THE EFFECTS OF PARTICIPATING IN AN AEROBIC TRAINING PROGRAM ON MALE FACULTY MEMBERS AND ADMINISTRATORS AT OKLAHOMA STATE UNIVERSITY

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CHAPTER I

INTRODUCTION

Adults are beginning to see the results of easy living and are becoming alarmed with the statistics concerning heart and lung diseases due to a general lack of exercise. Man's rapidly advancing technology has lessened the amount of physical work required of the average person which is reflected in our occupations, our homes, and our modes of transportation.

In addition to having less physical work to do, the average person spends fewer hours on the job and consequently has more leisure time. The amount of money spent on various leisure pursuits indicates the increasing amount of emphasis being placed on mechanized transportation and less vigorous forms of leisure activity. The worthy use of leisure time is one of the biggest problems facing our society today. Physical efforts are lessened not only in many vocations but in home and recreational pursuits as well.

A study of history points to the fact that all great cultures were founded by aggressive, vigorous people such as those found in ancient Greece, the United States, and the Roman Empire. Slaves were doing the physical labor in the waning years of ancient Greece and Rome with the citizens no longer personally active in sports and games. Athletes were paid or captives made to perform in athletic contests, and the cultures crumbled as a result of this shift from active participation to observation. Most American citizens would laugh at the idea of such a situation ever unfolding in our country; however, it may not be such a laughing matter. A quick analysis of the everyday pattern of life of the average citizen will soon draw out the obvious lack of physical exertion involved in day to day living. This general decay of physical conditioning leading to an overall softening of our citizens can best be summed up with a poem that the researcher wrote for the Journal of the Kansas Association for Health, Physical Education and Recreation in 1965, entitled "Central Tendency?"[1]

The outstretched web of a fielders glove
Will trap the hapless fly,
While thousands gaze upon the tube
And think of days gone by.

They think of days when they too played
For hours without rest,
But soon were forced to give it up
For they were second best.

The Roman nation tumbled down
They conquered all, then rested,
From lack of carry-over sports
Their kingdom soon was bested.

The people of the U.S.A.
Can gain from this mistake,
And start rebuilding muscles strong
For many now are cake.

In recent years the popular literature has contained many articles on the values of exercise; however, there appears to be a trend toward people now including more exercise in their daily activities. With more questions being asked and more interest being shown, the physical education specialist must bear the responsibility for answering many questions

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[1]Danny L. Thomas, "Central Tendency?" Journal of the Kansas Association for Health, Physical Education and Recreation, XXXIII (May, 1965), p. 12.

and developing proper alternatives for concerned parties. Physical educators are observing the need for better methods of evaluating the effectiveness of various physical fitness programs and for better means of measuring the physical proficiency of individuals.[2]

Exercise is not the panacea for all physical and mental ills, nor will it prevent the action of organisms responsible for infectuous disease. It is useful as a therapeutic tool for emotional release, greater efficiency, a feeling of well-being, and shorter periods of convalescence following illness. However, the immediate values of physical activity which include physical and emotional stimulation, fun, and personal satisfaction are important indeed. Equally important is the area of prevention since chronic diseases, such as cardiovascular disease and mental-emotional disorders, are on the increase. The need for a greater emphasis placed on discovering the causes of such diseases plus preventive measures seems apparent.

A wide variety of investigations lend support to the hypothesis that exercise as a way of life may help lessen the severity of and make recovery from cardiovascular disease more likely.[3]

The association of physical inactivity with clinical disorders has been an increasing concern of the medical profession. In spite of many handicaps which make definite conclusions difficult, the overwhelming majority of published reports seems to lend strong support to the concept that a relationship between exercise habits and the susceptibility

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[2]Edwin A. Fleishman, The Structure and Measure of Physical Fitness (Englewood Cliffs, N.J., 1964), p. v.

[3]Jean Mayer, "The Best Diet is Exercise," Reprinted in Science and Theory of Health (Dubuque, Iowa, 1966), pp. 186-191.

to functional and degenerative diseases of the myocardium may exist.

Cureton listed the types of chronic ailments which have been reported for business executives in connection with the Life Extension Medical Examinations in relative order of incidence as follows:

1. Obesity
2. Anxiety states
3. Hypertension
4. Arteriosclerosis
5. Functional gastrointestional disturbances
6. Varicose veins
7. Peptic ulcer
8. Cirrhosis of the liver[4]

Pohndorf[5] states that it is not necessary to be so fit that one is always eager to tear a telephone book apart, but one should be at least in moderately good physical condition. Adults seem to lose their desire to exercise as age increases. As one passes the forties, metabolic changes reduce the caloric needs; therefore, the same food intake causes increased weight which encourages less activity because the extra weight more quickly produces fatigue.[6] The problem is compounded in modern civilization due to the enormous amount of sitting and static standing in the white collar office work, in the factories and in the social

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[4]Thomas K. Cureton, Jr., Physical Fitness Workbook for Adults (Champaign, Illinois, 1970), p. 10.

[5]R. H. Pohndorf, "How Fit Are You," Journal of Health, Physical Education and Recreation, XXX (April, 1959), p. 36.

