general concepts of physical proficiency.

AAHPER Test Battery

The current national interest in physical fitness was preceded by comparisons between American youth and European youth on certain physical fitness tests. The Americans were found to be inferior, and an expressed concern brought about emphasis for change in the physical education programs and in the testing. Fleishman (35) concluded that the tests in the AAHPER Battery were assembled on the basis of expert judgment and recommended where normative data could be collected quickly for comparison purposes. The idea was to provide a standard set of tests for expediency in collection of data because of the expressed concern for fitness of American youth. According to Fleishman's evaluation, the AAHPER test battery measures well three components of fitness, which were dynamic strength, explosive strength, and stamina. The three came from a list of factor areas common in fitness testing. The areas of the total list of common parameters were: (1) strength area, which included explosive strength, dynamic strength, and static strength; (2) flexibility and speed area, which included extent flexibility, dynamic flexibility, speed of change of direction, running speed, and speed of limb movement; (3) balance area, which included static and dynamic balance; (4) coordination area, which included multilimb coordination and gross body coordination; and (5) endurance areas. Fleishman's criticisms of the AAHPER battery were based on non-inclusion of items to measure static strength, extent flexibility, dynamic flexibility, gross body coordination, and gross body equilibrium because they had been used as parameters of physical fitness in other tests.

Harry Olree and others (66) from Harding College made an evaluation of the AAHPER Youth Fitness Test to determine the nature and extent of the relationship between the percentile scores of the battery items and the objective physiological measure of physical fitness. They used maximum oxygen uptake as the physiological variable for determining capacity for sustained work. Based on seventy-six subjects, there was a significant relationship at the .05 level between each item of the test battery and maximal uptake per minute k/g of body weight. The correlation of three items--the shuttle run, the fifty-yard dash, and the 600-yard run-walk--was low. However, of the seven items, three items--fifty-yard dash, pull-ups, and sit-ups--seem to measure different aspects of physical fitness and correlate highly with the average AAHPER test scores and are easily administered. All three items may be given in short intervals and eliminate one-fifth of the length of the testing time.

Falls and others (34) investigated the validity of estimating maximal oxygen uptake from the AAHPER Youth Fitness Test items in adult subjects. Eighty-seven male subjects ranging in age from twenty-three to fifty-eight participated in the five-month program. The conclusion drawn from the research was that maximum oxygen uptake per kilogram body weight, as measured in this study, can be estimated with reasonable validity from the motor fitness items in AAHPER Youth Fitness Test. Since the maximum oxygen uptake per kilogram of body weight is considered by many to be the ultimate criterion of physical fitness, this study helps to validate the youth fitness test as an index of physical fitness. The best single estimator of maximum oxygen uptake is the 600-yard run-walk among the youth fitness test items. The optimally weighted youth fitness test items appear to be about as good in estimation of maximum oxygen uptake per kilogram of body weight as the more specialized methods that have been reported.

Locke (56) wrote a reply article to Willgoose (85) and others, on the reliability of the 600-yard run-walk at the junior high level. Willgoose, and others, found that a rank order correlation of .92 was obtained when the test was administered one week apart with instructions to do the best they could without emphasis of bettering their previous performance. The conclusion by Locke was that the 600-yard run-walk is reliable as an index of stamina. Admitting that orientation of subjects might affect the testing situations, the reliability can be improved by controlled uniformity of procedure in the administration of the test.

Parkman (68) used the AAHPER Youth Fitness Test for the purpose of assessing the fitness levels of subjects who were participating in activities followed by evaluation of the same subjects in periods of inactivity. He found their performance levels changed during activity and inactivity.

Corroll (24) investigated the AAHPER test battery by comparing score results to maximal oxygen uptake.

A factor analysis of the AAHPER Fitness Test was done by Ponthieux and Barker (70). They evaluated the seven items using 1,335 college freshmen, computing standard deviations and intercorrelations. Circulatory-respiratory endurance, gross body coordination, and dynamic strength were considered to be parameters of physical fitness that are assessed by the AAHPER battery. The intercorrelations indicate that the abilities measured by the seven test items are related. The relationships are described as seen in the following chart summary:

	S-ups	S.R.	S.B.J.	50-D	S.B.T.	600-R	Mean	S.D.
Pull-ups	+.30	+.30	+.44	+.41	+.20	+.37	7.07	3.50
Sit-ups		+.17	+.21	+.25	+.28	+.31	49.62	20.62
Shuttle-Run			+.51	±.41	+.33	+.35	10.01	.67 sec
Broad-Jump				+.54	+.34	+.42	86.81	8.24 in
50-Yard Dash					+.40	+.48	6.86	.44 sec
Softball Throw						+.27	183.16	28.52 ft
600-Yard Dash							114.98	16.71 sec

The reliability of the individual test items of the AAHPER Youth Fitness Test was done under actual classroom conditions by Stein (72). Pull-ups, broad-jump, sit-ups, fifty-yard dash, and softball throw had very high reliability coefficients, ranging from .90 to .98. The shuttle run and the 600-yard run-walk had .74 and .83 correlations. He concluded that the tester should have more confidence in the test reliability since the coefficients were obtained under actual physical education teaching conditions.

A study was done by Clarke and Degustis (19) to determine the relationship of standing broad jump as a test of leg power with maturational, anthropometric, and strength characteristics of twelve-year old boys. Physical educators have used the standing broad jump as a simple test of leg power for many years.

Ninety-five per cent of the coefficients derived from correlating strength with other test variables were significant at the .05 level. Of the sixteen product moment correlations between the experimental variables and the standing broad jump, only forty-four per cent were significant at the .05 level. The highest multiple correlation was .694. According to the correlations found, distance times weight might be a better measure of leg power. The independent variables used were elbow flexion strength, body weight hip extension strength, ankle plantar flexion strength, and leg flexion strength.

Bitcon (10) established validity and reliability for a four-item physical fitness test utilizing a correlation technique using the AAHPER Youth Fitness Test to establish norms for Iowa. The four test items were (1) pull-ups, (2) sit-ups, (3) standing broad jump, and (4) a 300-yard shuttle-run. The coefficient of correlation between the AAHPER battery composite score and the composite score of the four-item test was .934. The reliability coefficient on the same basis was .961.

Fleishman (35) evaluated some 100 motor fitness test items. The physical fitness components of the AAHPER fitness battery were evaluated. The individual items of the battery correlated well, but Fleishman (35) indicated that a fitness battery cannot be evaluated as individual test; it should be reviewed as a comprehensive test. Fleishman concluded that the significance of international comparisons was over-emphasized.

Cardiovascular Efficiency as an Index of Physical Fitness

Most modern circulatory exercise tests are based on the relationship between linear increase in heart rate and work load or oxygen uptake. Other testing assumptions involve differences between the trained and untrained state of fitness. The differences have involved blood volume, elasticity of blood vessels, stroke volume, resting heart rate, recovery rates, and the blood vessels of the muscle fibers.

The physical educator has investigated several variables for their effect on cardiovascular change. Oscia (67) studied the effects of blood volume on cardiovascular efficiency.

Howard (44) investigated the tension period of the left ventricle as an indication of the fitness level. Metz (61) studied work capacity as predictor of a state of fitness. Training and wheat germ oil effect on change in cardiac response was investigated by Dempsey (30).

Astrand and Rodahl (5) made presumptions for the assessment of circulatory capacity as an index of physical fitness by evaluation of physical work capacity tests. Heart rate or cardiac output at a given oxygen uptake varies only within reasonable limits. The larger the stroke volume is, the lower the heart rate. The maximal cardiac output and oxygen uptake should be determined by the individual's maximal heart rate. There are several problems which affect circulatory capacity and aerobic power, and experimental studies indicate that there are sources of error in prediction of the efficiency of the oxygen transport system from sub-maximal test. There are exceptions to the linear increase between heart rate and work load or oxygen uptake. The maximal heart rate declines with age. A fixed mechanical efficiency does not exist for all subjects. Cardiac output was not strictly related to oxygen uptake; therefore, studies involving stroke volume may be affected by deviations. They conclude by indicating a need for considering all the above factors before assessing the efficiency of the oxygen transport system as an index of physical work capacity.

Consolazio (22) emphasized endurance in assessing physical fitness. A good test of physical fitness involves large muscle groups in activity which places the cardiovascular system under considerable stress. The work load must be reproductible. The variables Consolazio assessed were (1) work efficiency, (2) steady state, (3) displacement of physical equilibrium, (4) maximal and economic ventilation, (5) oxygen consumption for a given amount of work, (6) oxygen uptake, (7) respiratory quotient, (8) blood lactate during exercise, (9) blood lactate before exhaustion, (10) pulse during sub-maximal work, (11) recovery following exercise, (12) stroke volume, (13) blood pressure, and (14) blood pressure return to normal following maximal work. Considering all of the measures for testing physical fitness, pulse rate during maximal exercise seems to be the most reliable of the physiological variables.

Cureton (26) and Consolazio are in agreement when testing physical fitness. They concluded that appraisal of physical fitness by pulse rate tests is the easiest to measure and the most reliable of the physiological variables. Cureton placed emphasis on pulse rate following strenuous exercise or recovery. Cardiovascular efficiency was measured by the heartometer, producing an electrocardiograph for determining the area under the brachial pulse wave curve, systolic pulse wave amplitude, dicrotic notch amplitude, fatigue ratio, angle of obliquity, heart rate, and several work to rest ratios. Cureton emphasized vital capacity when measuring respiratory fitness.

Maxfield and Brouha (58) emphasized total cardiac cost obtained by plotting the heart rate area under the curve for each minute during work and recovery. The total cardiac cost solves the problem of finding the true resting heart rate.

Wells, Balke, Fossan (81) used lactic acid accumulations for standardization of work into classifications. Three distinctly different increments of work intensity were established. They were classified as (1) light work; pulse rate not exceeding 120 beats per minute, (2) heavy work; pulse rate between 120 and 160 beats per minute, (3) severe work; pulse rate above 160 beats per minute. Lactic acid accumulations were greater as work load and heart rate increased.

Amasa and Hellerstein (3) used observations made under field conditions on fifty-two factory and steel workers to estimate energy expenditure from pulmonary ventilation. The formula for calories per minute was equal to 173 time ventilation minus .52. A standard error of the estimate was .42 calories per minute. Calories per minute expenditure and BTPS (body temperature and pressure, saturated with water vapor) were used to assess energy expenditure and pulmonary ventilation.

Astrand and Rhyming (6) found that an individual's capacity for prolonged work depends upon the supply of oxygen to the working muscle. They advocated that large muscle type work be used in producing aerobic capacity. The tests which were advocated were the step test, the treadmill test, and the cycle test. In testing wide-range fitness abilities, a sub-maximal test is suggested. The metabolism during the test should not exceed fifty per cent of the individual's aerobic capacity. The heart rate during steady state is considered to be between 120 and 170 beats per minute. A nomogram is presented where the individual's maximal attainable oxygen intake can be determined from heart rate and oxygen uptake during a sub-maximal work test. The individual's aerobic capacity will give a good indication of the state of fitness.

Issekutz and Rodahl (48) used oxygen intake and carbon dioxide output during exercise on the bicycle ergometer to determine three stages of change in the respiratory quotient. The three stages of the respiration change were the initial increase, slight drop, and a continuous rise until the steady state was reached. There is a straight line correlation between the non-metabolic excess carbon dioxide and lactate level. In pooled calculations, a correlation of .92 was found. The respiratory minute volume plotted against oxygen uptake or carbon dioxide output showed a relative hyperventile as the subject approached maximum aerobic capacity. It was concluded that change in respiratory quotient represents part of anaerobic glycolysis in the total energy expenditure rather than the fuel used during exercise.

Use of respiratory quotients in assessment of aerobic work capacity was investigated further by Issekutz, Girkhead, and Rodahl (47). Oxygen uptake and carbon dioxide output were measured in thirty-two untrained subjects during exercise on the bicycle ergometer. The authors inferred that work respiratory quotients under standard work conditions can be used to measure physical fitness. Changes in work respiratory quotients increased logarithmically with work load or maximum oxygen uptake. This observation offered the possibility of predicting the maximum oxygen uptake of a person based on measurement of sub-maximal work test.

Some physiological responses of men and women to moderate and strenuous exercise were studied by Metheny, Brouha, Johnson, and Forbes (60). A comparative study was made of seventeen women and thirty men to determine relative fitness by exhausting work. The treadmill was used and assessments were taken for heart rate, blook pressure, ventilation oxygen consumption, respiratory quotients, blood sugar and blood lactate levels. The higher fitness levels of women, as indicated by test performance scores, compared to the lower fitness levels of men.

Wells (80) developed an instrument for testing circulatory fitness. A rough index of blood flow can be determined by taking pulse pressure and multiplying it by pulse rate. The test consists of blowing thirty seconds following a standard exercise test. The assumption was that trained subjects would have a better circulatory response.

Practical evaluation of strain in muscular work and heat as they affect heart rate recovery were investigated by Brouha and Maxfield (13). Their findings supported the contention that in any environment, the work rate may be indicated by the rate of oxygen consumption and the physiological strain as determined by change in heart rate. The experiment involved eight to ten successive periods of work and rest. Oxygen consumption was allowed to return to normal during rest periods. Environmental heat had very little effect on heart rate increase or return of oxygen consumption to normal during rest periods.

Comparative effects of two physical fitness programs on cardiovascular fitness of men was done by Harper, Billings, and Matthews (42). In their studies they compared calisthenics and marching to running, using an interval training method. The subjects were twenty-five male students at Ohio State University. The interval training group's maximal oxygen consumption improved significantly. The control group and the calisthenics-marching group failed to show significant changes.

Alexander and Torpey (2) investigated cardiovascular improvements by Harvard Treadmill Test of students participating in circuit training exercises. The circuit involved seven stations which included shuttle-run, squat jumps, crab walk, basketball backboard jumps, rope skipping, a rowing exercise, and bend-twist-stretch exercises with emphasis placed on minimum time for the circuit. The results of the treadmill test show substantial increases in cardiovascular fitness as determined by ability to run on treadmill at a controlled rate and incline, followed by a measure of the recovery heart rates.

Tharp (73) investigated cardiac function tests as indexes of fitness. He concluded that most exercise physiologists agree that maximum oxygen uptake is the best index of physical fitness. The purpose of the investigation was to find an easier and more effective test. He concluded that a test should show a high degree of correlation with the established fitness test now employed. The results showed little correlation between the physical work capacity of 150 heart rate and the ventricular function measurements. From the correlations obtained, it was apparent that resting heart rate would be a better index of fitness than either of the ventricular function measurements. Most investigators, however, agree that there are too many variations in resting heart rates.

Aerobic Fitness

Cooper and Brown (23) have made suggestions for keeping fit at any age. Aerobics is a study dealing with exercises to improve the efficiency of the cardiovascular system. The respiratory and circulatory systems become more efficient when exercises are used that create an oxygen debt. The key to the entire program is oxygen transport proficiency. All activity requires energy, which is derived by the oxidation of foodstuffs in the cells. Oxidation can take place only if oxygen is present. There is no storage of oxygen in the body; it must be obtained by the respiratory system and then transported to the cells by the circulatory system. The main concern of the aerobics program is to make the body more efficient in obtaining oxygen and transporting it from the lungs to the cells.

Cooper's work was based on the question of how much exercise was needed to produce the desired effects. He decided that exercises should be measured for the energy required to do them. In his experiment, certain methods were applied to measure energy output of individuals doing different exercises. From this data, a program based on a point system was planned, and certain exercises were recommended for producing the greatest oxygen debt. The best exercises are running, swimming, cycling, walking, stationary running, handball, basketball, and squash. Isometric exercises and isotonic exercises were not recommended; these had little cardiovascular effect and served mainly to increase the size of the muscles or to increase strength. It is important to do these exercises regularly to develop endurance fitness or the ability to do prolonged work without fatigue.

The change produced in the body by oxygen debt exercises is called the training effect. This effect starts when the heart rate reaches 150 and remains for five minutes. Some characteristics of the training effect are:

1. The heart grows stronger and pumps more blood per stroke; thus, it pumps fewer strokes.

2. The number and size of the blood vessels increase.

3. The total blood volume increases.

4. The blood pressure goes down (particularly when abnormally high).

5. The resting heart rate is sometimes twenty beats less.

6. More blood vessels open up in the muscle tissue.

Cooper concluded that exercise programs should be built on aerobics. Any combination of oxygen debt activities yielding thirty points a week (from pre-figured chart) was sufficient. However, regularity is essential. The exercises should be done four times per week or every other day. He established the idea that the best fitness is endurance fitness. The ability to supply oxygen to the cells determines a person's relative level of physical proficiency.

Doolittle and Bigbee (32) investigated the twelve-minute test used by Cooper for evaluation of, the state of endurance fitness and the 600-yard run-walk of the AAHPER battery. They established that the distance covered during the twelve-minute run-walk was a highly reliable and a valid indicator of cardio-respiratory fitness and that it was preferred to the 600-yard run-walk. The maximum oxygen intake correlation for the twelve-minute run was .90 and for the 600-yard run-walk was .62. The reliability coefficient for the twelve-minute run-walk on test-retest basis was .94. Administration of the twelve-minute test was demonstrated to be equally feasible for the 600-yard run-walk.

deVries (31), in discussing items of physical fitness and motor fitness tests, concluded that the concept of physical work capacity has gained favor over other measures of physical fitness. Physical work capacity may be defined as the maximum level of metabolism or work which an individual may complete.

Physical work capacity was dependent upon an individual's capacity to supply oxygen to the working muscle. This means that physical work capacity may disclose, directly or indirectly, the following components of physical fitness: (1) cardiovascular function, (2) respiratory function, (3) muscular efficiency, (4) strength, (5) muscular endurance, and (6) obesity. deVries concluded that physical work capacity is really "aerobic capacity." The best approach to measurement of physical work capacity is to have the subject repeat successive work for three to six minutes duration with an increasing intensity.

In summary of various cardiovascular tests, it seems plausible to refer to Cureton's (26) study of comparisons of various factor analyses of cardiovascular-respiratory test variables.

> Various factor analyses completed in the area of cardiovascular-respiratory tests between 1936 and 1962 were studied and the factors grouped into clusters

> of resting state, change of postural position from quiet sitting to lying or standing, moderate circulatory performing capacity, maximal performing capacity, recuperative ability after exercise, and respiratory capacity and reserve. The cardiovascular-respiratory tests were grouped according to three different types and periods of factor analyses. The factors from various studies are affected by the type of subjects, body position, and the relative state of fitness, and they can usually be subdivided. The various tests in the quiet state indicate relative sympathetic or parasympathetic dominance, blood flow, cardiac output, and metabolism. The electrographic and the ballistocardiographic observations have been included only in the last factor analyses. Moderate circulatory performing capacity tests indicate that there is relative economy to the work in terms of lower relative pulse rates, lower blood pressure during work, and lower oxygen intake for the relatively fitter men. The respiratory volumes have appeared as relatively independent from factor analyses of some authors (26, p. 317).

Physical educators have shown an interest in cardiovascular-respiratory factors as they are related to performance. Since many of the more recent test techniques were not in use with earlier studies, particularly oxygen uptake, the question of the relationship between fitness state and performance was not answered.

The purpose of Cureton's study was to give guidance to principal cluster factors used in varfous cardiovascular tests. The principal factors were (1) the resting state, (2) change in postural position, (3) moderate circulatory performing capacity, (4) maximal performing capacity, (5) recuperative ability after exercise, and (6) respiratory capacity and reserves.

Comments about use of the test related to specific clusters should provide some guidance to the physical educator.

Resting state tests have the greatest amount of total variance, and they are not very valuable for predicting performance. The postural change does not affect the veins in return of the blood to the heart except in extreme situations. Submaximal work shows that there was relative economy for the trained subjects during work. Maximal performing capacity was dependent upon capacity of the heart and blood vessels to perform maximum work. Recuperation data in terms of pulse rates, respiration rate, and blood lactate cannot be used with any degree of accuracy to estimate previous work. The amount of work is usually better measured by direct assessments. Although respiratory and circulatory factors have been found to be relatively independent, it is clear that circulatory and respiratory phenomena are closely related physiologically.

The factor analyses produce a very helpful classification of the cardiovascular-respiratory tests, but they are usually not adequate to establish validity of any test items in relation to the performances. The factors from various studies were affected by the different type subjects, body positions, and relative states of fitness. The factors with the highest percentages to total variance are not necessarily the most important physiologically or from the standpoint of performance.

Conditioning Methods and Physical Fitness

During the last decade, there has been great emphasis placed on improvement of physical fitness of the American people, particularly the youth. Physical educators and the medical profession were more aware of the needs than the general population. The parameters of fitness are considered to be varied but usually will include strength, endurance, agility, reaction time, speed, balance, coordination, and circulatory-respiratory variables. It may reasonably be concluded that these parameters are interrelated and that they produce a relative state of fitness.

In the last two decades, the investigation of the programs for the improvement of physical proficiency has been an area of major concern for the physical educators. A review of dissertations by physical educators supports the previous conclusion. Carlson (16), Helvey (44), and Waddle (78) have investigated weights or isotonics, exergenie, and isometrics in comparative studies and for their contributions to the improvement of fitness. Milton (28) studied track and calisthenics combinations. Webb's (79) study involved investigation of interval training to fitness changes. Physical education activities and sport activities were investigated by Butts (15) and White (83).

Physical fitness as described by Penman (69) was subdivided into three basic areas: cardiovascular efficiency, strength efficiency, and efficiency in executing basic skills in daily living. Bucher (14) indicated that the building of physical fitness involves many essentials other than physical activity. Examples of some of the other essentials are nutrition, rest, sleep, relaxation, and medical care. However, physical exercise was an essential ingredient for physical educators to consider when organizing a program of activities.

Updyke and Johnson (74) made the following exercise suggestions for deriving maximum enjoyment from physical activity. A program of activities should be started at an early age and continued throughout life, making adjustments as needs change. The amount of vigorous activity varies from thirty minutes to an hour daily as a minimum. The ability to recover quickly after activity indicates that the activity was not too strenuous. Exercise is one of the most important factors contributing to total fitness. The contributions of exercise to fitness include a sense of well-being as well as strength, endurance, agility, and skill. Active game sports, swimming, rhythmic activities, hobbies, and prescribed corrective exercises may all make contributions to physical fitness. Each individual differs in his capacity to enjoy and benefit from activity; however, one must continue to exercise in order to maintain a desirable state of physical fitness.

deVries (31) discussed the time necessary for improvement of physical fitness. A frequent question was "How much can we really accomplish in two thirty-minute periods per week?" To answer this question, a research study was organized involving sixty-seven college men using two thirty-minute or five fifteen-minute periods per week. The pre-test and post-test items were (1) standing broad jump, (2) push-ups, and (3) 300-yard shuttle run. The test was given at the beginning and end of the semester. Highly significant improvements were found on all test items. The students participating three to five days per week usually have the best improvements.

Wilt (86) describes training as a series of physical activities deliberately planned and executed with mental attitudes deliberately cultivated to increase personal efficiency. This particular description of training was written for the track prospect. Some of the different types of training techniques discussed were (1) interval training, (2) weight training, (3) circuit training, (4) repetition-running, and (5) fartlek.

Types of exercises and programs used to improve adult fitness were discussed by Cureton (27). Exercise includes calisthenics, games, sports, recreation, and various types of physical work. Strength exercise involved resistance; power exercise involved speed; balance involved equilibrium; and endurance involved a sustained effort. Attempts have been made to include different types of exercises into a fitness program. Some of the parameters usually included are (1) balance, (2) flexibility, (3) agility, (4) strength, and (5) power and some complicated coordinations. Some programs are combinations of weight lifting, or hard strength endurance exercises, and running, which were called circuit training. Other programs involve steeplechase, barbells, dumbbells, pulleys, rowing, treadmills, and other gadgets, but the effects produced were seldom evaluated.

Cureton divided his fitness programs for middle-aged men into three categories, which were labeled low gear, middle gear, and high gear. The first two to six months were devoted to forced breathing, rhythmic exercises for every part of the body emphasizing flexibility, rhythm, and very little endurance work. Emphasis was placed on the progression from very light work to slightly more vigorous efforts. The middle gear work was from one to three years. This was the intermediate program, and an increase in duration of exercises was prescribed. The exercises were walking, jogging, running, swimming, skating, skiing, climbing, canoeing, rowing, and similar activities. The high gear work was done once or twice weekly and involved all-out efforts, provided the low and middle gear progression had been completed.

Cooper and Brown (23) have devised a guide which can be used to establish a fitness program based upon a person's physical fitness state. Aerobics is a large-scale scientific program designed to answer questions about exercises and their contribution to participants. The program begins by taking a twelve-minute test of distance covered by running or walking to determine the present state of fitness. The distance a subject is able to cover in twelve minutes indicates his fitness category. The classifications by distance covered are very poor, poor, fair, good, or excellent. After determining the fitness category, a progressive program of walking, running, cycling, rope skipping, running in place, tennis, golf, etc., is begun to improve the aerobic fitness state. Regular participation is essential. Thirty points per week is considered necessary through participation, of varied choice, to maintain a satisfactory state of physical fitness.

The enhancement of muscular strength and endurance through exercise programs was investigated by Clarke and Stull (20). The optimal training regiments for strength and endurance development are not known, but there seems to be little doubt that physical performance can be improved by repetitive and overload exercises. Twenty-four male university students participated in a seven-week training program meeting three times per week. In each work session, subjects did forty repetitions per minute on an arm lever ergometer against 11.03 pounds of resistance.

The pre-test and post-test consist of five-minute periods during which time the subjects contracted the elbow flexors maximally every two seconds for a total of 150 contractions. Results revealed that training elicited significant increases in initial strength, final strength, and total work. Changes did not occur in fatigable work. It was concluded that muscular strength was improved by low resistance endurance training.

Berger (8) compared effects of three weight training techniques for improvement of strength. Weight training procedures involved routines used by competitive weight lifters compared with those used for rehabilitation purposes. The professional lifters used heavy weights, few repetitions, and several sets. Physical therapists prescribed light weights, several repetitions, and a minimum number of sets. Those enrolled in the training program met three days per week for nine weeks. Using analysis of covariance, there was no significant differences between the mean improvements for the two programs.

Westering (82) conducted a study to determine the effects of four physical conditioning programs and their respective time variable upon selected measures of physical performance. The four conditioning programs and time factors were (1) isometric for four minutes each period, (2) intensity for seven minutes each period, (3) circuit training for thirteen minutes each period, and (4) calisthenics for fifteen minutes each period. All groups participated in tennis for the remainder of each class period. The treatment was conducted over a period of eight weeks. Circuit training or intensity programs developed a higher degree of physical performance in less time than did calisthenics.

Frank (36) did a pre-test and post-test study at Murray State University to justify the inclusion of physical conditioning classes. Twenty-three male students were involved in a six-station circuit training program. Physical condition of the subjects in each of the fitness factors was improved between pre-test and post-test measures.

A comparative study of physical fitness parameters, as measured by the sports method and the apparatus method, was conducted by Wilbur (84). He concluded that the sports method was superior to apparatus method in body coordination, agility, control, for improving arm and shoulder-girdle strength, and in improving physical fitness. The apparatus and sports methods were equal in improvement in leg speed, jumping, and leg strength. There was no significant improvement of one group over the other in arm and shoulder-girdle coordination or in enduranne.

Strength and endurance development during participation in soccer, basketball, weight training, general activities, touch football, tennis, trampoline, and badminton were investigated by Mullins (65). The study was conducted for ten weeks and involved pre-test and post-test. Analysis of data indicated (1) achievement in strength was achieved through general activities, weight training, trampoline, and basketball; (2) soccer, basketball, weight training, general activities, touch football, tennis, and badminton resulted in improvement of endurance.

A similar study was conducted by Kistler (53) to determine the achievement of physical fitness from regular participation in a program designed to improve strength, endurance, and agility. The study was conducted for eight weeks, thirty minutes per day, three days per week, involving 1650 male college students. The program consists of chinning bars, obstacle course, pick-a-pack wrestling, modified boxing, catch-as-catch-can, Indian wrestling, a cross-country running program, wind sprints, and relays.

Kistler concluded that through specified training, physical fitness components of strength, endurance, and agility can be improved significantly. The time required for achieving improvements in physical fitness of the type involved is not excessive. Of the three variables, endurance appears to be the most difficult to improve.

Calisthenics are normally used as a warm-up routine before some selected activity. Coker (21) used three different calisthenic routines preceding regular class touch football participation. A pre-test and post-test was administered for the six-weeks study. Analysis of data indicated that supplemental pre-activity programs of calisthenics and touch football did not produce significant improvements in any aspect of the physical fitness components measured.

On the assumption that physical fitness is one of the objectives of physical education, Mahanes and Jones (57) were instrumental in planning a physical education program for Fayette County Public Schools, Lexington, Kentucky. The following outline will illustrate the basic elements of their program. The elementary level activities were:

1. games
2. relays
3. basic movements
4. rhythms
5. stunts and tumbling, at each grade level

Physical fitness and lead-up team sports were emphasized at the fifth and sixth grade levels. The program progressed from team sports, gymnastics, and large group activities at the junior high school level to electives encouraging students to develop their avocational interests at the senior high school level.

Bodley (11) suggested building an obstacle course for improvement of muscle tone, agility, flexibility, endurance, strength, and pride or attitude. He suggested that the obstacle course can be an added dimension in an attempt to develop a high level of fitness.

deVries (31) suggested that individuals pressed for time can use the Royal Canadian Air Force 5BX Plan of Calisthenics Exercises (71) to develop and maintain a fitness state. The exercise routine consists of stretching exercises, sit-ups, push-ups, stationary run, and semi-squat jumps. The specific routine has prescribed instructions and time factors.

As previously concluded, physical educators need to acquire a basic knowledge of the physiological principles underlying the development of strength, power, muscular endurance, cardiovascular efficiency, and appropriate methods for assessing these parameters of physical fitness. Van Huss (77) indicated that overload was required for improvement in performance. Overload exercise routines may involve (a) an increase in the work load, (b) an increase in the work rate, (c) an increase in duration time, or (d) a decrease in rest intervals (29, 38, 39, 40, and 41). Rate of improvement is related to intensity of training within the limit of exercise tolerance. The greater the intensity of the overload, the greater will be the rate of improvement. Van Huss and others (75) stated that greater rates of improvement in dynamic strength are found to result from programs involving fewer repetitions with heavy loads, even when all subjects perform as many repetitions as they can during each training period. The effects of training are specific to the type of overload applied (9, 75, 76). Some other principles related to physiological improvements are (1) retrogression often precedes improvement, (2) repetition is essential for muscular efficiency, (3) fatigue impairs motor learning, (4) response to training is individual and unique, and (5) motivation is essential for effective training (77).

CHAPTER BIBLIOGRAPHY

1. Adams, F. A. and others, "Symposium on Exercise Fitness: Their Physiological Basis and Clinical Application to Pediatrics," Pediatrics, XXII (October, 1963), 653-778.

2. Alexander, J. P. and J. E. Torpey, "Conditioning Improves Cardiovascular Fitness," Minnesota Journal of Education, XLVIII (October, 1967), 12-15.

3. Amasa, Ford and Herman Hellerstein, "Estimation of Energy From Pulmonary Ventilation," Journal of Applied Physiology, XIV (November, 1959), 891.

4. American Association for Health, Physical Education, and Recreation, Test Manual, Washington, D. C., 1961.

5. Astrand, Per-Olof and Kaare Rodahl, Textbook of Work Physiology, St. Louis, McGraw-Hill Book Co., 1970.

6. Astrand P. O. and I. Rhyming, "A Nomogram for Calculation of Aerobic Capacity (Physical Fitness) From Pulse Rate During Submaximal Work," Journal of Applied Physiology, VII (March, 1954), 218-221.

7. Bentley, Earl J., "The Influence of Three Training Programs on Strength, Speed, Power, General Endurance and Speed of Movement," unpublished doctoral dissertation, University of Southern Mississippi, 1968.

8. Berger, Richard A., "Comparison of the Effect of Various Weight Training Work Loads on Strength," Research Quarterly XXXVI (May, 1965), 141-146.

9. Berger, R. A. and J. M. Henderson, "Relationship of Power to Static and Dynamic Strength," Research Quarterly, XXXVII (March, 1966), 9-13.

10. Bitcon, Lawrence E., "Validation of a Physical Fitness Test for High School Boys in Iowa," unpublished doctoral dissertation, University of Arkansas, Fayetteville, Arkansas, 1965.

11. Bodley, Dean, "Build an Obstacle Course," The Physical Educator, XXXVII (October, 1970), 123-124.

12. Brooker, Charles, "The Effects on Efficiency of Endurance Training Controlled by Heart Rate," unpublished doctoral dissertation, Syracuse University, New York, 1966.

13. Brouha, L. and Mary E. Maxfield, "Practical Evaluation of Strain in Muscular Work and Heat Exposure by Heart Rate Recovery Curves," Ergonomics, V (January, 1962).

14. Bucher, Charles A., Foundations of Physical Education, 5th Ed., St. Louis, The C. V. Mosby Company, 1968.

15. Butts, Eugene M., "The Contributions of Ten Selected Physical Education Activities to Physical Fitness and Motor Ability," unpublished doctoral dissertation, Syracuse University, New York, 1966.

16. Carlson, Leon R., "Comparison of Muscular Strength and Relative Muscular Endurance in Isotonics and Isometrics Contractions," unpublished doctoral dissertation, University of Texas, Austin, 1968.

17. Carpenter, A., "An Analysis of the Relationships of the Factors of Velocity, Strength and Dead Weight to Athletic Performance," Research Quarterly, XII (1941), 34-39.

18. Clarke, D. H. and H. H. Clarke, Research Processes in Physical Education, Recreation, and Health, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1970.

19. Clarke, H. Harrison and Ernest W. Degustis, "Relationship Between Standing Broad Jump and Various Maturational Anthrometric, and Strength Test of 12-Year Old Boys, Research Quarterly, XXXV (October, 1964), 258-264.

20. Clarke, D. H. and G. A. Stull, "Endurance Training As A Determinant of Strength and Fatigability," Research Quarterly, XLI (March, 1970), 12-26.

21. Coker, H. L., "Selected Pre-Activity Calisthenics Programs and Their Effects Upon the Physical Fitness of the College Male," unpublished doctoral dissertation, University of Arkansas, Fayetteville, Arkansas, 1964.

22. Consolazio, C. F. and others, Physiological Measurements of Metabolic Functions in Men, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1963.

23. Cooper, K. H. and K. Brown, Aerobics, New York, N. Evans and Co., Inc., 1963.

24. Corroll, Victor A., "AAPHER Youth Fitness Test Items and Maximal Oxygen Intake," unpublished doctoral dissertation, University of Illinois, Evanston, Illinois, 1967.

25. Cureton, T. K., Physical Fitness Apprisal and Guidance, St. Louis, C. V. Mosby, 1947.

26. ______________, "Comparison of Various Factor Analyses of Cardiovascular-Respiratory Test Variables," Research Quarterly, XXXIX (October, 1966), 317-325.

27. ______________, The Physiological Effects of Exercise Program on Adults, Springfield, Illinois, Charles C. Thomas Publisher, 1969.

28. Davis, Robert M., "A Comparison of Three Approaches to Increasing Physical Fitness in Students of Low Fitness," unpublished doctoral dissertation, George Peabody College, 1963.

29. DeLorme, T. L. and A. L. Watkins, Progressive Resistance Exercise: Technique and Application, New York, Appleton-Century-Crofts, Inc., 1951.

30. Dempsey, Cedric W., "A Ballistocardiographic Investigation of Cardiac Responses of Boys to Physical Training and Wheat Germ Oil," unpublished doctoral dissertation, University of Illinois, Evanston, Illinois, 1964.

31. deVries, Herbert A., Physiology of Exercise for Physical Education and Athletics, Dubuque, Iowa, William C. Brown Company, Publishers, 1968.

32. Doolittle, T. L. and R. Bigbee, "Twelve Minute Run-Walk Test: A Test of Cardio-Respiratory Fitness of Adolescent Boys," Research Quarterly, XXXIX (October, 1966), 491-495.

33. Duncan, Olen T., "The Effects of Dynamic Exercise on the Development of Physical Fitness," unpublished doctoral dissertation, North Texas State University, Denton, Texas, 1968.

34. Falls, Harold B. and A. H. Ismail, and D. F. MacLeod, "Estimation of Maximum Oxygen Uptake in Adults From AAHPER Youth Fitness Test Items," Research Quarterly, XXXVII (May, 1966), 192-201.

35. Fleishman, Edwin A., The Structure and Measurement of Physical Fitness, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1965.

36. Frank, J. A., "Comparisons of Pre- and Post-Fitness Scores in Conditioning Experiment," Research Quarterly, XXXVIII (October, 1967), 510-512.

37. Girardin, Juan, "The Comparative Effects of Two Levels of Training Intensity of Human Adaptations to a State of Stress," unpublished doctoral dissertation, Florida State University, Tallahassee, Florida, 1967.

38. Gordon, E. E., "Adaptation of Muscle to Different Exercise," Journal of the American Medical Association, CCI (March, 1967), 755-758.

39. Gordon, E. E. and others, "Adaptions of Muscle to Various Exercise," Journal of the American Medical Association, 199 (January, 1967), 103-108.