[6]Donald D. Dukelow, "A Doctor Looks at Exercise and Fitness," Journal of Health, Physical Education and Recreation, XXVIII (September, 1957), p. 26.

diversions.[7]

Physical fitness has many benefits to offer those that indulge in exercise among which is a greater enjoyment of physical activity.[8] Participation in such activity leads the participant to greater fitness along with the personal health advantages gained through the social, recreational, emotional, and relaxation aspects of the activities common to basic physical education programs.[9] The greatest effect of an exercise program is the improvement of bodily functions which support activity. This improved physiological efficiency is reflected in increased agility, strength, and endurance. The more often the normal heart and circulatory system are required to move blood to active regions of the body, the more efficient they become. This is accomplished chiefly by improved muscular tone of the heart, an increase in its output of blood per minute, and an increase in the number of active capillaries in the lungs.

Many individuals seek shortcuts to fitness with hundreds of advertisements seeking to attract the eye of the unwary individual. Physical fitness and diet quackery is running rampant in the United States with half-truths, fallacies, and blatant falsehoods continually being promoted by fitness commercializers.[10]

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[7] Thomas K. Cureton, The Physiological Effects of Exercise Programs on Adults (Springfield, Illinois, 1969), p. 16.

[8] Raymond A. Weiss, "Is Physical Fitness Our Most Important Objective," Journal of Health, Physical Education and Recreation, XXXV (February, 1964), p. 18.

[9] Dewart K. Grissom, "Man Living Healthfully Our Common Goal," Journal of Health, Physical Education and Recreation, XXXIX (September, 1968), p. 33.

[10] Bob L. Beasley, "Physical Fitness Quackery," Journal of Health, Education and Recreation, XLVI (June, 1975), p. 35.

Both Cureton[11] and Cooper[12] have established that many physiological measurements in adult men can be improved by following an exercise program. Unfit individuals can increase their tolerance for exercise by following a regular pattern of exercise, and the lack of such a program can cause certain body muscles to develop improperly. These underdeveloped muscles may be needed for unanticipated work activities, and in an emergency situation the resultant reliance upon such muscles could produce disasterous results. There is a considerable range of individual variation in need and complexity of exercise. A physically active person may need little, if any additional exercise to maintain fitness, whereas an active, relaxed person must add exercise to prevent becoming less fit.

Astrand[13] agrees that total fitness consists in the ability of the organism to maintain the various equilibria as closely as possible to the resting state during strenuous exertion and to restore promptly after exercise any equilibriums which have been disturbed.

Obesity can play an important role in the accident record of an individual. A man who allows his weight to increase steadily can be putting himself and his peers in a hazardous position, and, at a time when quick movement is necessary, he may be too sluggish to avoid an accident.[14] Obesity and rapid physical degeneration are the result of

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[11] Thomas K. Cureton, Physical Fitness, Appraisal and Guidelines (St. Louis, 1947), p. 144.

[12] Kenneth Cooper, The New Aerobics (New York, 1970), p. 191.

[13] P. O. Astrand, "Human Physical Fitness with Special Reference to Sex and Age," Physiological Review, XXXVI (July, 1956), pp. 307-335.

[14] Peter C. Yost, "Total Fitness and Prevention of Accidents," Journal of Health, Physical Education and Recreation, XXXVIII (March, 1967), p. 35.

sudden cessation of work activity in older individuals, as sometimes happens on retirement, if no substitute activity is added. The successful use of physical activity in the medical management of patients indicates the beneficial effects of exercise in preventing or delaying organic disease and degeneration.

On July 19, 1961, President Kennedy[15] released a statement to the press calling for Americans to get involved with physical fitness in America. The message stressed the importance of taking immediate steps to ensure that every American child be given the opportunity to make and keep himself physically fit to learn, fit to understand, to grow in grace and stature, to fully live. Such emphasis on personal fitness must be carried through the adult years to help alleviate the problem of our overfed society. There is no longer any doubt but that the level of physical activity does play a major role in weight control. Maintaining a good caloric balance between dietary intake and energy output requires a sound approach to both food consumption and exercise. The high mortality rate associated with being overweight suggests that obesity does directly contribute to organic degeneration.

Doctors have shown that exercise can often reduce the levels of several key factors that are frequently associated with heart disease. Exercise has another important effect on the heart that can help fight the development of a coronary. When you exercise your heart rate increases and your system begins to pour more and more blood through your coronary arteries to feed your heart muscle. As the pressure builds,

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[15] John F. Kennedy, "A Presidential Message to the Schools on Fitness of Youth," Journal of Health, Physical Education and Recreation (September, 1961), front cover.

your circulatory system must find new ways of moving blood into the muscles that bypass the coronary arteries altogether. The new paths to carry blood to the heart that develop in a well-conditioned person form the collateral blood system.

There is a current push to increase the level of physical fitness in America with organizations such as athletic clubs, schools, Y.M.C.A., private industry, and churches stressing the benefits of developing a high degree of personal fitness. The President's Council on Physical Fitness has developed several fitness programs. Presidents Eisenhower and Kennedy gave especially strong support in the area of physical fitness. Books concerning fitness were made available to the American public. The elementary school age students were offered a series entitled Youth Physical Fitness[16] with the principal purpose being to interest this age group in a personal 15-minute activity program daily. Vim (A Complete Exercise Plan for Girls 12 to 18)[17] and Vigor (A Complete Exercise Plan for Boys 12 to 18)[18] were two books offered to older students. The adults were offered Adult Physical Fitness[19] to serve as a guide in developing daily exercise programs.

Dr. Thomas Cureton has completed years of research concerning

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[16]The President's Council on Physical Fitness, Youth Physical Fitness, Suggested Elements of a School-Centered Program (Washington, D.C., 1961), p. 111.

[17]The President's Council on Physical Fitness, Vim, (A Complete Exercise Plan for Girls 12 to 18), Washington, D.C., 1964, p. 24.

[18]The President's Council on Physical Fitness, Vigor, (A Complete Exercise Plan for Boys 12 to 18), Washington, D.C., 1964, p. 24.

[19]The President's Council on Physical Fitness, Adult Physical Fitness, A Program for Men and Women (Washington, D.C., 1963), p. 64.

adult fitness programs at the University of Illinois. Several patterns of endurance training are utilized in the fitness programs developed by Dr. Cureton. Activities such as walking, cycling, hopping, skipping, jogging, hiking, climbing, canoeing, rowing, and bench stepping were used to improve fitness in the program developed by Dr. Cureton.[20]

Dr. Kenneth Cooper has developed the newest physical fitness program entitled "Aerobics," which means "with oxygen."[21] Dr. Cooper uses the term to denote activities that create a need for increased oxygen intake for an extended period of time to best develop cardiovascular endurance for the promotion of health. The "Aerobics" program is designed in such a manner as to encourage each participant, regardless of age, to earn a minimum of 30 points a week. The individual may choose a variety of activities in order to reach the goal of 30 points a week but each person is encouraged to exercise a minimum of four days per week. The program works to develop the cardiovascular system for an increased maximal amount of attainable oxygen which directly affects the amount of time an individual may work before fatigue becomes a factor. Dr. Cooper developed an aerobic point chart to rank individuals in one of five fitness categories, and the points are adjusted for various age levels. The point value assigned to each exercise indicates the amount of oxygen consumed by the body during a particular activity.[22]

The training effect refers to those changes brought on by exercise

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[20]Thomas K. Cureton, "The Meaning of Physical Fitness," Journal of Health, Physical Education and Recreation, XVI (March, 1945), pp. 111-112.

[21]Cooper, 1970, p. 16.

[22]Ibid., p. 17.

in the various systems and organs of the body. Exercise of a short duration will not produce an aerobic training effect and thus cannot be classified as an aerobic exercise. Cooper's point system helps make the distinction between aerobic and non-aerobic exercises, and the training effect will be reached only if the individual dilligently follows the proper exercise program and gains the required number of weekly points. The aerobic point chart is appealing to individuals since it allows the program participants to measure their own progress. The points obtained through exercise for specified times reveal the amount of oxygen consumed by the body during the exercise. The energy expenditure can thus be calculated easily by adding the points gained for each exercise period.

Dr. Cooper has developed his aerobics program to help individuals increase the maximum amount of oxygen that their bodies can process within a given time period. This maximum amount is your aerobic capacity which is the best index of an individual's overall physical fitness since it reflects the working capacity of the lungs, heart, and vascular system.

The present faculty fitness evaluation program at Oklahoma State University had its beginnings in 1969. Gerald Hudder, under the direction of Dr. A. B. Harrison, conducted a study to determine if a group of 30 middle-aged male subjects could through a consistent 16-week program of aerobic activities of their own choosing in which they earned a minimum of 30 points per week on Dr. Cooper's aerobic point system, maintain or improve their cardiovascular fitness to a level that would place them in a good or excellent category. The criterion for assessing the cardiovascular fitness was the performance on the

Balke Treadmill Test.

The subjects from the Hudder study continued to be tested by Dr. Harrison for two years after the conclusion of the initial study.

Max Oldham, under the supervision of Dr. Harrison, conducted a faculty fitness study during the 72-73 school year. Approximately 100 subjects were tested with the testing procedure expanded to include the EKG, body composition measures, and respirometry measures.

This study involves the second year of data collection in the faculty fitness evaluation program. The study included retest data on 65 subjects from the previous year as well as the addition of 20 new subjects to the program. The current study also has the addition of an aerobic point score kept by the participants in the program for the purpose of relating fitness activities to aerobic points gained per week. The study was conducted under the supervision of Dr. Harrison.

The Problem

The problem of this study was the appraisal of the current physical fitness of 85 males of the Oklahoma State University faculty and administration, 65 of which were retest subjects.

Subproblems

1. To determine if changes have occurred in the various physiological measurements over a one-year period in 65 retest subjects.

2. To relate scores on the various physiological measurements to physical activity patterns of the 65 retest subjects.

3. To determine if one activity seems to be more advantageous than another in producing high fitness levels or changing fitness levels.

Limitations

1. The subjects were all part of an ongoing program.

2. The subjects were all volunteers.

3. The personal habits of each subject, such as eating and sleeping, could not be controlled.

Delimitations

1. All of the subjects were associated with the University.

2. All of the subjects were males ranging in age from 22 to 62.

Assumptions

1. The subjects recorded aerobic points indicating exercise patterns.

2. The tests selected to determine cardiovascular fitness are valid predictors of adult physical fitness.

Definition of Terms

1. Aerobics: Activities or exercises that create a need for increased oxygen intake for a long period of time. Endurance type exercises are activities that tax the body's capacity to inhale oxygen and to deliver it to the cells in which it is combined with fuel foods for the production of energy.

2. Aerobic Capacity: The maximum amount of oxygen that the body can process within a given time and generally expressed in ml/kg/min.

3. EKG (electrocardiogram): A graphic recording of the electrical changes accompanying the cardiac cycle.

4. Schneider Index: Mild exercise test of circulatory efficiency

based primarily on pulse rates and blood pressures.