40. ____________________, "Changes in Rat Muscle Fiber with Forceful Exercise," Archives Physical and Medical Rehabilitation, XLVIII (February, 1967), 577-582.

41. ____________________, "Protein Changes in Quadriceps Muscle of Rat with Repetitive Exercises," Archives Physical and Medical Rehabilitation, XLVIII (February, 1967), 296-303.

42. Harper, D. D. and others, "Comparative Effects of Two Physical Conditioning Programs on Cardiovascular Fitness in Man," Research Quarterly, XL (May, 1969), 293-298.

43. Hayes, Asabel E., "Criteria for the Selection of Physical Fitness Activities in Physical Education Classes," unpublished doctoral dissertation, University of California, Los Angeles, California, 1968.

44. Helvey, Omer J., "The Effects of Isometric, Isotonic, and Sports Program on Physical Fitness," unpublished doctoral dissertation, University of Arkansas, Fayetteville, Arkansas, 1965.

45. Howard, Gordon E., "A Study of the Relationship Between the Tension ("isometric") Period of the Left Ventricle and Physical Training in Young Adult Men," unpublished doctoral dissertation, University of Michigan, Lansing, Michigan, 1968.

46. Hutto, L., "Measurement of the Velocity Factor and of Athletic Power in High School Boys," Research Quarterly, IX (October, 1938), 109-128.

47. Issekutz, B. and others, "Use of Respiratory Quotients in Assessment of Aerobic Work," Journal of Applied Physiology, XVII (January, 1962), 47.

48. Issekutz, B. and K. Rodahl, "Respiratory Quotient During Exercise," Journal of Applied Physiology, XVI (July, 1961), 606.

49. Jones, Herbert L., and others, Science and Theory of Health, DuBuque, Iowa, W. C. Brown Company Publishers, 1966.

50. Karpovich, Peter V., Physiology of Muscular Activity, Philadelphia, Saunders, 1965.

51. Kight, Carl R., "The Effects of Experimentally Induced Variations in Body Weight Upon Power," unpublished doctoral dissertation, Louisiana State University and Agricultural and Mechanical College, Baton Rouge, Louisiana, 1967.

52. Kirby, Ronald F., "The Effects of Various Exercise Programs Involving Different Amounts of Exercise on the Development of Certain Components of Physical Fitness," unpublished doctoral dissertation, Louisiana State University, Baton Rouge, Louisiana, 1966.

53. Kistler, J. W., "A Study of the Results of Eight Weeks of Participation in University Physical Fitness Program for Men," Research Quarterly, XV (March, 1944), 23-28.

54. Larson, L. A., "A Factor and Validity Analysis of Strength Variables and Tests with a Test Combination of Chinning, Dipping and Vertical Jump," Research Quarterly, XI (January, 1940), 82-96.

55. ____________, "A Factor Analysis of Motor Ability Variables and Tests, with Tests for College Men," Research Quarterly, XII (December, 1941), 499-517.

56. Locke, L. F., "Comments on the Article 'Reliability of the 600-Yard Run-Walk Test at the Junior High School Level,'" Research Quarterly, XXXIII (October, 1962), 326-328.

57. Mahanes, Thomas R. and R. R. Jones, "Physical Education in Fayette County," The Physical Educator, XXVII (October, 1970), 119-120.

58. Maxfield, Mary and Lucien Brouha, "Validity of Heart Rate as an Indicator of Cardiac Strain," Journal of Applied Physiology, XVIII (November, 1964), 1099-1104.

59. McNair, Daniel P., "Effects of Different Exercise Programs on the Development of Cardiovascular Fitness Strength and Muscular Development," unpublished doctoral dissertation, Louisiana State University and Agricultural and Mechanical College, Baton Rouge, Louisiana, 1967.

60. Metheny, E. L. and others, "Some Physiological Responses of Men and Women to Moderate and Strenuous Exercises: A Comparative Study," American Journal of Physiology, X (January, 1957), 51.

61. Metz, Kenneth F., "The Relationship Between Maximal Aerobic Capacity and Physical Fitness in 12-15 Year Old Boys," unpublished doctoral dissertation, University of Minnesota, St. Paul-Minneapolis, Minnesota, 1967.

62. Milton, George C., "The Effects of Three Programs of Long Distance Running and an Isometric Exercise Program on the Development of Cardiovascular Efficiency," unpublished doctoral dissertation, Louisiana State University, Baton Rouge, Louisiana, 1966.

63. Mitchell, J. H. and others, "The Physiological Meaning of the Maximal Oxygen Intake Test," Journal of Clinical Investigations, XXXVII (November, 1958), 538.

64. Morehouse, Lawrence E. and Augustus T. Miller, Physiology of Exercise, 5th Ed., St. Louis, 1967.

65. Mullins, P. M., "Measurement of the Extent to Which Certain College Physical Education Activities Contribute to Certain Strength and Endurance Objectives," unpublished doctoral dissertation, Department of Education, Washington State University, Pullman, Washington, 1961.

66. Olree, Harry and others, "Evaluation of the AAHPER Youth Fitness Test," The Journal of Sports Medicine and Physical Fitness, V (June, 1965), 65-71.

67. Oscia, Lawrence B., "Effects of Training on Blood Volume and Physical Fitness Test," unpublished doctoral dissertation, University of Illinois, Evanston, Illinois, 1967.

68. Parkman, James E., "An Analysis of the Physical Fitness of College Men as Shown by the AAHPER Fitness Test," unpublished doctoral dissertation, University of Southern Mississippi, Hattiesburg, Mississippi, 1964.

69. Penman, Kenneth, Physical Education for College Students, St. Louis, C. V. Mosby Company, 1964.

70. Ponthieux, N. A. and D. G. Barker, "An Analysis of AAHPER Fitness Test," Research Quarterly, XXXIV (December, 1963), 525-526.

71. Royal Canadian Air Force, 5BX Plan, Ottawa, Queen's Printer and Controller of Stationery, 1961.

72. Stein, Julian V., "The Rehability of the Youth Fitness Test," Research Quarterly, XXXV (October, 1964), 328-329.

73. Tharp, G. D., "Cardiac Function Test as Indexes of Fitness," Research Quarterly, XL (December, 1969) 818-822.

74. Updyke, Wynn F. and Perry B. Johnson, Principles of Modern Physical Education, Health, and Recreation, Dallas, Holt, Rinehart, and Winston, Inc., 1970.

75. Van Huss, W. D. and others, "Effects of Overload, Warm-Up on the Velocity and Accuracy of Throwing," Research Quarterly, XXXIII (December, 1962), 472-475.

76. __________________________, An Introduction to Measurement in Physical Education: Physical Fitness, Phi Epsilon Kappa Fraternity, Indianapolis, 1970.

77. __________________________, Physical Activity in Modern Living, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 2nd Ed., 1969.

78. Waddle, Benjamin, "A Study Comparing the Effectiveness of a Training Program Utilizing the Exergenie with Two Conventional Training Programs on the Development of Muscular Strength and Cardiovascular Endurance," unpublished doctoral dissertation, Florida State University, Tallahassee, Florida, 1967.

79. Webb, Wyatt M., "Three Interval Training Programs and Their Effects on Selected Physiological Variables," unpublished doctoral dissertation, Ohio State University, Columbus, Ohio, 1967.

80. Wells, J. G., "Flarimeter Test for Athletes," <u>American Heart Journal</u>, XLVIII (December, 1954), 914.

81. Wells, J. G. and others, "Lactic Acid Accumulation During Work, A Suggested Standardization of Work Classification," <u>Journal of Applied Physiology</u>, X (January, 1957), 51.

82. Westering, R. E., "The Effects of Various Programs of Physical Performance," unpublished doctoral dissertation, Colorado State College, Greeley, Colorado, 1966.

83. White, Robert E., "A Comparison of Two Methods of Developing Physical Fitness in Fourth and Fifth Grade Boys," unpublished doctoral dissertation, Ohio State University, Columbus, Ohio, 1962.

84. Wilbur, E. A., "A Comparative Study of Physical Education: The Sports Method and the Apparatus Method," <u>Research Quarterly</u>, XIV (October, 1964), 326-330.

85. Willgoose, Carle E. and Mildred and Nathaniel Askew, "Reliability of the 600-Yard Run-Walk Test at the Junior High Level," <u>Research Quarterly</u>, XXXII (May, 1961), 264-265.

86. Wilt, Fred, <u>Run Run Run</u>, Los Altos, California, Track and Field News, Inc., 1964.

CHAPTER III

PROCEDURES OF THE STUDY

Description of the Subjects

Subjects for the study were sixty-one freshman and sophomore college students enrolled in physical education activity classes at North Texas State University in the spring semester of 1971. The students' membership in the study was determined by their selection of Physical Education 116 activity courses. The class activities were (1) weight training and (2) track and field. From the original sixty-one, only those students completing the pre-test, treatments, and post-test were considered in the analysis of the data. The subjects meeting these requirements were forty-eight from the original sixty-one.

Orientation of the Subjects

The first two weeks of the semester were used for orientation and testing of the students. The first two days were devoted to an explanation of the specific nature of workouts, duration of the treatments, and pre-test and post-test procedures. Teacher and student expectations were discussed. Students were specifically instructed to attend regularly and to give a representative effort in each class.

Class Procedures

The general class routine for both groups involved regular meetings at the ten o'clock and eleven o'clock hours Monday, Wednesday, and Friday morning of each week. Class treatments started ten minutes after the hour for each class and ended twenty minutes before the following hour. A work period of thirty minutes duration existed for each group.

The class procedure for the group, designed to develop cardiovascular-respiratory efficiency, included jogging 880 yards, stretching exercises, and continuously running or walking. The stretching exercises were traditional sit-ups, push-ups, trunk rotations, and stretching exercises for the hamstrings and medial muscles of the thigh. The calisthenics were performed individually by the subjects in an unstructured procedure. The general design for the group was for the subjects to cover as much mileage as they could in each practice session. The range in mileage was between two and four-and-one-half miles per workout (see Appendix F).

The class procedure for the group, designed to emphasize strength and agility, included calisthenics, agility drills, and a power rack weight routine (see Appendix F). The time allotted to calisthenics and agility drills was five minutes with the remaining twenty-five minutes devoted to the weight training routine. The calisthenics were performed in a group to a verbal cadence. The exercises were traditional ones used by physical educators and coaches and consisted of the side straddle hop, push-ups, and sit-ups which were executed on a two-count cadence, while the squat thrust and the wind mill were performed to a four-count rhythm. The durations for each calisthenic were ten repetition.

Agility drills for the strength emphasis group were composed of short, quick movements which were executed within a ten-yard distance. One of these agility drills was the dipsie doodle, a lateral run alternating a lead foot in front and then behind the vertical plane of the body. Another agility drill was the run-turn-run which was an alternating forward and backward run. The start was a power drill involving an explosive drive for approximately four yards from a three or four point stance and then relaxing through the remaining distance. The bear crab drill was a power routine similar to the starts except the subjects remained in a quadruped position through the first four yards of the drill.

The weight routine involved lifting in excess of three-hundred pounds at the (1) low pull, (2) leg press, and (3) one-quarter squats. The low pull was a modified dead lift; the bar was slightly over knee high, and the lift started with flexed knees directly under the bar with an interlocked hand grip at approximately shoulder width. The interlocked grip involved pronation of one forearm and supination of the other. The lift was completed by extension of the knees and hips to an erect position. The inverted leg press was performed on an inclined board having the subject start from a supine position with his knees flexed. The barbell was pressed by an extension of the knees, hips, and ankles. The drill was completed by returning to the starting position. The one-quarter squat began by placing the barbell on the shoulders with the knees flexed. The lift was executed by extending the knees to an erect position and returning to the starting position. The height of the bar was set approximately at the distal apex of the scapula when the subjects were in an erect stance.

Pull-ups and abdominal curls were performed using body weight as the resistance. The procedure for the remaining stations involved less weight resistance. The bench press was performed with 140 to 160 pounds. The flexed arm pull-overs were performed with sixty to seventy pounds. The high pull and the curls were executed with eighty to one hundred pounds. The butterflies were performed with a ten-pound plate in each hand.

The starting positions, suspended from a chinning bar, for the pull-ups and abdominal curls were very similar. The pull-ups were performed from a position with the arms in full extension supporting the weight of the body. The palms of the hands were turned away from the ventral surface of the body by pronation of the forearms. By concentric and eccentric flexion of the arms, the subject's body was elevated and lowered. The performing position for the abdominal curls was the same as pull-ups except that the palms were toward the ventral surface of the body; this was done by supination of the forearms. To perform the exercise, the knees were flexed; the abdominal muscles were used to roll the body up into a tuck position, and the lift was completed by returning to the starting position.

The bench press, flexed arm pull-overs, high pulls, curls, and butterflies were performed by more isolated muscle groups. The bench press was the conventional press starting from a supine position with the arms flexed above the chest. The arms are extended to elevate the weight and returned to the starting position to complete the exercise. The flexed arm pull-overs were performed from a starting position similar to the bench press with the body in the supine position and the hands placed together near the center of the barbell. The bar rests on the subject's chest; the arms are flexed; the bar was raised above the face and then lowered behind the head. The lift was completed by pulling the barbell back to the starting position.

The high pull and the curl techniques were performed by utilizing approximately the same weight resistance. The starting position for the high pull began by placing the hands together near the middle of the barbell. The forearms were pronated with the hands toward the ventral surface of the body, and the bar was then pulled from approximately waist level to the chin and returned to the starting position to execute the lift. The curls were performed from the same position as the high pull except that the palms were turned up by supination of the forearms and the hands were placed at shoulder width. The lift was completed by raising the barbell to the chin and returned to the starting position.

The butterflies were performed from a supine position on a bench, and the weights were raised from approximately shoulder level with extended arms to a position above the head and returned to the starting position to complete the routine.

The entire weight routine involved a command procedure where subjects manipulated the bars as the instructor called commands for the lift. Each station procedure included three repetitions with the third repetition being held in a position of strain for approximately ten seconds. The subjects completed at least two clockwise rotations of all weight stations each workout. All weight stations which involved extension and flexion of the legs used a base of support with the feet approximately at shoulder width.

The conditioning programs chosen for this study represent different practices and theories concerning the development of physical fitness parameters. The strength emphasis program represents practices being applied by physical educators in conditioning classes and coaches in their off-season programs.

Van Huss (14) concluded that response to training is unique and individual. In contrast, other authors have concluded that certain common physiological changes occurred during given training programs (5, 6, 7, 8, 9, 15). Van Huss and others (12) indicated that rate of improvement is related to the intensity of the training program. In another study by Van Huss and a different group of co-workers (13), it was concluded that the effects of training was far more specific than is generally thought. In specific training routines where different groups used maximal load with few repetitions and moderate load with maximal repetitions, the gains were different. The group using the maximal load gained more significantly in dynamic strength while the group using moderate resistance and maximal repetitions gained more significantly in muscular endurance.

The endurance program used for the development of cardiovascular efficiency was based upon the principle or theory that heart rate is reduced with training (2). The functional improvement and capacity of the cardiovascular system is specific to the various kinds of tasks and work intensities (2, 4, 11). The assumption was as heart rate decreases, the cardiovascular efficiency of the trainee increases. The endurance training program was designed to place the cardiovascular system under stress by continuous running and walking.

The Testing Procedure

The basal heart rate, physical work capacity, and the AAHPER Youth Fitness Test were administered to each subject at the beginning of the study. After eight weeks of participation, the same tests were given following the pre-test procedure. The night preceding the recording of their basal heart rates, the test subjects reported to the women's gymnasium. The following morning, the basal heart rate was taken before any activity occurred. The physical work capacity test was taken using the bicycle ergometer with a progressing work load. The physiograph was used for monitoring the heart rate, and the test was terminated at the point when the participant's heart rate reached 180 beats per minute (10). The AAHPER Youth Fitness Test was administered according to the routine prescribed by the test manual (see Appendix A). The pull-ups, standing broad jump, shuttle run, and the sit-ups were given one class session; the fifty-yard dash, softball throw, and the 600-yard run were given two days later during the regular class period (1).

Instruments for Collection of Data

The large number of general methods and specific tests used to study exercise fitness or parameters of fitness suggests that a single test is not completely satisfactory (4). Usually, the response of an individual subject to stress which exceeds that in the resting state is measured to assess the current status or to predict reaction to still other situations. Two of the test measures, basal heart rate and physical work capacity, are for assessing cardiac output of the subjects. The physical work capacity is affected by other parameters of physical fitness than cardiac function, according to deVries (3).

He emphasized strength, muscular endurance, muscular efficiency, and obesity as other variables influencing work capacity levels. The AAHPER Youth Fitness Test is an examination of fitness on the basis of the subject's ability to perform learned skills, evaluations of strength, and evaluations of endurance. Details concerning the administration of these tests are enclosed in Appendix A.

Procedures for Treatment of the Data

The subjects were two intact groups from the physical education acitivty program. Each group was subjected to different experimental treatments for a period of eight weeks. One of the groups was a weight-training class, which was subjected to a strength improvement program, and the other group was a track class, which was subjected to an endurance improvement program.

Prior to the beginning of the experimental treatments, variables were selected for statistical control. The first three hypotheses were tested using the pre-test scores as the control variables. The statistical assumption is that the two population means are equal when the effects of the control variable is statistically controlled. The control variable for hypothesis one was pre-test basal heart rate, which was used to compute the variance that exists in post-test basal heart rate. The control variable for hypothesis two was pre-test physical work capacity, which was used to compute the variance that exists in post-test physical work capacity. For the third hypothesis, the control variable was pre-test AAHPER Youth Fitness Test scores, which were used to compute the variance that exists in the post-test AAHPER Youth Fitness scores. These three hypotheses were formulated to compare the two experimental groups' treatments.

Product moment correlation coefficients were computed among the test instruments to estimate the relationships that exist among these instruments for assessing levels of physical fitness parameters. The test instruments were basal heart rate, physical work capacity, and items of the AAHPER Youth Fitness Test.

CHAPTER BIBLIOGRAPHY

1. American Association for Health, Physical Education, and Recreation, Test Manual, Washington, D. C., 1961.

2. Cooper, K. H. and K. Brown, Aerobics, New York, M. Evans and Co., Inc., 1968.

3. deVries, Herbert A., Physiology of Exercise for Physical Education and Athletics, Dubuque, Iowa, William C. Brown Company Publishers, 1968.

4. Fleishman, Edwin A., The Structure and Measurement of Physical Fitness, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1965.

5. Gordon, E. E. and others, "Changes in Rat Muscle Fiber with Forceful Exercise," Archives Physical and Medical Rehabilitation, XLVIII (February, 1967), 577-582.

6. ______________________, "Adaptions of Muscle to Various Exercise," Journal of American Medical Association, CXCIX (January, 1967), 103-108.

7. ______________________, "Protein Changes in Quadriceps Muscle of Rat with Repetitive Exercises," Archives Physical and Medical Rehabilitation, XLVIII (February, 1967), 296-303.

8. Gordon, E. E., "Adaptation of Muscle to Different Exercise," Journal of American Medical Association, CCI (March, 1967), 755-758.

9. Helander, E.A. S., "Influence of Exercise and Restricted Activity on the Protein Composition of Skeletal Muscle," Biochemistry Journal, LXXVIII (1961), 478-481.

10. Olree, Harry D., "Methods of Achieving and Maintaining Physical Fitness for Prolonged Space Flight," Nassar Research Progress Report, Harding College, Searcy, Arkansas, 1969.

11. Updyke, Wynn F. and Perry B. Johnson, Principles of Modern Physical Education, Health, and Recreation, Dallas, Holt, Rinehart, and Winston, Inc., 1970.

12. Van Huss, W. D. and others, Physical Activity in Modern Living, Englewood Cliffs, New Jersey, Prentice-Hall Inc., 2nd Edition, 1969.

13. ______________, "Effect of Overload Warm-Up on the Velocity and Accuracy of Throwing," Research Quarterly, XXXIII (December, 1962), 472-475.

14. ______________, An Introduction to Measurement in Physical Education: Physical Fitness, Phi Epsilon Kappa Fraternity, Indianapolis, 1970.

15. Williams, C.G. and others, "Effect of Training on Maximum Oxygen Intake and an Anaerobic Metabolism in Man," Internationale Zeitschrift fur Angewandt Physiologie einschliesslich Arbeits-Physiologie, XXIII (1967), 18-23.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Students from two intact groups were administered three tests to determine the physical fitness levels at the beginning of the study. The tests were basal heart rate, physical work capacity, and the AAHPER battery. To assess changes that occurred, post-tests were administered after eight weeks of treatment. These tests emphasized two different conditioning programs. The two programs were (1) a conditioning program designed to develop strength and agility and (2) a conditioning program designed to develop cardiovascular-respiratory efficiency.

The statistical treatments used were analysis of covariance and product moment correlation. Analysis of covariance was used to compare the two conditioning methods, and product moment correlation was used to find the relationships that existed among the different instruments which were used to measure the parameters of physical fitness.

The purposes formulated for this study were to determine the changes in physical fitness status that occurred during the treatments and to evaluate the use of physical work capacity, basal heart rate, and the AAHPER Youth Fitness Test as instruments for assessing parameters of physical fitness.

Hypotheses were stated on each of the instruments used to compare the conditioning programs. A null hypothesis was formulated on the relationships that exist among the instruments used to determine the parameters of physical fitness. The .05 level of confidence was selected as the point for rejection of the null hypothesis.

The procedure used for developing the data in this chapter was twofold. The presentation of data was a general inclusion for a description of changes that occurred in the criterion measures and a nonspecific description of the relationships within the instruments used to determine physical fitness status. The analysis of data included the significant differences that existed as they were related to the hypotheses of the study.

Presentation of the Data

The test items were (1) sit-ups, (2) pull-ups, (3) shuttle run, (4) broad jump, (5) softball throw for distance, (6) 600-yard run, (7) 50-yard dash, (8) AAHPER battery, (9) physical work capacity, (10) basal heart rate and, (11) resting heart rate. These variables were tested to measure parameters of physical fitness. Some of the parameters were strength, power, endurance, speed, flexibility, coordination, agility, muscular efficiency, muscular endurance and cardiovascular-respiratory efficiency.

The changes in criterion measures between groups are included in Table I. Pre-test and post-test means, standard deviations, mean differences, and the group with the best mean gains are included in Table I.

TABLE I

PRE-TEST AND POST-TEST MEANS AND STANDARD DEVIATIONS AND MEAN GAINS FOR GROUPS I AND II AND EXCELLING GROUP

Group	Variable	Means Pre-T	Means Post-T	Means Gains	Standard-D Pre-T	Standard-D Post-T	Best Group
I	S-ups	70.46	81.33	9.13	22.00	19.41	
II		67.42	77.00	10.42	26.80	24.29	II
I	P-ups	8.04	10.54	2.50	2.88	2.30	
II		7.13	7.88	.75	3.55	3.89	I
I	SR	9.85	9.78	-.08	.55	.67	
II		9.86	9.65	-.22	.59	.62	II
I	BJ	85.29	87.67	2.38	5.02	7.21	
II		83.67	84.04	.38	10.85	9.43	I
I	50-D	6.66	6.56	-.10	.27	.31	
II		6.78	6.59	-.19	.55	.54	II
I	SBT	202.83	227.08	24.25	31.32	35.78	
II		185.25	205.83	20.58	34.01	42.76	I
I	600	110.88	113.58	2.71	10.30	11.72	
II		112.83	109.29	-3.54	20.55	20.28	II
I	A-PER	59.00	66.50	7.50	12.22	11.50	
II		54.00	63.04	9.04	22.33	19.97	II
I	PWC	11.02	13.05	2.03	1.51	1.81	
II		10.78	13.47	2.69	1.47	1.71	II
I	BHR	59.75	59.13	-3.63	6.69	5.09	
II		59.71	52.42	-7.29	6.41	6.47	II
I	RHR	82.58	79.75	-2.83	10.60	11.84	
II		76.38	73.75	-2.63	10.10	11.40	I

Mean gains indicated that the group treatment which emphasized the development of cardiovascular-respiratory efficiency (group II) had better gains in seven of the eleven variables studied. Group II had better mean gains than the group which emphasized strength and agility on sit-ups (1.2917), shuttle run (.1417 seconds), 50-yard dash (.0875 seconds), 600-yard run (6.2499 seconds), AAHPER battery (1.5417 per cent), physical work capacity (.6570 minutes), and basal heart rate (3.6666 beats per minute).

The conditioning program designed to develop strength and agility had better mean gains on four variables than did Group II. Mean gains in which Group I excelled were pull-ups (1.75 pull-up), broad jump (2 inches), softball throw for distance (3.6667 feet), and resting heart rate (.2083 beats per minute).

A correlation matrix was developed for Group I which was designed to emphasize the development of strength and agility. The matrix included age, height, weight, items of the AAHPER Test, AAHPER battery score, physical work capacity, basal heart rate, and resting heart rate. The correlations are included to indicate the degree of relationship that was established between the instruments for assessing the parameter levels and the test items that were used to indicate a particular physical proficiency. It was established that a correlation coefficient of $\pm .40$ was significant at the .05 level for Group I. Table II is a correlation matrix for the group emphasizing development of strength and agility.

TABLE II

A CORRELATION MATRIX FOR GROUP I

	Age	Ht.	Wt.	S-Up	S-Up	P-Up	P-Up	S.R.	S.R.
Age	1.00	-.28	.31	-.36	-.16	.11	-.14	-.31	-.29
Ht.	-.28	1.00	.35	.32	.05	-.02	-.01	.14	.36
Wt.	.31	.35	1.00	.15	.12	-.11	-.10	.03	.20
S-Up	-.36	.32	.15	1.00	.84	-.08	.10	-.09	.04
S-Up	-.16	.05	.12	.84	1.00	-.33	-.07	-.07	-.25
P-Up	.01	-.02	-.11	-.08	-.33	1.00	.87	-.08	.19
P-Up	-.14	-.01	-.10	.10	-.07	.87	1.00	-.03	.10
SR	-.31	.14	.03	-.09	-.07	-.08	-.03	1.00	.52
SR	-.29	.36	.20	.04	-.25	.19	.10	.52	1.00
BJ	-.24	-.01	-.18	-.01	.08	.17	.22	-.28	-.36
BJ	-.01	.05	.03	.01	.01	-.14	-.16	-.44	-.48
50-D	-.01	.17	.23	-.14	-.21	.16	.06	.15	.39
50-D	-.39	.11	-.26	.14	.25	-.16	.01	.38	.28
SBT	.33	-.15	.56	.05	.15	-.16	-.11	-.27	-.24
SBT	.15	.11	.67	.17	.13	-.11	-.06	.02	-.01
600	.19	-.01	-.01	-.48	-.43	-.05	-.12	.05	.24
600	.03	-.05	.04	-.33	-.30	-.29	-.39	-.01	.03
PWC	.21	-.12	.39	.01	.09	.06	.14	-.08	-.03
PWC	.13	.11	.45	.13	.12	.07	.14	-.04	.11
BHR	-.26	.14	-.07	.13	.26	-.39	-.23	-.12	-.10
BHR	-.25	.31	-.05	.06	.05	-.21	-.10	.04	-.04
A-PER	-.09	.01	.17	.55	.43	.14	.20	-.52	-.40
A-PER	.19	-.01	.18	.30	.32	.05	.09	-.41	-.64
RHR	.36	.08	.11	.12	.36	-.46	-.43	.09	-.24
RHR	.01	-.08	-.10	.24	.38	-.36	-.38	.06	-.02

TABLE II --Continued

	B.J.	B.J.	50-D	50-D	SBT	SBT	600-R	600-R
Age	-.24	-.01	-.01	-.39	.33	.15	.20	.03
Ht.	-.00	.05	.17	.11	-.15	.11	-.01	-.05
Wt.	-.18	.03	-.23	-.26	.56	.67	-.00	-.04
S-Up	-.01	.01	-.14	.14	.05	.17	-.48	-.33
S-Up	-.08	.01	-.21	.25	.15	.13	-.43	-.30
P-Up	.17	-.14	.16	-.16	-.16	-.11	-.05	-.29
P-Up	.22	-.16	.06	.00	-.11	-.06	-.12	-.39
SR	-.28	-.44	.15	.38	-.27	.02	.05	-.01
SR	-.36	-.48	.39	.28	-.24	-.01	.24	.03
BJ	1.00	.65	-.33	-.28	-.07	-.15	-.21	-.15
BJ	.65	1.00	-.50	-.52	.04	.01	-.37	-.24
50-D	-.33	-.50	1.00	.59	-.30	-.24	.51	.19
50-D	-.28	-.52	.59	1.00	-.23	-.18	.14	.04
SBT	-.07	.04	-.30	-.23	1.00	.78	-.05	.08
SBT	-.15	.01	-.24	-.18	.79	1.00	-.06	.22
600	-.21	-.37	.51	.14	-.05	.06	1.00	.77
600	-.15	-.24	.19	.04	.08	.22	.77	1.00
PWC	-.00	.29	-.29	-.32	.29	.19	-.38	-.54
PWC	.12	.25	-.14	-.21	.25	.33	-.23	-.41
BHR	.18	.29	.06	.24	-.15	-.28	-.18	-.11
BHR	.20	.43	.04	-.01	-.06	.02	-.25	-.32
A-PER	.46	.52	-.63	-.43	.43	.28	.72	-.47
A-PER	.40	.71	-.60	-.54	.39	.28	-.66	-.54
RHR	.13	.15	-.10	.08	.19	.00	-.12	-.13
RHR	-.14	-.07	.05	.16	-.04	-.14	.02	.08

TABLE II --Continued

	PWC	PWC	BHR	BHR	A-PER	A-PER	RHR	RHR
Age	.21	.13	-.26	-.25	-.09	.18	.36	.01
Ht.	-.12	.11	.14	.31	.02	.01	-.08	-.08
Wt.	.39	.45	-.07	-.05	.17	.18	.11	-.10
S-Up	.01	.13	.13	.07	.55	.30	.12	.24
S-Up	.09	.12	.26	.05	.43	.32	.36	.38
P-Up	.06	.07	-.39	-.21	.14	.05	-.46	-.36
P-Up	.14	.14	-.23	-.10	.20	.09	-.43	-.38
SR	-.08	-.04	-.12	.04	-.52	-.41	.09	.06
SR	-.03	.11	.10	.04	-.40	-.64	-.24	-.02
BJ	-.00	.12	.18	.20	.46	.40	.13	-.14
BJ	.29	.25	.29	.43	.52	.71	.15	-.07
50-D	-.29	-.14	.06	.04	-.63	-.60	-.10	.05
50-D	-.32	-.21	.24	-.01	-.43	-.54	.08	.16
SBT	.29	.25	-.15	-.06	.43	.39	.19	-.04
SBT	.19	.33	-.28	.02	.28	.28	-.00	-.14
600	-.38	-.23	-.18	-.25	-.72	-.66	-.12	.02
600	-.54	-.41	-.11	-.32	-.47	-.54	-.13	.08
PWC	1.00	.72	.15	-.49	.33	.43	-.12	-.22
PWC	.72	1.00	-.08	.44	.31	.30	-.11	-.54
BHR	.15	-.08	1.00	.55	.01	.06	.19	.31
BHR	.49	.44	.55	1.00	.14	.31	-.04	-.14
A-PER	.33	.31	.01	.14	1.00	.79	.04	-.08
A-PER	.43	.30	.06	.31	.79	1.00	.23	-.07
RHR	-.12	-.11	.19	-.04	.04	.23	1.00	.50
RHR	-.22	-.54	.31	-.14	-.08	-.07	.50	1.00

A correlation matrix was developed for Group II, the group which was designed to emphasize the cardiovascular-respiratory parameter of physical fitness. The correlation matrix included the same variables as Table II. The co-efficients for Group II are consistently higher than co-efficients between common variables for Group I. An explanation for this difference could be that Group II was more heterogeneous as indicated by standard deviation scores in Table I. It was established that a correlation coefficient of ±.40 was significant at the .05 level for Group II. Table III is a correlation matrix for Group II.

A correlation matrix was developed for the total group of subjects which included both training groups. The same variables were included for comparison of the degree of relationship that existed between the test items that were included in Tables I and II. The coefficients for the total group indicated that items of the AAHPER Youth Fitness Test were correlated significantly with other items of the AAHPER battery. Some AAHPER items were correlated significantly with pre-test and post-test physical work capacity and basal heart rate scores. Specific pre-test or post-test scores indicate that significant relationships do exist among the test instruments. It was established that a correlation coefficient of ±.28 was significant at the .05 level for the total group of subjects. The correlation matrix for the total group is included in Table IV.

TABLE III

A CORRELATION MATRIX FOR GROUP II

	Age	Ht.	Wt.	S-Up	S-Up	P-Up	P-Up	S.R.	S.R.
Age	1.00	-.06	.09	-.45	-.40	-.30	-.29	.25	.45
Ht.	-.06	1.00	.24	.08	.01	-.37	-.24	-.00	.06
Wt.	.09	.24	1.00	-.51	-.47	-.57	-.54	.43	.24
S-Up	-.45	.08	-.51	1.00	.83	.51	.51	-.49	-.43
S-Up	-.40	.01	-.47	.83	1.00	.65	.63	-.72	-.41
P-Up	-.30	-.36	-.57	.51	.65	1.00	.93	-.61	-.30
P-Up	-.29	-.24	-.54	.51	.63	.93	1.00	-.58	-.39
S.R.	.25	-.00	.43	-.49	-.72	-.61	-.58	1.00	.36
S.R.	.45	.06	.24	-.43	-.40	-.30	-.39	.36	1.00
BJ	-.26	.04	-.41	.59	.67	.62	.56	-.75	-.41
BJ	-.21	.35	-.26	.59	.50	.37	.45	-.50	-.59
50-D	.20	-.15	.44	-.53	-.71	-.57	-.53	.78	.33
50-D	.24	-.17	.55	-.48	-.69	-.68	-.69	.80	.47
SBT	-.08	.03	.12	.36	.42	.10	.12	-.30	-.40
SBT	-.17	-.05	-.12	.49	.35	.08	.07	-.27	-.42
600	.01	-.15	.34	-.33	-.58	-.55	-.59	.55	.10
600	-.02	-.01	.42	-.31	-.58	-.60	-.63	.57	.11
PWC	.12	-.01	.42	.11	.05	-.23	-.25	.11	-.01
PWC	-.07	.22	.35	-.20	-.05	-.03	-.04	-.04	.09
BHR	-.11	.07	.58	-.47	-.48	-.27	-.30	.40	.33
BHR	-.09	-.21	.57	-.34	-.40	-.24	-.31	.47	.28
A-PER	-.40	-.03	-.44	.70	.85	.73	.70	-.80	-.42
A-PER	-.40	.01	-.53	.70	.76	.71	.76	-.75	-.67
RHR	-.33	.48	.12	-.24	-.30	-.16	-.13	.14	.27
RHR	-.10	.01	.30	-.33	-.23	-.11	-.07	.28	.19

TABLE III --Continued

	B.J.	B.J.	50-D	50-D	SBT	SBT	600-R	600-R
Age	-.26	-.21	.20	.24	-.08	-.17	.01	-.02
Ht.	.04	.35	-.15	-.17	.03	-.05	-.15	-.01
Wt.	-.41	-.26	.44	.55	.12	-.12	.34	.42
S-Up	.59	.59	-.53	-.48	.36	.49	-.33	-.31
S-Up	.67	.50	-.71	-.69	.42	.35	-.58	-.58
P-Up	.62	.37	-.57	-.68	.10	.08	-.55	-.60
P-Up	.56	.45	-.53	-.69	.12	.07	-.59	-.63
SR	-.75	-.50	.78	.80	-.30	-.27	.55	.57
SR	-.41	-.59	.33	.47	-.40	-.42	.10	.11
BJ	1.00	.77	-.71	-.71	.52	.44	-.52	-.48
BJ	.77	1.00	-.59	-.63	.48	.40	-.39	-.30
50-D	-.71	-.59	1.00	.88	-.39	.43	.73	.73
50-D	-.71	-.63	.88	1.00	-.30	-.24	.67	.68
SBT	.52	.48	-.39	-.30	1.00	.81	-.29	-.19
SBT	.44	.40	-.43	-.24	.81	1.00	-.19	-.11
600	-.52	-.38	.73	.67	-.29	-.19	1.00	.95
600	-.48	-.30	.73	.68	-.20	-.11	.95	1.00
PWC	-.06	-.14	-.01	.16	.34	.09	-.08	-.04
PWC	.13	.06	-.14	-.01	.16	.06	-.27	-.21
BHR	-.53	-.52	.42	.42	-.19	-.17	.44	.48
BHR	-.52	-.59	.62	.59	-.20	-.26	.58	.57
A-PER	.88	.65	-.85	-.79	.56	.50	-.68	-.66
A-PER	.79	.76	-.81	-.86	.52	.52	-.59	-.59
RHR	-.25	-.19	.32	.13	-.51	-.46	.22	.27
RHR	-.44	-.37	.46	.28	-.37	-.60	.19	.20