5. Blood Pressure: A quantitative measure of the pressure of the blood against the inner walls of the blood vessels.

6. Sphygmomanometer: Instrument used to measure blood pressure.

7. Systolic Pressure: The greatest pressure in the arteries following contraction of the ventricle.

8. Diastolic Pressure: The pressure in the arteries at the time of relaxation of the ventricle.

9. Pulse Rate: The number of times per minute your heart beats.

10. P Wave: Depolarization of the atria as seen in EKG.

11. R Wave: Depolarization of the ventricular myocardium that precedes ventricular systole as seen in EKG.

12. T Wave: Repolarization wave preceding ventricular diastole as seen in EKG.

13. Work Time: Time of ST interval as seen in EKG.

14. Rest Time: Time from end of T wave to next ST segment as seen in EKG.

15. Rest/Work: Rest Time/Work Time as taken from EKG.

16. Spirometry: A technique of measuring the oxygen consumption as well as various respiratory capacities.

17. Inspiratory Capacity: Total amount of air that can be inhaled in one breath following normal exhalation.

18. Expiratory Reserve: Total amount of air that can be exhaled after a normal expiration.

19. Vital Capacity: The maximum amount of air that can be exhaled after a maximum inhalation.

20. Timed Vital Capacity: The greatest amount of air that can be

forcefully expired in one second.

21. Maximal Breathing Capacity: The maximal amount of air that a person can move through his lungs in a given period of time. The test is for 15 seconds and the results expressed as liters/min.

22. Ventilation Equivalent: The number of liters which the subject must ventilate for an oxygen uptake of 100 ml., normally 2.2 to 2.8 L./100 ml.

Description of Instruments

1. Quinton Motorized Treadmill - An apparatus with a moving belt that can be made to run at varying speeds and inclines. (Model 642; Speed Range 1.5 - 25 miles per hour; Elevation (per cent grade) 0 - 40; Seattle, Washington.

2. Tissot Tank - A large stainless steel tank used to collect expired air during Maximum Breathing Capacity Test. (Warren E. Collins Incorporated, 555 Huntington Avenue, Boston 15, Mass.; Capacity - 120 liters (0 mm - 720 mm); Serial No. 1440.)

3. Physiograph - An apparatus used to monitor and record heart rate and blood pressure. (Type PMR-4A - Six Channels; E & M Instrument Co., Inc., Houston, Texas.)

4. Telemetry - A unit that sent a signal by radio waves from a small transmitter which was attached to the subject to a receiver from which the signal was recorded on the physiograph (Model FM-1100 - 7; E & M Instrument Co., Inc., Houston, Texas.)

5. Transmitter and Electrodes - Equipment that transmitted heart sounds by radio waves into the telemetry apparatus (Model FM 6 1100 - E2, Part No. 98 - 100 - 71; E & M Instrument Co., Inc., Houston, Texas.)

6. Birtcher Electrocardiograph - An apparatus used to record the electrical activity of the heart. (Model 335, The Birtcher Corporation, Los Angeles 32, California.)

7. Collins Respirometer - An apparatus used to record various capacities of the lungs. (9 liter, Factor 20.73 cc/mm, Warren E. Collins Incorporated, 555 Huntington Avenue, Boston 15, Mass.)

8. Sphygmomanometer - A device to monitor blood pressure manually. (Medisco Inc., New York, N.Y. 10012.)

9. Stethoscope - An instrument to monitor heart sounds manually. (Bowles Stethoscope, No. 4034, Medisco Inc., New York, N.Y. 10012.)

10. Lange Skinfold Calipers - An instrument to measure body fat. (No. HH4 - 8, Cambridge Scientific Industries, 101 Virginia Avenue, Cambridge, Maryland.)

11. Tape Measure - A measuring device to measure body circumferences. (6 foot, 2 m Woven Tape 317 GME, Lufkin.)

12. Scales - Device to measure height and weight. (Fairbanks - Morse.)

13. Calculator - Instrument used in computing formulas pertaining to all data. (SR - 10 Texas Instruments Inc., Dallas, Texas.)

CHAPTER II

REVIEW OF RELATED LITERATURE

Electrocardiogram Studies

Beckner and Winsor[1] studied cardiovascular adaptations to prolonged physical effort and concluded that the recognition of the acute and chronic physiologic adaptations of the cardiovascular system which occur as a result of intensive, prolonged physical exertion, is of importance because the changes which result are similar in many respects to those seen in disease.

Scherf and Schaffer[2] state that the interpretation of the electrocardiogram varies tremendously. Normal changes during exercise may be considered as being abnormal in many cases since individual investigators set up separate ranges for normalcy concerning changes which occur after exercise.

Bellet, Eliakim, Deliyiannis, and Figallo made a list of changes in the radioelectrocardiogram during strenuous exercise in normal subjects.

The following list includes "definitely abnormal" changes:

1. Ischemic (flat or downward) ST-segment depression of 1 mm

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[1] George L. Beckner and Travis Winsor, "Cardiovascular Adaptations to Prolonged Physical Effort," Circulation, IX (June, 1954), p. 835.

[2] D. Scherf and A. I. Schaffer, "The Electrocardiographic Exercise Test," American Heart Journal, XLIII (June, 1952), p. 927.

or more.

2. ST-segment elevation of 1 mm or more.

3. Inversion of a positive or reversion of a negative T wave.

4. Marked changes in the width of the QRS complex.

5. Appearance of multiple premature beats in couples or runs.

6. Frank inversion of the U wave.

The following list includes "probably abnormal" changes:

1. Ischemic ST-segment depression or T wave inversion, appearing in a few cycles.

2. Biphasic T waves.

3. Appearance of U waves of high amplitude.

4. Appearance of a few premature beats as an isolated finding.[3]

Master, Friedman, and Dack[4] reported that the changes in the electrocardiogram usually last only a few minutes, rarely more than 8 to 15, and occasionally they disappear within one minute after cessation of exercise. Within two minutes after cessation of the exercise, the blood pressure and pulse rate should return to within ten points of the resting figures. Otherwise, the exercise tolerance was considered poor or below average.

The exercise test adds much to the diagnosis of coronary artery disease, but much still needs to be done relative to:

1. More adequate standardization of the type of exercise to suit

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[3]Samuel Bellett, Marcel Eliakim, Stavros Deliyiannis, and Eduardo Figallo, "Radioelectrocardiographic Changes During Strenuous Exercise in Normal Subjects," Circulation, XXV (April, 1962), p. 686.

[4]Arthur Master, Rudolph Friedman, and Simon Dack, "The Electrocardiogram After Standard Exercise as a Functional Test of the Heart," American Heart Journal, XXIV (1942), pp. 788-799.

the individual subjects.

2. Standardization of leads and their placement.

3. Improvement of standardization of apparatus.

4. More rigid standardization of criteria for normality and abnormality.[5]

Schneider Index

The Schneider Index[6] is used widely to determine physical condition and circulatory efficiency. The test measures and scores reclining blood pressure and pulse rate, standing blood pressure and pulse rate, pulse rate immediately after exercise, and pulse rate each 30 seconds after exercise until it returns to the standing normal rate. The Schneider Index is thus a rough measure of the condition of the autonomic nervous system, the heart and the respiratory mechanism.

Skinfold and Circumference Measurement

One of the best methods of estimating body fatness involves simply measuring the thickness of skinfolds at various body sites. Body fatness can be estimated from such measurements, since about half the fat of most individuals is located under the skin in the subcutaneous area. The adipose tissue under most parts of the skin can readily be pinched between the fingers and lifted up from the muscle layer underneath.

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[5]Samuel Bellett and Otto Muller, "The Electrocardiogram During Exercise Its Value in the Diagnosis of Angina Pectoris," Circulation, XXXII (September, 1965), p. 485.

[6]E. C. Schneider, "A Cardiovascular Rating as a Measure of Physical Fatigue and Efficiency," Journal of American Medical Association, LXXIV (1920), pp. 1507-1510.

Brozek[7] concluded that fat-folds are useful measures of relative fatness.

Crook, Bennett, Norwood, and Mahaffey[8] performed skinfold measurements with a Lange skin-fold caliper and determined that the younger age groups have a lower average per cent fat, and individuals deviate less from this average.

Studies have indicated that the average desirable weight was about 20 pounds lower than the present average weight.[9]

Myhre and Kessler[10] stated that for a given body weight, fatness increases with advancing age. Such an increase in fat is said to occur with a corresponding loss of active (lean) tissue cells, which is generally accepted as a phenomenon of the physiological aging process.

Laubach[11] investigated the basic relationships between measures of body composition and physical performance items. Stature, weight, lean body mass and body surface area yielded fairly high significant zero-order correlations with measures of muscle strength but not with range

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[7]J. Brozek, "Body Compositon," Science, CXXIV (September, 1961), pp. 920-930.

[8]Guy H. Crook, Carl A. Bennett, Doggett Norwood, and Judith A. Mahaffey, "Evaluation of Skin-Fold Measurements and Weight Chart to Measure Body Fats," American Medical Association Journal, CLXXXXVIII (October, 1966), p. 160.

[9]S. L. Halpern, M. B. Glenn, and R. S. Goodhart, "New Height-Weight Tables: Importance of New Criteria," Journal of American Medical Association, CLXXIII (August, 1960), p. 1576.

[10]Loren G. Myhre and W. V. Kessler, "Body Density and Potassium 40 Measurements of Body Composition as Related to Age," Journal of Applied Physiology, XXI (July, 1966), p. 1254.

[11]Lloyd L. Laubach, "Body Composition in Relation to Muscle Strength and Range of Joint Motion," From the Anthropology Research Project, Antioch College, Yellow Springs, Ohio. Journal of Medicine and Physical Fitness, IX (1969-1970), p. 94.

of joint motion data.

Behnke, Feen, and Welham[12] studied the relationship between specific gravity and the fat content of the body. This research project helped support the concept that the comparatively low specific gravity of fat makes the measurement of specific gravity of the body mass valid for the estimation of fat content.

Tcheng and Tipton[13] undertook the anthropometric assessment of average and champion Iowa high school wrestlers in order to develop a multiple regression equation that could be used to predict a minimal wrestling weight. They concluded that the physical characteristics of both populations were markedly similar and that it was scientifically possible to predict a minimal body weight for an average Iowa high school wrestler using the anthropometrical constants derived from the finalists.

Behnke[14] developed an anthropometric method for which quantitative evaluation of body build can be made easily with no other apparatus than a tape measure. The test provides an ideal weight for each subject based on body size.

Ventilation Studies

The measurement of timed vital capacity is especially valuable

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[12] A. R. Behnke, B. C. Feen, and W. C. Welham, "The Specific Gravity of Healthy Men," Journal of the American Medical Association, CXVIII (February, 1942), p. 495.

[13] Tse-Kia Tcheng and Charles M. Tipton, "Iowa Wrestling Study: Anthropometric Measurements and the Prediction of a 'Minimal' Body Weight for High School Wrestlers," Medicine and Science in Sports, V (1973), p. 3.