TABLE III --*Continued*

	PWC	PWC	BHR	BHR	A-PER	A-PER	RHR	RHR
Age	.12	-.07	-.11	-.09	-.40	-.40	.33	-.10
Ht.	-.01	.22	.07	-.21	-.03	-.01	.48	.01
Wt.	.42	.35	.58	.57	-.44	-.53	.12	.30
S-Up	-.11	-.20	-.47	-.34	.70	.70	.24	.33
S-Up	.05	-.05	-.48	-.40	.85	.77	-.30	-.23
P-Up	-.23	-.03	-.27	-.24	.73	.71	-.16	-.11
P-Up	-.25	-.04	-.30	-.31	.70	.76	-.13	-.07
SR	.11	-.04	.40	.47	-.80	-.75	.14	.28
SR	-.01	.09	.33	.28	-.42	-.67	.27	.19
BJ	.06	.14	-.53	-.52	.88	.79	-.25	-.44
BJ	-.14	-.06	-.52	-.59	.65	.76	-.19	-.37
50-D	-.01	-.14	.42	.62	-.85	-.81	.32	.46
50-D	.16	-.01	.42	.59	-.79	-.86	.13	.28
SBT	.34	.16	-.19	-.20	.56	.52	-.51	-.37
SBT	.09	.06	-.17	-.26	.50	.52	-.46	-.60
600	-.08	-.27	.44	.58	-.68	-.59	.22	.19
600	-.04	-.21	.48	.57	-.66	-.59	.27	.20
PWC	1.00	.60	-.00	.16	.00	-.08	-.32	.03
PWC	.60	1.00	.23	.01	.13	.04	.14	-.18
BHR	-.00	.23	1.00	.66	-.48	-.49	.51	.23
BHR	.16	.01	.66	1.00	-.49	-.56	.23	.63
A-PER	.01	.13	-.48	-.49	1.00	.91	-.33	-.35
A-PER	-.08	.04	-.49	-.56	.91	1.00	-.30	-.38
RHR	-.32	.14	.51	.23	-.33	-.30	1.00	.37
RHR	.03	-.18	.23	.63	-.35	-.38	.37	1.00

TABLE IV

A CORRELATION MATRIX FOR THE TOTAL GROUP

	Age	Ht.	Wt.	S-Up	S-Up	P-Up	P-Up	S.R.	S.R.
Age	1.00	-.14	.10	-.41	-.34	-.23	-.30	.09	.18
Ht.	-.14	1.00	.30	.19	.05	-.17	-.06	.06	.23
Wt.	.10	.30	1.00	-.28	-.25	-.38	-.32	.27	.23
S-Up	-.41	.19	-.28	1.00	.83	.28	.37	-.31	-.20
S-Up	-.34	.05	-.25	.83	1.00	.28	.40	-.44	-.31
P-Up	-.23	-.17	-.38	.28	.28	1.00	.88	-.38	-.05
P-Up	-.30	-.06	-.32	.37	.40	.88	1.00	-.35	-.13
S.R.	.09	.06	.27	-.31	-.44	-.38	-.35	1.00	.44
S.R.	.18	.23	.23	-.20	-.31	-.05	-.13	.44	1.00
BJ	-.26	.04	-.33	.42	.46	.49	.48	-.57	-.35
BJ	.18	.25	-.12	.37	.33	.20	.32	-.46	-.50
50-D	.18	-.06	.25	-.41	-.56	-.37	-.41	.55	.31
50-D	.12	-.07	.32	-.28	-.39	-.51	-.49	.63	.37
SBT	-.01	-.00	.31	..23	.32	.03	.14	-.28	-.28
SBT	-.13	.07	.19	.37	.28	.04	.13	-.14	-.18
600	.05	-.11	.24	-.36	-.53	-.40	-.47	.37	.13
600	-.03	-.00	.33	-.30	-.47	-.47	-.46	.35	.09
PWC	.12	.05	.41	-.05	.08	-.08	.06	.02	.01
PWC	.01	.13	.35	-.05	.01	-.00	-.02	-.04	.08
BHR	-.14	.11	.30	-.19	-.14	-.32	-.24	.14	.10
BHR	-.17	.07	.39	-.15	-.18	-.17	-.09	.27	.16
A-PER	-.35	.01	-.25	.64	.71	.55	.58	-.68	-.37
A-PER	-.30	.02	-.31	.57	.62	.50	.58	-.61	-.61
RHR	-.17	.32	.16	-.06	.02	-.23	-.10	.11	.04
RHR	-.10	.01	.17	-.05	.07	-.18	-.06	.16	.10

TABLE IV --Continued

	B.J.	B.J.	50-D	50-D	SBT	SBT	600-R	600-R
Age	-.26	-.18	.18	.12	-.01	.13	.05	-.03
Ht.	.04	.24	-.06	-.07	-.00	.07	-.11	.33
Wt.	-.33	-.12	.25	.32	.31	.19	.24	.33
S-Up	.42	.37	-.41	-.38	.23	.37	-.36	-.30
S-Up	.46	.33	-.56	-.39	.32	.28	-.53	-.47
P-Up	.49	.20	-.37	-.51	.03	.04	-.40	-.47
P-Up	.48	.32	-.41	-.49	.14	.13	-.47	-.46
S.R.	-.57	-.46	.55	.63	-.28	-.14	.37	.35
S.R.	-.35	-.50	.31	.37	-.28	-.18	.13	.09
BJ	1.00	.72	-.65	-.62	.34	.28	-.47	-.39
BJ	.72	1.00	-.56	-.58	.34	.29	-.38	-.25
50-D	-.65	-.56	1.00	.81	-.37	-.38	.69	.58
50-D	-.62	-.58	.81	1.00	-.27	-.22	.55	.51
SBT	.34	.34	-.37	-.27	1.00	.81	-.22	-.06
SBT	.28	.29	-.38	-.22	.81	1.00	-.12	.03
600	-.47	-.38	.69	.55	-.22	-.12	1.00	.89
600	-.39	-.25	.58	.51	-.06	.03	.89	1.00
PWC	-.03	.06	-.10	-.02	.32	.15	-.17	-.21
PWC	.11	.05	-.11	-.08	.16	.15	-.23	-.28
BHR	-.27	-.16	.28	.34	-.17	-.21	.21	.24
BHR	-.27	-.12	.38	.37	-.05	-.05	.30	.31
A-PER	.79	.61	-.80	-.70	.51	.44	-.69	-.58
A-PER	.71	.74	-.79	-.78	.47	.44	-.60	-.55
RHR	-.09	.02	.13	.10	-.09	-.16	.08	.16
RHR	-.28	-.17	.26	.21	-.13	-.29	.10	.18

TABLE IV --Continued

	PWC	PWC	BHR	BHR	A-PER	A-PER	RHR	RHR
Age	.12	.01	-.14	-.17	-.35	-.30	-.17	-.10
Ht.	-.05	.13	.10	.07	.01	.02	.32	.01
Wt.	.41	.35	.30	.39	-.25	-.31	.16	.17
S-Up	-.05	-.05	-.19	-.15	.64	.57	-.06	-.05
S-Up	.08	.01	-.14	-.18	.71	.62	.02	.07
P-Up	-.08	-.00	-.32	-.17	.55	.50	-.23	-.18
P-Up	-.06	-.02	-.24	-.09	.58	.58	-.10	-.06
S.R.	.02	-.04	.14	.27	-.68	-.61	.11	.16
S.R.	-.01	.08	.10	.16	-.37	-.61	.04	.10
BJ	-.03	.11	-.27	-.27	.79	.71	-.09	-.28
BJ	.06	.05	-.16	-.12	.61	.74	.02	-.17
50-D	-.10	-.11	.28	.38	-.80	-.77	.13	.26
50-D	-.02	-.08	.34	.37	-.70	-.78	.10	.21
SBT	.32	.16	-.17	-.05	.51	.47	-.09	-.13
SBT	.15	.15	-.21	-.05	.44	.45	-.16	-.29
600	-.17	-.23	.21	.30	-.69	-.60	.08	.10
600	-.21	-.28	.24	.31	-.58	-.55	.16	.18
PWC	1.00	.65	.08	.31	.13	.11	-.19	-.07
PWC	.65	1.00	.07	.15	.17	.12	-.02	-.38
BHR	.08	.07	1.00	.57	-.29	-.27	.33	.26
BHR	.31	.15	.57	1.00	-.24	-.24	.19	.33
A-PER	.13	.17	-.29	-.24	1.00	.88	-.14	-.19
A-PER	.11	.12	-.27	-.24	.88	1.00	-.07	-.22
RHR	-.19	-.02	.33	.19	-.14	.07	1.00	.47
RHR	-.07	-.38	.26	.33	-.19	-.22	.47	1.00

Analysis of the Data

It was hypothesized that no significant relationships would exist among the different test instruments used in this study for evaluation of the physical fitness parameters. It was further hypothesized that no significant differences would exist between the physical fitness means for the group designed to develop strength and agility and the group that was designed to develop cardiovascular-respiratory efficiency.

Hypothesis I

It was hypothesized that no significant difference would exist between the two conditioning programs' physical fitness means when basal heart rate was used as the criterion. The null hypothesis was rejected at .05 level. Group II, which was designed to develop cardiovascular-respiratory efficiency, was significantly different from Group I. Each group had a reduction in its basal heart rate during treatments. Group I had a reduction of 3.63 beats per minute mean gain, while Group II had a reduction of 7.29 beats per minute mean gain. Group II excelled with a better mean gain of 3.67 beats per minute.

Hypothesis II

It was hypothesized that no significant difference would exist between the two conditioning programs' physical fitness means when physical work capacity was used as the criterion. The null hypothesis was retained. Group I had a mean gain of

2.03 minutes between pre-test and post-test. Group II had a mean gain of 2.70 minutes which was 40 seconds greater than Group I. The difference was not significant at the .05 level.

Hypothesis III

It was hypothesized that no significant difference would exist between the two conditioning programs' physical fitness means when the AAHPER Youth Fitness Test was used as the criterion. The total battery score and each item of the AAHPER Test were used as criterion measures. The two programs were not significantly different at the .05 level when the AAHPER battery score was used as the criterion. The shuttle run, 50-yard dash, softball throw for distance, sit-ups, and broad jump did not distinguish significant differences between the two conditioning programs at the .05 level when used as separate items for criterion measures. The 600-yard run and pull-ups as individual criterion items did distinguish between the two conditioning programs at the .05 level. The conditioning program designed to develop cardiovascular-respiratory efficiency was significantly different at the .05 level from Group I when the 600-yard run was used as the criterion. The conditioning program designed to develop strength and agility was significantly different at the .05 level from Group II when pull-ups were used as the criterion measure.

Analyses of data for hypotheses I, II, and III were developed in Table V. The data presented in Table V includes

TABLE V

ANALYSIS OF DATA FOR HYPOTHESES I, II, AND III

Variable	Group	Adjusted Mean	F-Ratio	Probability
S-Ups	I II	80.20 S-Ups 78.13	.3347	.5726
P-Ups	I II	10.13 P-Ups 8.28	20.4126	.0002*
SR	I II	9.78 Seconds 9.64	.6525	.5710
BJ	I II	87.08 Inches 84.62	2.0893	.1517
50-D	I II	6.61 Seconds 6.54	.8190	.6264
SBT	I II	218.63 Feet 214.29	.3634	.5566
600	I II	114.49 Seconds 108.38	9.2028	.0042*
A-Per	I II	64.51 Per Cent 65.03	.0514	.8163
PWC	I II	12.96 Minutes 13.57	2.4672	.1195
BHR	I	56.11 Beats 52.43	7.3867	.0091*
RHR	I II	78.30 Beats 75.20	.9472	.6628

*Indicates significant differences

significant differences on the items of the AAHPER Youth Fitness Test, AAHPER battery score, physical work capacity, and basal heart rate. The units of measure are different between instruments and items of the test used for comparing the two training programs.

Hypothesis IV

It was hypothesized that no significant relationships would exist among the physical work capacity test, basal heart rate, or the AAHPER Youth Fitness Test items as evaluative instruments for measures of physical fitness parameters. Basal heart rate was the only test instrument that distinguished between the experimental treatments. This was established in Hypothesis I.

The statistic used for developing Hypothesis IV was product moment correlation. A correlation of $\pm.40$ was needed to establish a significant relationship within groups at the .05 level. A correlation coefficient of $\pm.28$ was needed for significance at the .05 level for the total group of subjects. The data were presented in Table II for the group emphasizing development of strength and agility as parameters of physical fitness. Data for the group emphasizing development of cardiovascular-respiratory parameters of physical fitness were presented in Table III.

The correlations among the physical work capacity test, AAHPER test battery, and basal heart rates were significant at the .05 level only for some specific pre-test and post-test measures when a combined group of the total test subjects was used. Correlations among the test instruments were significant at the .05 level when data were tabulated on a per group basis. Pre-test physical work capacity was correlated significantly with post-test basal heart rate in Group I. The AAHPER Youth Fitness Test battery pre-test and post-test correlated with pre-test physical work capacity at the .05 level within Group I.

The correlation coefficients between the pre-test and post-test physical work capacity, basal heart rates, AAHPER battery, and items of the AAHPER Test are included in Table VI to indicate the stability of the control variable between the two tests during the treatments. The table included

TABLE VI

STABILITY OF COVARIABLE FROM PRE-TEST TO POST-TEST AS INDICATED BY PRODUCT MOMENT CORRELATIONS BETWEEN THE TWO TESTS

Variable	Group I	Group II	Total Group
Physical work capacity	.72	.60	.65
Basal heart rate	.55	.66	.57
Sit-ups	.84	.83	.83
Pull-ups	.87	.93	.88
Shuttle run	.52	.36	.44
Broad Jump	.65	.59	.72
Soft ball throw	.79	.81	.81
600 yard run	.77	.95	.89
50 Yard dash	.59	.88	.81
AAHPER battery	.79	.91	.88

between groups and total group analysis of the variable coefficients. All test variables improved during treatments as indicated by raw scores except the 600-yard run for Group I.

Physical work capacity was correlated significantly at the .05 level with basal heart rate, the 600-yard run and the AAHPER battery within Group I. Pre-test physical work capacity was correlated with post-test basal heart rate (.49). Post-test physical work capacity was correlated with post-test basal heart rate (.44). Pre-test physical work capacity was correlated with the post-test 600-yard run (-.54). Post-test physical work capacity was correlated with the post-test 600-yard run (-.41). The pre-test physical work capacity was correlated with the post-test AAHPER battery (.43). A correlation coefficient of (.40) was needed for a significant relationship at the .05 level. All other relationships between physical work capacity were found not related significantly at this level.

Basal heart rate was correlated significantly at the .05 level with physical work capacity and the broad jump within Group I. The post-test basal heart rates were significantly related to pre-test physical work capacity (.49) and post-test physical work capacity (.44). Post-test basal heart rate relationship to post-test broad jump was also significant (.43).

Within Group II physical work capacity as a test instrument was found not to be correlated significantly at the .05

level with the other test instruments. However, basal heart rate as a test instrument was correlated significantly at the .05 level with sit-ups, shuttle-run, broad jump, the 600-yard run, the 50-yard dash, and the AAHPER battery.

The pre-test basal heart rates were correlated significantly with pre-test sit-ups (-.47) and post-test sit-ups (-.48). Post-test basal heart rates were correlated significantly with post-test sit-ups (-.40).

Pre-test basal heart rates were significantly correlated at the .05 level with scores for pre-test shuttle run (.40). Post-test basal heart rates were significantly correlated with scores for pre-test shuttle run (.47).

The pre-test basal heart rates were significantly correlated with pre-test broad jump scores (-.53) and post-test broad jump scores (-.52). The post-test basal heart rates were significantly correlated with pre-test broad jump scores (-.52) and post-test broad jump scores (-.59).

Pre-test basal heart rates were significantly correlated with the pre-test 600-yard run (.44) and the post-test 600-yard run (.48). Post-test basal heart rates were significantly correlated with the pre-test 600-yard run (.58) and the post-test 600-yard run (.57).

The pre-test basal heart rates were significantly correlated with the pre-test 50-yard dash (.42) and the post-test 50-yard dash (.42). Post-test basal heart rates were significantly correlated to the pre-test 50-yard dash (.62) and the post-test 50-yard dash (.59).

The pre-test basal heart rates were significantly correlated with the pre-test AAHPER battery (-.48) and post-test AAHPER battery (-.49). The post-test basal heart rates were significantly correlated with the pre-test AAHPER battery (-.49) and the post-test AAHPER battery (-.56).

When all test subjects were combined into a total group without regard for their training program, neither basal heart rate nor physical work capacity was significantly correlated at the .05 level with the AAHPER battery except for specific pre-test and post-test variables. The correlation coefficients among specific variables of the test instruments were significant between the pre-test physical work capacity test and post-test basal heart rates (.31), and the pre-test basal heart rates and the pre-test AAHPER battery score (-.29).

Items of the AAHPER Youth Fitness Test were significantly correlated with the basal heart rates and the physical work capacity test. Pre-test pull-ups were significantly correlated at the .05 level with pre-test basal heart rates (-.32). The pre-test 50-yard dash was significantly correlated with pre-test and post-test basal heart rates (.28 and .38). Post-test 50-yard dash was significantly correlated with pre-test and post-test basal heart rates (.34 and .37). The pre-test softball throw for distance was significantly correlated with pre-test physical work capacity (.32). The pre-test and post-test 600-yard run was significantly correlated with post-test basal heart rates (.30 and .31).

Correlation coefficients between items of the AAHPER test and the AAHPER Battery were significant for each item at the .05 level. A matrix for total group correlation coefficients was included in Table IV, page 84.

In Hypothesis IV, it was stated that no significant relationships existed among test instruments for assessing parameters of physical fitness. This hypohtesis was rejected at the .05 level. Specific correlations indicate that significant relationships do exist among the test instruments. It should be stated, however, that physical work capacity, basal heart rates, and the AAHPER Youth Fitness Test are not identical instruments. Even though they are not identical, neither are these instruments completely uncommon in their ability to assess physical fitness parameters.

In summary, significant correlations were found between pre-test and post-test basal heart rates and pre-test and post-test AAHPER scores within Group II. The physical work capacity was not significantly related to the other two instruments within Group II. Items of the AAHPER test battery correlated significantly at the .05 level with basal heart rates and physical work capacity (see Tables II, III, and IV). Group II, designed to improve cardiovascular-respiratory parameters, had more significant correlations than did Group I, and the degree of numerical value of the correlation was higher. A correlation coefficient for Group I and II of $\pm .40$ was significant at the .05 level.

Significant correlation coefficients were established among age, height, weight, items of the AAHPER test, physical work capacity, basal heart rate, and the AAHPER battery score in the combined group of total test subjects. Physical work capacity and basal heart rate were significantly correlated with the weight of the test subjects (see Table IV, page 84).