[14] W. L. Taylor and A. R. Behnke, "Anthropometric Comparison of Muscular and Obese Men," Journal of Applied Physiology, XVI (1961), pp. 955-959.

in the diagnosis of conditions causing obstructive ventilatory deficiency, in particular in emphysema and bronchial spasm.

The maximum breathing capacity measure of maximal voluntary ventilation can indicate obstructive ventilatory defects in that a diminution of MBC can be caused by partial occlusion of major airways or a reduction in diameter of minute air passages due to spasm or edema.

Stuart and Collins[15] compared vital capacity and maximal breathing capacity of athletes and non-athletes and results showed the mean vital capacity score of the athletes to be significantly higher than the mean nonathlete vital capacity, but insignificant differences existed between the two groups in MBC and MBC/VC.

The vital capacity as a measure of maximal displaceable lung volume normally is directly related to the size of the individual and it is generally accepted that the main determinant is height. The force of the respiratory muscles is opposed by the elastic forces of the lung and chest wall during the performance of vital capacity. The predictable effect of age on the vital capacity is largely a result of an alteration in the balance of these forces.

Beaver and Wasserman[16] concluded that the often abrupt rise within a few seconds after the onset of exercise of the end-tidal CO_2 tension implies that the increased venous delivery of CO_2 more than outweighs the increased ventilation at the start of exercise even though the

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[15] Douglas G. Stuart and W. D. Collins, "Comparison of Vital Capacity and Maximum Breathing Capacity of Athletes and Nonathletes," Journal of Applied Physiology, XIV (1959), p. 507.

[16] William L. Beaver and Karlman Wasserman, "Transients in Ventilation at Start and End of Exercise," Journal of Applied Physiology, XXV (October, 1969), p. 398.

venous return from the exercising tissues could not yet have reached the lungs.

Respiratory oxygen utilization at resting and in exercise was investigated in various diseases by Simonson and Enger.[17]

Gray[18] states that test batteries are designed to measure the capacity of organs for normal functioning. The physiologist then compares test results to predicted norms to determine functional capacities of individuals.

Blood Pressure Studies

Whyte[19] calls for caution in accepting without question the hypothesis that hypertension is more common among the obese than among the lean and that a positive relationship exists between the level of blood pressure and the degree of obesity. Age, height, and size of the arm are thus factors that are likely to obscure the true relationship between obesity and blood pressure. The study concluded that the bigger and heavier a man is, in relation to his height, the higher will be his blood pressure. The most important consideration is the over-all bulk, be it fat or muscle.

Although the auscultatory method of estimating blood pressure when patients are at rest in the supine or sitting position has been evaluated

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[17] E. Simonson and N. Enger, "Philosophy of Muscular Exercise and Fatigue in Disease," Medicine, XXI (1942), p. 345.

[18] J. S. Gray, D. R. Barnum, H. W. Matheson, and S. N. Spies, "Ventilatory Function Tests. I. Voluntary Ventilation Capacity," Journal of Clinical Investigation, XXIX (1950), pp. 677-681.

[19] H. M. Whyte, "Blood Pressure and Obesity," Circulation, XIX (April, 1959), p. 514.

without systematic errors, there may be systematic errors of some consequence when the indirect method is used during exercise or during recovery.[20]

Loosely applied blood pressure cuffs will give high readings with a mean increase of 8.1 mm systolic and 9.3 mm diastolic due to central ballooning of the bag, which exerts the pressure-effect of a narrow cuff with effective longitudional axis shortened as well.[21]

When determining the dystolic pressure by the auscultatory method the stethoscope receiver should be applied over the artery in the antecubital space and free from contact with the cuff. The sphygmomanometer pressure should be raised rapidly and lowered slowly until a sound is heard with each heart beat.

When determining the diastolic pressure by the auscultatory method the point of complete cessation of all sound is the best index.[22]

Norris, Shock, and Yiengst[23] determined that following a tilt of 45 degrees, older subjects showed greater decrease and slower recovery of systolic pressure, while diastolic blood pressure levels remained unchanged in all groups.

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[20]Henschel Austin, Frederick De La Vega, and Henry Longstreet Taylor, "Simultaneous Direct and Indirect Blood Pressure Measurements in Man at Rest and Work," Journal of Applied Physiology, VI (February, 1954), p. 507.

[21]William F. Neussle, "The Importance of a Tight Blood Pressure Cuff," American Heart Journal, LII (December, 1956), p. 905.

[22]James Bordley, III, Charles A. R. Connor, W. F. Hamilton, William J. Kerr, and Carl J. Wiggers, "Recommendations for Human Blood Pressure Determinations by Sphygmomanometers," Circulation, XXV (October, 1951), p. 505.

[23]Arthur H. Norris, Nathan W. Shick, and Marvin J. Yiengst, "Age Changes in Heart Rate and Blood Pressure Responses to Tilting and Standardized Exercise," Circulation, VIII (October, 1953), p. 525.

Following the tilt to stationary, older subjects showed a greater decrease and slower recovery of diastolic blood pressure, while systolic blood pressures declined similarly in both young and old.

Heart Rate Studies

Raab[24] considered heart rate as one of the most reliable of all physiological variables reflecting the internal efficiency of the bodily processes in response to exercise and work.

Henry[25] saw the importance of the resting heart rate as a reflection of the physiological benefits that result from training.