Except for the softball throw for distance, items of the AAHPER test were significantly correlated with each remaining item of the test and total AAHPER battery score either with a pre-test or a post-test measure. The broad jump was significantly correlated with each pre-test and post-test item of the AAHPER battery except the pre-test pull-ups. Pull-ups were significantly correlated with each pre-test and post-test item of the AAHPER battery except the post-tests for the shuttle run and broad jump. The 600-yard run was significantly correlated with each pre-test and post-test item of the AAHPER battery except post-test shuttle run. A correlation matrix was developed in Table IV to indicate the coefficients of test items for the combined group of test subjects.

A correlation between a test item and a battery score is spuriously high. To correct this error, the AAHPER test items and battery score correlations were adjusted. Guilford's correlation formula was used to partial out the effect of comparing the item to a battery score which included the same item (2).

CHAPTER BIBLIOGRAPHY

1. Arkin, Herbert and Raymond Colton, Statistical Methods, 4th Edition, New York, Barnes and Noble, Inc., 1968.

2. Guilford, J. P., Fundamental Statistics in Psychology and Education, 4th. Edition, St. Louis, McGraw-Hill Book Company, 1965.

3. Roscoe, John T., Fundamental Research Statistics, New York, Holt, Rinehart and Winston, Inc., 1969.

4. Van Dalen, Deobold B., Understanding Educational Research, St. Louis, McGraw-Hill Book Company, 1962.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

The present investigation was an attempt to explore the effects of two conditioning programs on the development of parameters of physical fitness as they were measured by three test instruments. The programs were designed to develop strength and agility and cardiovascular-respiratory efficiency. The test instruments used for measure of the parameters of physical fitness were the AAHPER Youth Fitness Test, basal heart rate, and physical work capacity. The relationships that exist among the test instruments for measurement of the parameter of physical fitness were evaluated as were the effects of the two conditioning programs.

During the first two weeks of the Spring semester, the subjects were oriented to class procedures, teacher expectation, and they were given the pre-test to determine beginning physical fitness levels. The basal heart rate, physical work capacity, and the AAHPER Youth Fitness Test were given in respective order. The subjects were housed overnight in the women's gymnasium and their basal heart rates were taken as they awoke the following morning before any activity was permitted.

After basal heart rates were taken, the subjects were assigned to take the progressive work capacity test (180) on the bicycle ergometer. The physiograph was used to monitor the heart rate the last fifteen seconds of each minute following the preliminary three-minute ride until the subjects' heart rate reached 180 beats per minute (see Appendix D). Following the physical work capacity test, the AAHPER Youth Fitness Test was administered to the subjects. The AAHPER test was administered according to the directions given in the AAHPER Test Manual (see Appendix A).

The subjects for this study were students from two activity classes designated as (1) a weight training class and (2) a track class in the Registration Bulletin for the Spring semester of 1971. The treatments were begun following the pre-test and orientation. The class designated as weight training was subjected to a training procedure designed to develop strength and agility. The class designated as track was subjected to a training program designed to develop cardiovascular-respiratory efficiency.

The training procedure for Group I was a structured class in which calisthenics, agility, and a power-rack weight routine were administered. The training procedure for Group II was unstructured class routine in which jogging, calisthenics, and continuous running were administered. The classes met three days per week with each training session lasting for thirty minutes. The treatments were administered for eight weeks, and post-tests were given following the treatments. The procedures for the post-test were the same as those used for the pre-tests.

The statistics used for the study were analysis of co-variance and product moment correlations. The effects of the two conditioning methods were investigated by use of analysis of covariance. The relationships that exist among the testing instruments were investigated by use of product moment corre-lations. The .05 level was established for rejection of the null hypotheses which were developed for this study.

It was hypothesized that no significant differences would exist between the adjusted means for the two conditioning pro-grams designed to develop physical fitness when basal heart rate was used as the criterion. This hypothesis was rejected at the .05 level. Significant differences did exist between the two conditioning procedures. Group II which was designed to develop cardiovascular-respiratory efficiency had a better basal heart rate reduction during the treatments than did Group I.

In a second hypothesis, it was hypothesized that no significant differences would exist between the two condition-ing procedures adjusted means when physical work capacity was used as the criterion. The null hypothesis was retained as there were not significant differences between the two conditioning methods when physical work capacity was used as the criterion to determine the differences.

In a third hypothesis, it was hypothesized that no significant differences would exist between the two conditioning methods adjusted means when the AAHPER Youth Fitness Test battery score was used as the criterion. The null hypothesis was retained as the differences were not significant at the .05 level. The AAHPER Youth Fitness Test did not distinguish between the two conditioning methods used in this study. When an item from the AAHPER Test was used as a criterion measure, the two programs were not significantly different at the .05 level when the shuttle run, 50-yard dash, softball throw for distance, sit-ups, or the broad jump were used as the individual criterion measure. Items of the AAHPEH test which did distinguish a significant difference between the two conditioning programs when used as a criterion were pull-ups and the 600-yard run.

In the fourth hypothesis, it was hypothesized that a significant relationship would not exist among the physical work capacity, basal heart rate or the AAHPER Youth Fitness Test as evaluative instruments for measure of physical fitness parameters. The correlation coefficients among the test instruments were significant at the .05 level only for specific test items. The null hypothesis of no significant relationship among test instruments was rejected. Specific correlations indicate that significant relationships do exist among the test instruments. Correlations among the test instruments were significant at the .05 level when data were tabulated on a per group basis. Pre-test physical work capacity was correlated significantly with post-test basal heart rate in Group I. The AAHPER Youth Fitness Test battery pre-test and post-test scores correlated with pre-test physical work capacity at the .05 level within Group I. Pre-test and post-test basal heart rates and pre-test and post-test AAHPER battery scores within Group II were significantly correlated at the .05 level. Physical work capacity did not have significant correlation coefficients with the other two instruments within Group II. Individual items from the AAHPER test battery within groups did have significant correlations at the .05 level with basal heart rate and physical work capacity (see Tables II and III).

Significant correlation coefficients were established among age, height, weight, items of the AAHPER Youth Fitness Test, physical work capacity, basal heart rate, and the AAHPER battery score in a combined group of total test subjects. Each variable, physical work capacity and basal heart rate, was significantly correlated with the weight of the test subjects. Specific test instruments were correlated at the .05 level. Specific basal heart rate measures were correlated with physical work capacity and the AAHPER battery. Specific physical work capacity measures were correlated at the .05 level with basal heart rate. Physical work capacity did not correlate significantly with the AAHPER test.

Items of the AAHPER Youth Fitness Test except the softball throw for distance were individually correlated with most of the other items of the AAHPER test. The broad jump was significantly correlated to the 50-yard dash and the 600-yard run. Pull-ups were significantly correlated with sit-ups, 50-yard dash, and the 600-yard run. In addition, the 600-yard run was significantly correlated with sit-ups and the 50-yard dash. The shuttle run was significantly correlated with sit-ups, the broad jump, and the 50-yard dash. The total group correlation coefficients for items of the AAHPER test with the AAHPER battery were significant at the .05 level.

Conclusions

The following conclusions were formulated as a result of the findings that occurred during this study,

1. The AAHPER Youth Fitness Test, basal heart rate, and physical work capacity are different tests which tend to emphasize different parameters of physical fitness. However, the significant difference is only partial as specific significant relationships exist among these test instruments.

2. Different physical fitness parameters can be developed to a higher degree by programs designed to develop those qualities of fitness which are desired.

3. The instrument for measurement of a physical fitness parameter must be appropriate to distinguish that parameter.

4. The physical work capacity test did not distinguish between the training programs which were designed to develop (1) strength and agility and (2) cardiovascular-respiratory efficiency at a significant level.

5. Pull-ups, considered to be a test of dynamic strength, did distinguish between the two conditioning programs at a significant level.

6. The 600-yard run, a test of endurance, did distinguish between the two conditioning programs at a significant level.

7. Basal heart rate, a measure of cardiovascular-respiratory efficiency, did distinguish between the two conditioning programs at a significant level.

8. The AAHPER Youth Fitness Test battery score did not distinguish between the two conditioning programs at a significant level.

9. Items of the AAHPER Youth Fitness Test which did not distinguish between the two training programs when used as an individual item were sit-ups, shuttle run, 50-yard dash, softball throw for distance, and standing broad jump.

10. Within group gains were made on each variable tested as determined by mean gains except the group designed to develop strength and agility did not have a gain in the 600-yard run. Group I actually performed with a slower mean time on the post-test than they did on the pre-test. The effects of training seem to be specific to the type of overload used.

11. The group designed to develop cardiovascular-respiratory efficiency had more significant correlations with higher numerical value than did the group designed to develop strength and agility.

12. Basal heart rate is a good test for measure of cardiovascular-respiratory efficiency.

Implications

The following implications were developed during this study as a result of conclusions, observations, review of literature, and the analysis of data.

The AAHPER Youth Fitness Test measures with specific test items the ability that is related to explosive strength or power. Test items to measure these components are 50-yard dash, standing broad jump, and the softball throw. Still other ability measures are taken to assess dynamic strength and gross body movement. Pull-ups, sit-ups, and the shuttle run are used for this purpose. The endurance measure of the AAHPER test is the 600-yard run.

Basal heart rate is a specific measure of cardiovascular-respiratory efficiency and will have better correlation with specific measures of endurance. The physical work capacity test (180) measures strength, endurance, and muscular efficiency. Physical work capacity has been used for assessment of cardiovascular-respiratory fitness. The physical work capacity test of 180 did not distinguish between the strength and cardiovascular-respiratory variables present in the subjects tested. It appears that a low score on a specific parameter does not make a person physically unfit nor does the presence of a specific parameter make a subject physically fit. The more parameters a person possesses, the better his state of physical efficiency. It appears that testing should evaluate specific parameters without an attempt to predict a general state of efficiency.

Specific parameters can be developed better by a specific training procedure. If strength, agility, flexibility, balance, coordination, and muscular efficiency are specific parameters of physical fitness or efficiency, it appears that the most profitable procedure for their development would occur through specific training programs. This does not mean that concomitant improvements are not achieved with other parameters of physical proficiency.

If measurements of these physical fitness parameters are desired, a specific test for the purpose of assessing a particular parameter should be used. An abundance of strength should not compensate for a lack of endurance or vice versa. It is less reliable to predict one parameter from another than a particular evaluation will give from a specific test.

The physical work capacity test did not distinguish between the training program designed to develop cardiovascular-respiratory efficiency and the group designed to develop strength and agility. The gains of strength as indicated by improvement in explosive leg strength and shoulder girdle strength in Group I seemed to have been equated by gains in cardiovascular-respiratory efficiency as indicated by basal heart rate and the 600-yard run in Group II.

The specific training in the program designed to improve strength and agility emphasized the arms and shoulder girdle as well as the large muscle groups of the legs in a majority of the stations. Pull-ups did distinguish between the two conditioning programs, a result which seems to indicate that specific training develops specific outcomes.

The specific training in the programs designed to develop cardiovascular-respiratory efficiency adds support to the previous conclusions. The 600-yard run, which is considered a measure of endurance, and the basal heart rate, did distinguish between the training programs.

The AAHPER battery scores did not distinguish between the two training programs designed to emphasize different parameters of physical fitness. When one item is averaged into a group of variables, it loses the significance that it has if it is an extreme score. In accepting a general or battery score, the specific weakness is lost in the general description. The improvements in strength made by Group I were off-set by similar gains in endurance in Group II, thus making it impossible for the AAHPER test to distinguish between the two groups.

Specific items of the AAHPER Youth Fitness Test did distinguish between the training programs. Pull-ups and the 600-yard run made this distinction while the other five test items were unable to distinguish between the groups. Specificity of training and testing seem to be the most logical explanation for these findings. The training programs were intense for the subjects involved in the study, and the overload was specific for each group.

The group designed to develop cardiovascular-respiratory efficiency had more significant correlations with greater numerical values. A possible explanation is that Group II was more hetergeneous than Group I, thus resulting in higher correlations. The classes were elective, and it appeared that the group selecting track activities may have been more interested in conditioning than Group I. Group I may have had greater interest in strength and weight gains than Group II.

Some of the subjects were overtly fatigued in reaching a work capacity of 180 while others seemed under little stress. The groups represented a wide range of physical efficiency in the beginning, and even though they became more homogeneous through training, the physical efficiency range remained great. It seems plausible to assume the subjects who were less taxed by the test could have carried their work capacity to a higher level because of greater physical proficiency.

Motivation becomes more of a problem in the later stages of the training programs. Precaution and plans should be made to compensate for this additional problem. Some of the subjects seemed to enjoy pushing themselves while others needed all the encouragement and enticement possible. Overload or stress is necessary for gains to occur through the training programs. Because of the necessity for intensity, subjects should be aware of the demand during the orientation sessions rather than at a later stage of the study.

The 600-yard run is a test item that causes apprehension in test subjects who are willing to work with great intensity in the weight room. This seems to imply that running has a negative value possibly associated with punishment or discipline experiences. Physical educators should promote the importance of running. A change is essential if cardiovascular-respiratory efficiency is as significant as it is assumed to be at the present time. There is no reason to assume that cardiovascular-respiratory efficiency is not one of the more important physical fitness parameters.

Basal heart rate is a good indication of cardiovascular-respiratory efficiency. It is relatively a simple test to administer without any equipment. An individual can take his basal heart rate by placing the palm of one hand across the opposite carotid artery of the neck for fifteen to thirty seconds before getting out of bed in the mornings. The rate can be recorded periodically to evaluate the progress which occurred during a training program. Oxygen uptake is considered to be the best single indication of physical proficiency.

This particular variable is dependent upon cardiovascular-respiratory efficiency, which can be improved through training that places these systems under stress.

This test appears to be more appropriate for use as a testing device to be used in individualized instruction and self-testing rather than as an instrument to be used in a teacher-pupil evaluation.

Recommendations

The progressive work capacity test of 180 has limited usefulness in comparing one individual's change with another or one program with that of another when different parameters of physical proficiency are emphasized. It appears the test is more useful when the same individual is to be studied before and after training effect. The physical work capacity test will determine the degree of change between pre-test and post-test, but it will not distinguish the specific parameter causing the change.

When the bicycle ergometer is used to provide work stress, excessive weight of the subjects did not seem to be a handicap. deVries indicated that obesity was a variable which adversely affected work capacity. The subjects who were under weight and had some of the better 600-yard run performances and basal heart rates did not perform comparitively on the physical work capacity test. These subjects also performed above means on some of the strength measures in the AAHPER battery where the amount of resistance was body weight.

Basal heart rate can be used to indicate cardiovascular-respiratory efficiency more accurately than the physical work capacity test or the AAHPER battery score. These tests are more general and a specific item may be compensated for by a high proficiency in another item.

Specific parameters of physical proficiency have been well documented through repeated research. Some of these parameters are strength, muscular efficiency, muscular endurance, cardiovascular-respiratory efficiency, and flexibility.

It is recommended that programs be designed to develop specific parameters of physical proficiency. A general state of physical proficiency will not exist unless sufficient levels of the parameters are developed in the subjects, a situation which in turn results in a desirable state of efficiency. Testing should be devised to identify and evaluate the specific parameters that are being developed through the training programs. It seems apparent that a general proficiency does exist in some trained and skilled individuals; however, it is not clear which specific parameters cause this general state unless the parameters are tested specifically.

In general, if one wishes to improve strength, agility, endurance, or cardiovascular-respiratory efficiency, it is necessary to overload the movement or systems of the body involved. For strength, resistance must be increased beyond normal levels of stress; for endurance or cardiovascular-respiratory efficiency, these systems must be placed under stress. It appears the most effective program would involve activities bringing about circulatory-respiratory stress. Running seems to be the best medium through which a test subject can maintain a high-rate steady state which places the primary systems and related systems under stress. It is recommended that individuals desiring improvement in cardiovascular-respiratory efficiency engage in regular participation and that it is important to maintain a steady state through an extended period of time.

Specificity of training indicates that one obtains the kind of results for which he trains. Training methods must be specific to the desired outcomes. If testing is to be effective as it indicates the presence of specific parameters, it must also be specific to the parameter.

Physical educators may place too much emphasis on the best technique available for the desired outcome. They should, it appears, concern themselves with developing a good program on the basis of the desired parameters. Until more agrement has been achieved in the best technique by research and practice, physical educators should become aware of the range of program advocations and make a best judgment decision.

More research should be conducted in the classroom so that students may be involved. It appears that if students are part of the research and familiar with the results, the gap between research and what is practiced in the field would be reduced.

On a time item such as the 600-yard run, wind is a significant factor that is critical in a test-retest situation. It is recommended that the starting point be selected that allows the least amount of distance against the wind. This will not correct the wind factor but it will reduce the severity of this factor.

The progressive work capacity test, basal heart rate, and the AAHPER Youth Fitness Test are good tests when used for the specific purposes for which they are suited to discriminate the variables or parameters being evaluated. The AAHPER battery and the physical work capacity tests should be used for more general discriminations while the items of the AAHPER or the basal heart rate can be used to detect more specific strengths or weaknesses.

When the results of the two conditioning programs are compared on the basis of mean gains, it is apparent that a program designed to develop cardiovascular-respiratory efficiency should have a more significant role than it now occupies in the physical education curriculum. It is recommended that physical educators seek the inclusion of activities into the conditioning classes that are designed to place the cardiovascular-respiratory systems under stress.

It is recommended that physical educators avoid attempting to find a specific physical fitness parameter for the purpose of predicting all other parameters or performances. It seems apparent that physical fitness is a general state of efficiency dependent upon the presence of at least a degree of several parameters. Physical education testing and program planning should reflect specific physical fitness parameters designed to promote a general state of physical proficiency.

APPENDIX A

DIRECTIONS FOR ADMINISTRATION OF THE AAHPER YOUTH FITNESS TEST

Pull-ups

Description: The pupil hangs from a bar by the use of an overhand grasp. The bar must be high enough that the pupil's feet cannot touch the floor. The pupil raises himself so that his chin can be placed over the bar and then lowers himself back to the starting position. The exercise is repeated as many times as possible.

Rules: Only one trial is allowed per pupil. The body can not swing in executing the exercise. The movement must be a straight pull, not a snap movement. Kicking the legs and feet or raising the knees is not permitted.

Scoring: Only the number of complete pull-ups are recorded as the pupil's score.

Sit-ups

Description: The pupil begins from a position on the mat with his legs extended and feet approximately two feet apart. He is on his back with his fingers interlocked behind his neck. His elbows are on the floor. With a partner holding his ankles in contact with the mat, the pupil sits up, turning the trunk to the left and touching his right elbow to his left knee. He then returns to the starting position and sits up to the opposite alternating sides.

Rules: The pupil's fingers must remain interlocked behind the neck throughout each repetition. The knees must remain on the floor during the sit-up but may be bent slightly while touching the elbow to the knee. The back should be rounded and the elbows and head brought forward while sitting up. The pupil must return to the starting position before sitting up again.

Scoring: One point is given for each complete movement of touching the elbow to the knee as long as it is executed according to the rules. The maximum number for boys should be 100.

Shuttle Run

Description: On the signal "Ready? Go!" the pupil starts from a line on the floor and runs thirty feet to another line. Here he picks up a block, runs back to the starting line and places the block behind that line. He then runs back and picks up the second block, which he carries back across the starting line. He does not set this block down.

Rules: The pupil is allowed two trials with several minutes of rest in between.

Scoring: Only the time of the fastest of the two trials is recorded.

Standing Broad Jump

Description: The pupil stands with his feet several inches apart and his toes just behind the take-off line. Before jumping, he swings his arms backward and bends his knees. He jumps by simultaneously extending his knees and swinging his arms forward.

Rules: The pupil is allowed three trials. Measurement is made with a metal tape from the take-off line to the part of the body which touches the ground nearest the take-off line.

Scoring: Only the best jump of the three trials is recorded. It is recorded to the nearest foot and inch.

50-Yard Dash

Description: The pupil takes his position behind a starting line. The starter gives the commands "Are you ready?" and "Go." The command "Go" is accompanied by a downward sweep of his arm in order that the timer will have a visual signal.

Rules: The pupil is allowed only one trial, and his score is the amount of time between the starter's signal and the instant the pupil crosses the finish line.

Scoring: The pupil's time is recorded to the nearest tenth of a second.

Softball Throw

Description: The pupil throws a regulation softball while remaining within two parallel lines, six feet apart. The point at which the ball lands is marked with a small stake and if he throws a further distance with his second or third throw, the stake is moved to his furthest throw.

Rules: Only an overhand throw is allowed. The pupil gets three throws. The distance recorded is that which is fartherest from the restraining line.

Scoring: Only the best of the three trials is recorded to the nearest foot.

600-Yard Run-Walk

Description: The pupil uses a standing start and starts on the signal "Ready? Go!" He is instructed to run the distance in as fast a time as possible but his running may be interspersed with walking if he wishes. In this event the pupils are paired. One pupil runs while his partner listens for his time which is called out as the runner crosses the finish line.

Rules: Walking is permitted, but the object is to cover the distance in the shortest possible time.

Scoring: The pupil's time is recorded in minutes and seconds.

APPENDIX B

AAHPER PHYSICAL FITNESS DATA SHEET

Student	Ht.	Wt.	Age	Sit-ups		Pull-ups		Shuttle Run		Standing Broad Jump		50-Yard Dash		Softball Throw		600-Yard Run/Walk	
				Act. Score	%	Act. Score	%	Act. Score	%	Act. Score	%	Act. Score	%	Act. Score	%	Act. Score	%

APPENDIX C

AAHPER PHYSICAL FITNESS NORMS: PERCENTILE SCORES FOR COLLEGE MEN

Percentile	Pull-up	Sit-up	Shuttle Run	Standing Broad Jump	50-Yard Dash	Softball Throw	600-Yard Run/Walk
100th	20	100	8.3	9'6"	5.5	315	1:12
95th	12	99	9.0	8'5"	6.1	239	1:35
90th	10	97	9.1	8'2"	6.2	226	1:38
85th	10	79	9.1	7'11"	6.3	217	1:40
80th	9	68	9.2	7'10"	6.4	211	1:42
75th	8	61	9.4	7'8"	6.5	206	1:44
70th	8	58	9.5	7'7"	6.5	200	1:45
65th	7	52	9.5	7'6"	6.6	196	1:47
60th	7	51	9.6	7'5"	6.6	192	1:49
55th	6	50	9.6	7'4"	6.7	188	1:50
50th	6	47	9.7	7'3"	6.8	184	1:52
45th	5	44	9.8	7'1"	6.8	180	1:53
40th	5	41	9.9	7'0"	6.9	176	1:55
35th	4	38	10.0	6'11"	6.7	171	1:57
30th	4	36	10.0	6'10"	6.7	166	1:59
25th	3	34	10.1	6'9"	7.1	161	2:01
20th	3	31	10.2	6'7"	7.1	156	2:05
15th	2	29	10.4	6'5"	7.2	150	2:09
10th	1	26	10.6	6'2"	7.5	140	2:15
5th	0	22	11.1	5'10"	7.7	125	2:25
0	0	0	13.9	4'2"	9.1	55	3:43

APPENDIX D

DIRECTIONS FOR THE WORK TEST: BICYCLE ERGOMETER

1. Energetic bodily activity should not be engaged in during the hours preceding the work test.

2. Test should not be performed within thirty minutes of light meal or one hour of a heavy meal.

3. The test is preceded by rest in a reclining or sitting position.

4. The seat height should provide for slight knee flex with toe on pedal and knee aligned in the same vertical plane.

5. When heart rate does not change more than five beats per minute, a steady state has been reached. Usually four to six minutes time will be sufficient for reaching the steady state.

6. Choice of work load:
   a. Trained state of fitness=900 Kilopond meters per minute or 3 Kilopond braking resistance.
   b. Untrained state of fitness=300 Kilopond meters per minute or 1 Kilopond.
   c. When the heart rate exceeds 130 beats per minute, the load is considered adequate for producing a steady state.
   d. When a heart rate of 180 beats per minute is reached, the physical work capacity has been attained.

7. The oxygen uptake during steady state of various work loads for subjects with normal mechanical efficiency is indicated below.

BRAKING RATE	KILOPOND METERS PER MINUTE	OXYGEN UPTAKE LITERS PER MINUTE
1 KP	300	0.9
2 KP	600	1.5
3 KP	900	2.1
4 KP	1200	2.8
5 KP	1500	3.5
6 KP	1800	4.2

APPENDIX D --Continued

8. A progressive physical work capacity test was performed on the monarch bicycle ergometer. The test was devised by Olree of Harding College, Searcy, Arkansas. The Olree Test is comparable to the Balke Progressive Test on the treadmill. Each subject rode the bicycle for three minutes with a work load of one kilopond resistance (300 kilopond meters per minute). After the preliminary ride of three minutes, the work load was increased by 1/4 kilopond resistance (75 kilopond meters per minute) each minute until the heart rate reached a work load rate of 180 beats per minute. The heart rate was monitored with the physiograph the last 15 seconds of each work load until the subjects rate reached 160 beats per minute. At that point, the physiograph was used for continuous monitoring until the work rate of 180 beats per minute was reached (15 beats per five seconds with a paper speed of .5 centimeters).

9. Physical work capacity resistance adjustments and work loads for this test:

MINUTES	BRAKING RESISTANCE	KILOPOND METERS PER MINUTE
0-3	1.00 KP	(300)
3-4	1.25 KP	(375)
4-5	1.50 KP	(450)
5-6	1.75 KP	(525)
6-7	2.00 KP	(600)
7-8	2.25 KP	(675)
8-9	2.50 KP	(750)
9-10	2.75 KP	(825)
10-11	3.00 KP	(900)
11-12	3.25 KP	(975)
12-13	3.50 KP	(1050)
13-14	3.75 KP	(1125)
14-15	4.00 KP	(1200)
15-16	4.25 KP	(1275)
16-17	4.50 KP	(1350)
17-18	4.75 KP	(1425)
18-19	5.00 KP	(1500)

10. Items 4, 5, and 6 are not particularly pertinent to this test but should aid in general to better understanding of the progressive work capacity test.

APPENDIX E

DIRECTIONS FOR MEASURE OF THE BASAL HEART RATE

1. Subjects will report to gymnasium and spend the night preceding measurement of the heart rate.
2. The basal heart rate will be taken as they awaken the following morning.
3. The heart rate will be taken before the subjects have an opportunity to do any physical activity.
4. The heart rate will be taken before the subjects have an opportunity to smoke.
5. The heart rate will be taken before the subjects have an opportunity to eat.
6. The heart rate will be taken before the subjects have an opportunity to drink coffee.
7. The subjects will have an opportunity to sleep and rest at least eight hours.
8. Precaution will be taken to avoid any apprehension or emotion in the subjects preceding administration of the heart rate measure.

APPENDIX F

TRAINING PROGRAMS

1. Cardiovascular-respiratory training procedure
   a. Jog 880 yards
   b. Stretching exercises
      1. Stretching hamstrings
      2. Stretching medial muscles of the thigh
      3. Trunk rotation
      4. Push-ups (10 repetitions)
      5. Sit-ups (10 repetitions)
   c. Continuously running and walking (2 to 4.5 miles per day)

2. Strength and agility training procedure
   a. Group calisthenics (10 repetitions each)
      1. Side straddle
      2. Push-ups
      3. Sit-ups
      4. Squat thrust
      5. Wind mill
   b. Agility drills
      1. Dipsie doodle
      2. Run turn run
      3. Ten-yard starts
      4. Bear crab
   c. Weight routine
      1. Low pull
      2. Flexed arm pullover
      3. Chins
      4. High pull
      5. Curls
      6. Inverted leg press
      7. Butterflies
      8. Squat rack
      9. Abdominal lift hang
      10. Bench.

The weight routine was done on the commands of the instructor. The power rack procedure was used, involving the over-load principle based upon maximum weight resistance. Each station involved the subjects, in three lifts with his holding the third call in a position of strain for approximately ten seconds.

APPENDIX G

PRE-TEST RAW SCORES - GROUP I

Subj.	Ht.	Wt.	Age	S-Up	P-Up	S.R.	B.J.	50-D	SBT	600-R	BHR	PWC	RHR	A-PER
101	68.5	168	19.8	78	6	9.1	7'7"	6.4	240'	1:54	59	9:20	80	72
102	71.5	163	19.6	50	8	9.8	7'3"	6.8	240'	1:47	62	13:10	86	61
103	70.5	169	20.0	47	8	10.7	6'10"	6.5	219'	1:30	64	11:30	80	64
104	74.0	176	18.1	100	8	10.8	7'8"	6.7	180'	1:43	66	12:15	88	61
105	68.0	139	10.0	58	6	10.3	6'10"	6.7	161'	1:52	68	9:55	90	43
106	68.5	134	19.2	100	9	9.7	6'10"	6.8	204'	1:49	52	9:00	78	63
107	71.5	163	19.6	100	7	10.0	6'5"	6.5	165'	1:44	64	12:40	78	57
108	64.5	155	18.10	65	8	10.4	6'10"	6.6	237'	1:50	61	12"25	72	58
109	74.5	156	18.11	61	5	10.6	7'3"	6.8	180'	1:43	58	11:45	76	50
110	72.5	173	10.9	80	8	10.5	7'10"	6.6	228'	1:49	50	10:35	93	60
111	73.0	163	10.10	90	10	9.4	7'0"	6.5	170'	1:42	54	10:20	76	68
112	68.5	177	21.3	80	8	8.9	7'7"	6.0	246'	1:35	62	14:25	87	87
113	69.5	143	19.5	50	10	9.8	8'0"	6.6	150'	1:51	54	9:40	90	58
114	71.0	143	18.7	100	9	9.5	7'5"	6.6	217'	1:39	56	10:05	92	78
115	74.0	158	19.4	100	8	9.6	7'8"	6.6	211'	1:39	72	10:15	100	77
116	70.0	175	21.6	68	2	9.6	6'7"	7.0	234'	2:07	58	10:30	100	45
117	72.0	167	17.10	79	12	10.8	6'11"	6.8	173'	1:52	53	10:00	64	51
118	67.0	147	20.2	55	7	9.4	7'2"	6.8	177'	1:49	60	12:25	72	57
119	72.0	153	19.9	40	4	10.3	7'0"	6.8	183'	2:10	64	7:30	90	33
120	72.0	175	18.10	50	9	9.6	7'4"	6.2	240'	2:03	52	11:20	66	66
121	71.0	185	22.5	55	15	9.8	6'5"	7.1	231'	2:04	48	11:25	80	50
122	70.0	130	19.10	34	14	9.3	7'7"	7.1	156'	2:06	64	10:50	68	46
123	75.0	179	18.3	100	6	9.1	7'0"	7.0	210'	1:57	74	11:10	76	61
124	69.5	175	21.3	51	6	10.4	7'1"	6.4	216'	2:06	59	12:00	100	50

APPENDIX G --Continued

POST-TEST RAW SCORES - Group I

Subj.	S-Up	P-Up	S.R.	B.J.	50-D	SBT	600-R	BHR	PWC	RHR	A-PER
101	90	9	8.9	7'6"	6.4	275'	2:20	50	10:30	90	72
102	68	11	9.4	7'10"	6.8	245'	1:48	63	13:50	68	75
103	60	10	9.6	7'4"	6.5	225'	1:39	56	12:35	72	75
104	100	12	10.3	8'0"	6.8	265'	1:40	64	16:30	76	75
105	100	9	9.7	7'0"	7.1	166'	1:58	52	10:50	100	50
106	100	13	9.8	6'3"	7.0	235'	1:53	52	13:00	64	59
107	100	11	10.2	7'0"	6.4	195'	1:45	56	11:10	100	66
108	85	11	10.1	6'11"	6.8	265'	1:43	58	13:00	88	64
109	65	7	10.6	7'0"	6.6	235'	1:47	70	14:40	78	56
110	100	12	9.6	6'6"	6.9	240'	1:45	51	13:22	78	66
111	95	11	9.1	8'1"	6.5	225'	1:48	55	13:20	68	82
112	100	12	8.8	8'7"	5.8	250'	1:31	61	16:47	72	96
113	51	11	10.4	7'9"	6.5	156'	1:49	50	12:10	84	56
114	100	10	9.4	7'8"	6.5	215'	1:39	54	11:05	100	84
115	100	10	9.5	7'1"	6.4	220'	1:51	63	12.10	92	79
116	96	6	9.4	7'3"	6.6	260'	2:07	55	13:40	96	63
117	75	14	10.8	6'6"	6.5	215'	1:58	52	12:45	68	53
118	70	8	9.3	7'5"	6.3	174'	1:54	58	15:10	64	66
119	53	7	10.0	7'5"	6.6	220'	2:15	55	9:00	84	55
120	54	11	10.1	7'10"	6.0	285'	2:13	54	14:10	64	66
121	55	13	11.0	6'4"	6.4	270'	1:57	48	13:42	80	57
122	53	16	9.0	7'3"	6.6	166'	1:52	61	12:00	72	64
123	100	10	10.8	6'11"	7.1	217'	2:06	58	14:04	80	51
124	82	9	9.5	6'10"	6.4	228'	1:58	53	13:46	76	66

APPENDIX G --Continued

PRE-TEST RAW SCORES - GROUP II

Subj.	Ht.	Wt.	Age	S-Up	P-Up	S.R.	B.J.	50-D	SBT	600-R	BHR	PWC	RHR	A-PER
201	71.0	146	19.0	47	7	9.8	7'3"	6.2	156'	1:41	66	7:25	88	57
202	68.0	169	26.7	30	6	9.8	6'10"	6.9	195'	1:56	61	11:10	62	41
203	68.5	145	19.6	60	10	9.6	8'2"	6.2	192'	1:37	50	12:25	69	84
204	73.5	176	19.2	100	5	9.2	8'11"	6.3	255'	1:43	52	12:10	68	81
205	69.0	141	20.1	33	8	10.2	6'1"	7.6	105'	2:08	66	9:40	96	16
206	72.0	200	19.3	69	4	10.1	6'5"	6.8	219'	2:01	72	11:05	78	45
207	67.0	220	18.6	21	0	11.5	5'1"	8.7	165'	2:47	72	11:45	84	04
208	71.0	136	18.10	79	5	10.2	6'10"	7.0	171'	1:44	62	9:30	82	46
209	70.0	158	18.9	58	5	9.7	6'6"	6.6	166'	1:44	58	12:25	84	50
210	66.5	114	19.10	100	14	9.6	8'1"	6.7	219'	1:39	50	7:15	66	80
211	73.0	139	18.9	100	10	9.3	7'10"	6.6	153'	1:33	56	8:45	88	74
212	67.0	174	21.5	48	12	9.6	7'9"	6.7	225'	1:44	66	12:25	72	69
213	73.0	181	22.10	35	2	10.6	6'6"	7.2	153'	1:55	54	10:15	76	19
214	69.0	132	19.3	66	4	9.9	6'8"	7.1	201'	2:10	60	10:15	78	40
215	69.0	148	19.10	100	10	9.6	6'1"	6.6	147'	2:01	64	10:50	74	50
216	72.0	135	18.9	100	8	9.8	7'3"	7.0	186'	1:41	58	10:45	96	62
217	68.0	145	18.6	100	9	10.3	7'1"	6.4	240'	1:42	58	12:10	60	71
218	67.0	147	19.7	67	12	9.0	7'3"	6.4	177'	1:41	62	9:50	76	74
219	68.0	139	18.4	100	9	9.3	8'1"	6.5	177'	2:12	52	10:30	68	67
220	76.0	182	20.5	50	7	10.3	7'5"	6.6	165'	1:48	68	11:25	96	52
221	71.0	150	18.11	60	5	9.2	6'9"	6.3	222'	1:38	60	11:20	74	69
222	70.0	150	30.1	45	1	10.5	6'2"	7.3	177'	2:01	55	11:20	66	21
223	68.0	138	21.6	50	8	10.6	6'9"	6.7	153'	1:40	57	11:50	72	47
224	70.0	140	19.9	100	10	9.9	7'0"	6.3	198'	1:21	54	12:20	60	77

APPENDIX G --Continued

POST-TEST RAW SCORES - Group II

Subj.	S-Up	P-Up	S.R.	B. J.	50-D	SBT	600-R	BHR	PWC	RHR	A-PER
201	47	7	10.1	7'3"	6.4	225'	1:37	45	14:00	56	64
202	60	9	9.6	7'2"	6.6	177'	1:43	48	12:00	64	61
203	100	11	9.2	7'6"	6.0	183'	1:34	50	14:30	80	81
204	100	5	8.9	9'0"	6.4	264'	1:54	42	13:52	60	79
205	50	9	9.4	6'4"	6.9	120'	2:09	53	13:55	76	40
206	80	5	9.8	6'11"	6.9	255'	2:10	66	13:00	80	51
207	24	0	10.4	5'1"	8.6	165'	2:42	70	14:20	92	07
208	61	6	9.5	7'7"	6.6	211'	1:43	54	11:33	72	69
209	62	7	9.6	6'9"	6.6	220'	1:40	48	15:25	72	67
210	100	16	8.8	8'0"	6.0	260'	1:37	46	9:30	72	93
211	100	13	9.7	7'8"	6.4	171'	1:32	52	13:35	84	76
212	60	12	9.4	7'4"	6.4	234'	1:42	62	16:30	84	78
213	45	4	9.6	7'3"	6.8	135'	1:49	53	11:13	96	44
214	63	5	9.1	6'6"	6.6	234'	2:00	56	11:00	78	58
215	100	10	9.4	6'6"	6.5	183'	1:48	56	11:30	80	65
216	100	10	10.1	7'5"	6.6	193'	1:39	50	13:41	80	69
217	100	10	8.8	7'7"	6.6	285'	1:39	57	14:15	52	86
218	100	11	10.9	6'2"	6.3	171'	1:34	54	12:00	76	61
219	100	7	9.0	7'4"	6.4	225'	1:53	54	13:26	60	75
220	75	7	10.0	7'2"	6.0	177'	1:46	53	16:12	72	61
221	100	6	9.1	6'5"	6.1	252'	1:36	47	14:58	72	77
222	45	0	11.2	6'0"	7.5	225'	2:00	50	13:35	60	24
223	76	6	10.3	6'3"	6.7	156'	1:37	54	12:54	88	46
224	100	13	9.6	7'2"	6.2	219'	1:19	48	15:30	64	81

BIBLIOGRAPHY

Books

American Association for Health, Physcial Education, and Recreation, Test Manual, Washington, D. C., 1961.