Taylor[26] stated that exercise heart rate is a better indicator of fitness than recovery heart rate.

Astrand, Astrand, and Rodahl[27] felt that a decrease in maximal heart rate with age would be expected to cause a reduction in the aerobic work capacity, since a compensatory increase in stroke volume during exercise is unlikely.

LeBlanc[28] reported that there is a correlation between pulse rate

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[24] W. Raab, P. de Paula E. Silva, and Y. K. Starcheska, "Adrenergic and Cholinergic Influences on the Dynamic Cycle of the Normal Heart," Cardiologia, XXXIII (1958), p. 350.

[25] F. M. Henry, "The Influence of Athletic Training on the Resting Cardiovascular System," The Research Quarterly, XXV (1954), pp. 38-41.

[26] C. Taylor, "Some Properties of Maximal and Submaximal Exercise with Reference to Psychological Variation and the Measurement of Exercise Tolerance," American Journal of Physiology, CXLII (1944), pp. 200-212.

[27] Irma Astrand, Per-Olof Astrand, and Kaare Rodahl, "Maximal Heart Rate During Work in Older Men," Journal of Applied Physiology, XIV (1955), p. 565.

[28] J. A. LeBlanc, "Use of Heart Rate as an Index of Work Output," Journal of Applied Physiology, X (March, 1957), p. 280.

and level of activity.

Wyndham, Strydom, Maritz, Morrison, Peter, and Potgieter,[29] in their study of maximum oxygen intake and maximum heart rate during strenuous work, stated that after the maximum heart rate is reached, the O_2 intake continues to rise. This is due to the small amount of oxygen that can be obtained from the circulatory minute-volume of blood after the maximum cardiac output is obtained.

Astrand and Saltin[30] studied maximal oxygen uptake and heart rate in various types of muscular activity. The two researchers concluded that in maximum work with the arms the heart rate was higher than predicted from the oxygen uptake.

Sheffield, Holt, and Reeves[31] feel that the general effect of physical training is on decreasing the heart rate, not only at rest, but also at any given level of exercise. The maximal heart rate possible is not materially affected by training, but the level of effort to produce it is increased. Lack of regular physical activity tends to have the opposite effect.

Treadmill Studies

Erickson, Simonson, Taylor, Alexander, and Keys suggest that except

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[29] C. H. Wyndham, N. B. Strydom, J. S. Maritz, J. F. Morrison, J. Peter, and Z. U. Potgieter, "Maximum Oxygen Intake and Maximum Heart Rate During Strenuous Work," Journal of Applied Physiology, XIV (1959), p. 934.

[30] Per-Olof Astrand and Bengt Saltin, "Maximal Oxygen Uptake and Heart Rate in Various Types of Muscular Activity," Journal of Applied Physiology, XVI (1961), p. 979.

[31] L. T. Sheffield, John H. Holt, and Joseph T. Reeves, "Exercise Graded by Heart Rate in Electrocardiographic Testing for Angina Pectoris," Circulation, XXXII (October, 1965), p. 623.

for the cost and portability factors, the treadmill is preferable to the bicycle ergometer with the main differences as follows:

1. The work load on the treadmill is fixed without any requirement for the subject to keep time as is the case with the bicycle ergometer.

2. Skill and apparatus-training factors are minimal on the treadmill since everyone knows how to walk.

3. A larger total energy expenditure is obtainable with the treadmill.

4. The work load is automatically adjusted to the body size on the treadmill.

5. Since walking is generally a social and occupational necessity, the treadmill provides a ready basis for evaluation of the handicaps of many injuries and diseases.[32]

Taylor[33] suggests that all tests should eliminate factors of motivation and skill. A submaximal test should not exceed the limits of the poorest subject with respect to duration and intensity. A maximal test, however, should require all subjects to reach a comparable state of exhaustion.

Reeves, Grover, Blount, and Filley[34] studied cardiac output

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[32] Lester Erickson, Ernst Simonson, Henry Longstreet Taylor, Howard Alexander, and Ancel Keys, "The Energy Cost of Horizontal and Grade Walking on the Motor-Driven Treadmill," American Journal of Physiology, CXLV (March, 1946), p. 391.

[33] C. Taylor, "Studies in Exercise Physiology," American Journal of Physiology, CXXXV (1941), pp. 27-42.

[34] John T. Reeves, Robert F. Grover, Gilbert S. Blount, Jr., and Giles F. Filley, "Cardiac Output Response to Standing and Treadmill Walking," Journal of Applied Physiology, XVI (1961), p. 287.

response to standing and treadmill walking. This investigation led them to the conclusion that it is apparent that the peripheral and central mechanisms of oxygen transport differ greatly in the standing and supine resting subject. The circulatory reserves which can be called into play as the resting individual begins to exercise are also different in the supine and upright positions.

Nagle and Bedecki[35] studied the relationship between the 180 heart rate per minute to signs of physiological fatigue. The results of their study produced a +.85 correlation between heart rate times and all out run times for 44 subjects. They concluded that the 180 beats per minute heart rate would serve as a valid cut-off point of reference in measuring aerobic work capacity.

Balke and Ware studied physical work capacity in their investigation using the treadmill and concluded the following:

1. High diastolic blood pressure of 100 mm Hg and above usually designates low levels of work capacity.

2. Factors such as age, weight, personal habits, and levels of activity have some effect on the work capacity of subjects.