Arkin, Herbert and Raymond Colton, Statistical Methods, 4th. Edition, New York, Barnes and Noble, Inc., 1968.

Astrand, Per-Olog and Kaare Rodahl, Textbook of Work Physiology, St. Louis, McGraw-Hill Book Co., 1970.

Bucher, Charles A., Foundations of Physical Education, 5th. Edition, St. Louis, The C. V. Mosby Company, 1968.

Buros, O. K., editor, Mental Measurement Year Books, Highland Park, New Jersey, Grython, 1969.

Clarke, D. H. and H. H. Clarke, Research Processes in Physical Education, Recreation, and Health, Englewood Cliffs: New Jersey, Prentice-Hall Inc., 1970.

Consolazio, C. F. and others, Physiological Measurements of Metabolic Functions in Men, Englewood Cliffs, Prentice-Hall Inc., 1963.

Cooper, K. H. and Ken Broawn, Aerobics, New York, M. Evans and Co. Inc., 1968.

Cureton, Thomas Kirk, The Physiological Effects of Exercise Programs on Adults, Springfield, Illinois, Charles C. Thomas Publisher, 1969.

Cureton, T. K., Physical Fitness Appraisal and Guidance, St. Louis, C. V. Mosby Company, 1947.

Davis, Elwood Craig, and others, Quality of Living: Sources of Personal Health, DuBuque, Iowa, William C. Brown Company Publishers, 1967.

DeLorme, T. L. and A. L. Watkins, Progressive Resistance Exercise: Technique and Application, New York, Barnes and Noble, Inc., 1967.

deVries, Herbert A., Physiology of Exercise for Physical Education and Athletics, DuBuque, Iowa, William C. Brown Company Publishers, 1968.

Encyclopedia of Educational Research, 2nd. Edition, New York, The Macmillan Company, 1950.

Fleishman, Edwin A., The Structure and Measurement of Physical Fitness, Englewood Cliffs, New Jersey, Prentice-Hall Inc., 1965.

Guilford, J. P., Fundamental Statistics in Psychology and Education, 4th Edition, St. Louis, McGraw-Hill Book Company, 1965.

Henderson, John, Emergency Medical Guide, New Brunswick, McGraw-Hill Book Company, 1969.

Hickman, Cleveland P., Health for College Students, Englewood Cliffs, New Jersey, Prentice-Hall Inc., 1968.

Jones, Herbert L., and Margaret B. Schutt, and Ann L. Shelton, Science and Theory of Health, DuBuque, Iowa, W. C. Brown Company Publishers, 1966.

Karpovich, Peter V., Physiology of Muscular Activity, Philadelphia, Saunders, 1965.

Morehouse, Lawrence E. and Augustus T. Miller, Physiology of Exercise, 5th Edition, St. Louis, McGraw-Hill Book Company, 1967.

Penman, Kenneth, Physical Education for College Students, St. Louis, C. V. Mosby Company, 1964.

Roscoe, John T., Fundamental Research Statistics, New York, Holt, Rinehart and Winston, Inc., 1969.

Royal Candadian Air Froce, 5BX Plan, Ottawa, Queen's Printer and Controller of Stationery, 1961.

Smolensky, Jack and Franklin B. Haar, Principles of Community Health, Philadelphia, W. B. Sanders Co., 1967.

Van Dalen, Deobold B., Understanding Educational Research, St. Louis, McGraw-Hill Book Company, 1962.

UpDyke, Wynn F. and Perry B. Johnson, Principles of Modern Physical Education, Health, and Recreation, Dallas, Holt, Rinehold and Winston, Inc., 1970.

Van Huss, W. D., and others, Physical Activity in Modern Living, 2nd Edition, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1969.

Van Huss, W. D., and others, An Introduction to Measurement and Physical Education: Physical Fitness, Indianapolis, Phi Epsilon Kappa Fraternity, 1970.

Wilt, Fred, Run Run Run, Los Altos, California, Track and Field News Inc., 1964.

Articles

Adams, F. A., and others, "Symposium on Exercise Fitness: Their Physiological Basia and Clinical Application to Pediatrics," Pediatrics, XXXII (October, 1963), 653-778.

Alexander, J. F. and J. E. Torpey, "Conditioning Improves Cardiovascular Fitness," Minnesota Journal of Education, XXXXVIII (October, 1967), 12-15.

Amasa, Ford and Herman Hellerstein, "Estimation of Energy From Pulmonary Ventilation," Journal of Applied Physiology, XIV (November, 1959), 891.

Astrand, Per-Olof and I. Phyming, "A Nomogram for Calculation of Aerobic Capacity (Physical Fitness) From Pulse Rate During Submaximal Work," Journal of Applied Physiology, VII (March, 1954), 218-21.

Berger, Richard A., "Comparison of the Effect of Various Weight Training Loads on Strength," Research Quarterly, XXXVI (May, 1965), 141-146.

Berger, Richard A., and J. M. Henderson, "Relationship of Power to Static and Dynamic Strength," Research Quarterly, XXXVII (March, 1966), 9-13.

Bodley, Dean, "Build an Obstacle Course," The Physical Educator, XXXVII (October, 1970), 123-124.

Brouha, L. and Mary E. Maxfield, "Practical Evaluation of Strain in Muscular Work and Heat Exposure by Heart Rate Recovery Curves," Ergonomics, V (January, 1962), 87.

Carpenter, A., "An Analysis of the Relationships of the Factors of Velocity, Strength and Dead Weight to Athletic Performance," Research Quarterly, XII (March, 1941), 34-39.

Clarke, H. Harrison and Ernest W. Degustis, "Relationship Between Standing Broad Jump and Various Maruratlonal Anthrometric, and Strength Test of 12-Year Old Boys," Research Quarterly, XXXV (October, 1964), 258-264.

Clarke, D. H. and G. A. Stull, "Endurance Training As a Determinant of Strength and Fatigability," Research Quarterly, XXXXI (March, 1970), 12-26.

Cureton, T. K., "Comparison of Various Factor Analyses of Cardiovascular-Respiratory Test Variables," Research Quarterly, XXXIX (October, 1966), 317-325.

Doolittle, T. L., and R. Bigbee, "Twelve Minute Run-Walk Test: A Test of Cardio-Respiratory Fitness of Adolescent Boys," Research Quarterly, XXXIX (October, 1966), 491-495.

Falls, H. B., "Development of Physical Fitness Test Batteries by Factor Analysis Technique," Journal of Sports Medicine, V (December, 1965), 185-197.

Falls, Harold B. and others, "Estimation of Maximum Oxygen Uptake in Adults From AAHPER Youth Fitness Test Items," Research Quarterly, XXXVII (May, 1966), 192-201.

Frank, J. A., "Comparisons of Pre-and Post-Fitness Scores in Conditioning Experiment," Research Quarterly, XXXVIII (October, 1967), 510-512.

Franks, B. D., "Smoking and Selected Cardiovascular-Respiratory Measures," Research Quarterly, XXXXI (May, 1970), 140-144.

Gordon, E. E. and others, "Changes in Rat Muscle Fiber with Forceful Exercise," Archives, Physical and Medical Rehabilitation, XXXXVIII (February, 1967), 577-582.

Gordon, E. E. and others, "Adaptations of Muscle to Various Exercise," Journal of the American Medical Association, CIC (January, 1967), 103-108.

Gordon, E. E. and others, "Protein Changes in Quadriceps Muscle of Rat with Repetitive Exercises," Archives, Physical and Medical Rehabilitation, XXXVIII (February, 1967), 296-303.

Gordon, E. E. and others, "Adaptation of Muscle to Different Exercise," Journal of the American Medical Association, CCI (March, 1967), 755-758.

Harper, D. D. and others, "Comparative Effects of Two Physical Conditioning Programs on Cardiovascular Fitness in Man," Research Quarterly, XXXX (May, 1969), 293-298.

Helander, E. A. S., "Influence of Exercise and Restricted Activity on the Protein Composition of Skeletal Muscle," Biochemistry Journal, LXXVIII (May, 1961), 478-481.

Hutto, L., "Measurement of the Velocity Factor and of Athletic Power in High School Boys," Research Quarterly, IX (October, 1938), 109-128.

Issekutz, B. Jr., and others, "Use of Respiratory Quotients in Assessment of Aerobic Work," Journal of Applied Physiology, XVII (January, 1962), 47.

Issekutz, B. Jr., and K. Rodahl, "Respiratory Quotient During Exercise," Journal of Applied Physiology," XVI (July, 1961), 606.

Kistler, J. W., "A Study of the Results of Eight Weeks of Participation in University Physical Fitness Program for Men," Research Quarterly, XV (March, 1944), 23-28.

Larson, L. A., "A Factor and Validity Analysis of Strength Variables and Tests with a Test Combination of Chinning, Dipping, and Vertical Jump," Research Quarterly, XI (January, 1940), 82-96.

Larson, L. A., "A Factor Analysis of Motor Ability Variables and Tests, with Tests for College Men," Research Quarterly, XII (December, 1941), 499-517.

Linde, L. M., "An Appraisal of Exercise Fitness Tests," Pediatrics, XXXII (October, 1963), 656-659.

Locke, L. F., "Comments on the Article "Reliability of the 600-Yard Run-Walk Test at the Junior High School Level," Research Quarterly, XXVIII (October, 1962), 326-328.

Lovell, J. A., "Prior for Fitness," Journal of Health, Physical Education, and Recreation, XXXIX (June, 1968), 26.

Mahanes, Thomas R. and R. R. Jones, "Physical Education in Fayette County," The Physical Educator, XXVII (October, 1970), 119-120.

Maxfield, Mary and Lucien Brouha, "Validity of Heart Rate as an Indicator of Cardiac Strain," Journal of Applied Physiology," XVIII (November, 1964), 1099-1104.

Metheny, E. L., and others, "Some Physiological Responses of Men and Women to Moderate and Streneous Exercises: A Comparative Study," American Journal of Physiology, X (January, 1957), 51.

Metz, K. F. and J. F. Alexander, "Investigation of the Relationship Between Maximum Aerobic Work Capacity on Physical Fitness in 12- to 15-Year Old Boys, Research Quarterly, XXXXI (March, 1970), 75-81.

Mitchell, J. H. and others, "The Physiological Meaning of the Maximal Oxygen Intake Test," Journal of Clinical Investigations, XXXVII (November, 1958), 538.

Olree, Harry D., "Methods of Achieving and Maintaining Physical Fitness for Prolonged Space Flight," Nassar Research Progress Report, Harding College, Searcy, Arkansas, 1969.

Ponthieux, N. A. and D. G. Barker, "An Analysis of AAHPER Fitness Test," Research Quarterly, XXXIV (December, 1963), 525-526.

Rhodes, E. and others, "The Effects of a Pre-Season Ankle Exercise Program on the Prevention of Ankle Injuries in High School Basketball Players," Journal of Physical and Mental Rehabilitation, XIV (May, 1960), 78-79.

Stein, Julian V., "The Reliability of the Youth Fitness Test," Research Quarterly, XXXV (October, 1964), 328-329.

Tharp, G. D., "Cardiac Function Test as Indexes of Fitness," Research Quarterly, XXXX (December, 1969), 818-822.

Thompson, J. C., "Physical Fitness for the 1970's," Physical Educator, XXVI (December, 1969), 146.

Van Huss, W. D., and others, "Effects of Overload, Warm-up on the Velocity and Accuracy of Throwing," Research Quarterly XXXIII (December, 1962), 472-475.

Wells, J. G., "Flarimeter Test for Athletes," American Heart Journal, XXXXVIII (December, 1954), 914.

Wells, J. G. and others, "Lactic Acid Accumulation During Work, A Suggested Standardization of Work Classification," Journal of Applied Physiology, X (January, 1957), 51.

Wilbur, E. A., "A Comparative Study of Physical Education: The Sports Method and the Apparatus Method," Research Quarterly, XIV (October, 1964), 326-330.

Willgoose, Carle E. and Mildred and Nathaniel Askew, "Reliability of the 600-Yard Run-Walk Test at the Junior High Level," Research Quarterly, XXXII (May, 1961), 264-265.

Williams, C. G. and others, "Effect of Training on Maximum Oxygen Intake and an Anaerobic Metabolism in Man," Internationale Zeitschrift fur Angewandt Physiologie einschliesslich Arbeits-Physiologie, XXIIII (June, 1967), 18-23.

Unpublished Materials

Bentley, Earl J., "The Influence of Three Training Programs on Strength, Speed, Power, General Endurance and Speed of Movement," unpublished doctoral dissertation, University of Southern Mississippi, Hattiesburg, 1968.

Bitoon, Lawrence E., "Validation of a Physical Fitness Test for High School Boys in Iowa," unpublished doctoral dissertation, University of Arkansas, Fayetteville, Arkansas, 1965.

Brooker, Charles, "The Effects on Efficiency of Endurance Training Controlled by Heart Rate," unpublished doctoral dissertation, Syracuse University, New York, 1966.

Butts, Eugene M., "The Contributions of Ten Selected Physical Education Activities to Physical Fitness and Motor Ability," unpublished doctoral dissertation, Syracuse University, New York, 1966.

Carlson, Leon R., "Comparison of Muscular Strength and Relative Muscular Endurance in Isotonics and Isometrics Contractions," unpublished doctoral dissertation, University of Texas, Austin, Texas, 1968.

Coker, H. L., "Selected Pre-Activity Calisthenics Programs and Their Effects Upon the Physical Fitness of the College Male," unpublished doctoral dissertation, University of Arkansas, Fayetteville, Arkansas, 1964.

Corroll, Victor A., "AAHPER Youth Fitness Test Item and Maximal Oxygen Intake," unpublished doctoral dissertation, University of Illinois, Evanston, Illinois, 1967.

Davis, Robert M., "A Comparison of Three Approaches to Increasing Physical Fitness in Students of Low Fitness," unpublished doctoral dissertation, George Peabody College, Nashville, Tennessee, 1963.

Dempsey, Cedric W., "A Ballistocardiographic Investigation of Cardiac Responses of Boys to Physical Training and Wheat Germ Oil," unpublished doctoral dissertation, University of Illinois, Evanston, Illinois, 1964.

Duncan, Olen T., "The Effects of Dynamic Exercise on the Development of Physical Fitness," unpublished doctoral dissertation, North Texas State University, Denton, Texas 1968.

Girardin, Uan, "The Comparative Effects of Two Levels of Training Intensity on Human Adaptations to a State of Stress," unpublished doctoral dissertation, Florida State University, Tallahassee, Florida, 1967.

Hayes, Asabel E., "Criteria for the Selection of Physical Fitness Activities in Physical Education Classes," unpublished doctoral dissertation, University of California, Los Angeles, California, 1968.

Helvey, Omer J., "The Effects of Isometric, Isotonic, and Sports Program on Physical Fitness," unpublished doctoral dissertation, University of Arkansas, Fayetteville, Arkansas, 1965.

Howard, Gordon E., "A Study of the Relationship Between the Tension ("isometric") Period of the Left Ventricle and Physical Training in Youth Adult Men," unpublished doctoral dissertation, University of Michigan, Lansing, Michigan, 1968.

Kight, Carl R., "The Effects of Experimentally Induced Variations in Body Weight Upon Power," unpublished doctoral dissertation, Louisiana State University and Agricultural and Mechanical College, Baton Rouge, 1967.

Kirby, Ronald F., "The Effects of Various Exercise Programs Involving Different Amounts of Exercise on the Development of Certain Components of Physical Fitness," unpublished doctoral dissertation, Louisiana State University, Baton Rouge, Louisiana, 1966.

McNair, Daniel P., "Effects of Different Exercise Programs on the Development of Cardiovascular Fitness, Strength and Muscular Development," unpublished doctoral dissertation, Louisiana State University and Agricultural and Mechanical College, Baton Rouge, Louisiana, 1967.

Metz, Kenneth F., "The Relationship Between Maximal Aerobic Capacity and Physical Fitness in 12-15 Year Old Boys," unpublished doctoral dissertation, University of Minnesota, St. Paul-Minneapolis, Minnesota, 1967.

Milton, George C., "The Effects of Three Programs of Long Distance Running and an Isometric Exercise Program on the Development of Cardiovascular Efficiency," unpublished doctoral dissertation, Louisiana State University, Baton Rouge, Louisiana, 1966.

Mullins, P. M., "Measurement of the Extent to Which Certain College Physical Education Activities Contribute to Certain Strength and Endurance Objectives," unpublished doctoral dissertation, Department of Education, Washington State University, Pullman, Washington, 1961.

Oscia, Lawrence B., "Effects of Training on Blood Volume and Physical Fitness Test," unpublished doctoral dissertation, University of Illinois, Evanston, Illinois, 1967.

Parkman, James E., "An Analysis of the Physical Fitness of College Men as Shown by the AAHPER Fitness Test," unpublished doctoral dissertation, University of Southern Mississippi,

Waddle, Benjamin, "A Study Comparing the Effectiveness of a Training Program Utilizing the Exergenie with Two Conventional Training Programs on the Development of Muscular Strength and Cardiovascular Endurance," unpublished doctoral dissertation, Florida State University, Tallahassee, Florida, 1967.

Webb, Wyatt M., "Three Interval Training Programs and Their Effects on Selected Physiological Variables," unpublished doctoral dissertation, Ohio State University,

Westering, F. E., "The Effects of Various Programs of Physical Performance," unpublished doctoral dissertation, Colorado State College, Greeley, Colorado, 1966.

White, Robert E., "A Comparison of Two Methods of Developing Physical Fitness in Fourth- and Fifth-Grade Boys," unpublished doctoral dissertation, Ohio State University,