3. A high level of capacity for aerobic work can be maintained as one ages.

4. Overweight individuals had a lower work capacity on the average.

5. Eighty-two per cent of the subjects in the study were rated below the "good" category.

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[35] F. J. Nagle and T. B. Bedecki, "Use of 180 Heart Rate Response as a Measure of Circulatory Capacity," The Research Quarterly, XXXIV (1963), pp. 361-369.

6. Smokers displayed less functional reserves than non-smokers after age 30.[36]

The Balke Treadmill Test[37] is one of the most widely accepted tests to determine work capacity or maximal oxygen intake.

Hermansen and Saltin[38] investigated the question concerning whether or not the same values for oxygen uptake can be obtained during maximal bicycle and treadmill exercise, with two standard procedures for attaining maximal values in the two types of work.

Results showed that oxygen uptake on the treadmill run uphill was 0.28 liter/min. higher than on the bicycle (50 rpm). Individual variation was great and the difference in oxygen uptake between treadmill and bicycle varied from +18.7% to -3.9%.

An equation to predict O_2 consumption for subjects walking on the treadmill was developed by Workman and Armstrong.[39] The height and weight of the subject was combined with the speed and the grade of the treadmill in order to make the prediction.

Cooper, Gey, and Bollenberg reported that during treadmill studies, smokers had a decrease in respiratory minute volume and a lower O_2

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[36]B. Balke and C. W. Ware, "An Experimental Study of 'Physical Fitness' of Air Force Personnel," U.S. Armed Forces Medical Journal, XIX (1959), pp. 675-683.

[37]Lars Hermansen and Bengt Saltin, "Oxygen Uptake During Maximal Treadmill and Bicycle Exercise," Journal of Applied Physiology, XXVI (January, 1969), p. 36.

[38]J. M. Workman and B. W. Armstrong, "A Nomogram for Predicting Treadmill-Walking O_2 Consumption," Journal of Applied Physiology, XIX (1964), pp. 150-151.

[39]K. H. Cooper, G. O. Gey, and R. A. Bollenberg, "Effects of Smoking on Endurance Performance," Journal of American Medical Association, CCIII (1968), p. 123.

consumption at equivalent heart rates than those not smoking.[40]

Cooper[41] correlated the field and treadmill tests and determined that the laboratory testing method was best if the cost and time expenditures were not factors.

Cooper related the per cent of grade at which time the heart rate reached 180 beats per minute to the Balke Chart and the maximum oxygen intake is charted with reference to fitness levels. Oxygen consumption in ml/kg/min as determined by the Balke Chart is then related to the fitness category chart of Dr. Cooper's book on page 28.[42]

Cardiovascular Fitness

Kraus and Raab[43] developed the thesis of hypokinetic disease in which mention is made of several diseases that may be caused by lack of exercise which are both neuromuscular and circulatory-respiratory in nature. Kraus and Raab concluded that coronary heart disease is twice as frequent in the sedentary as in the active.

Fox and Skinner[44] believe considerable evidence exists to indicate that physical inactivity is a risk factor in the occurrence of coronary heart disease.

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[40] B. Balke and R. T. Clark, "Cardio-Pulmonary and Metabolic Effects of Physical Training," Health and Fitness in the Modern World (Chicago, 1961), pp. 82-89.

[41] K. H. Cooper, "A Means of Assessing Maximal O_2 Intake," Journal of American Medical Association, CCIII (1968), p. 123.

[42] Cooper, 1970, p. 28.

[43] H. Kraus and W. Raab, Hypokinetic Disease (Springfield, Illinois, 1961), p. 193.

[44] S. Fox and J. S. Skinner, "Physical Activity and Cardiovascular Health," American Journal of Cardiology, XIV (1964), pp. 731-736.

Boyer and Kasch[45] indicate that persons with high blood pressure may lower this condition significantly through supervised exercise programs.

Effect of Training

Physical activity is needed in our society in order to help delay the physiological deterioration of aging, and fitness programs for adults are the outgrowth of such a need.

Hudder[46] concluded that an aerobic training period of 16 weeks in which the subjects earned 30 points per week on Cooper's aerobic point scale was sufficient to increase or maintain fitness at the good level.

Douglas and Becklake[47] found that after training, subjects performed any prescribed work load with less cardiac output and minute ventilation, less of an increase in heart rate, and there was less stress placed on the respiratory and circulatory systems.

Sharkey and Hollerman[48] felt that during intense activity training there will be more improvement than at lower levels of activity. An exercise program that raises the heart rate to 180 beats per minute will develop the training effect more efficiently than an exercise program

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[45] J. L. Boyer and F. W. Kasch, "Exercise Therapy in Hypertensive Men," Journal of the American Medical Association, CCXI (1970), pp. 1668-1671.

[46] G. D. Hudder, "The Effect of Participation in an Aerobic Training Program for Selected Men Over Age 25," (Ed.D. Thesis, Higher Education, Oklahoma State University, 1970), p. 3.

[47] F. G. V. Douglas and M. R. Becklake, "Effect of Seasonal Training on Maximal Cardiac Output," Journal of Applied Physiology, XXV (1968), p. 602.

[48] B. J. Sharkey and J. P. Holleman, "Cardiorespiratory Adaptations to Training at Specified Intensities," The Research Quarterly, XXXVIII (1967), pp. 698-704.

that raises the heart rate to only 120 to 150 beats per minute.

Cooper refers to training effects when discussing a variety of exercises that stimulate heart, blood and lung activity for a time period sufficient enough to produce changes beneficial to the body.[49]

Summary

In summary, the literature points to a need for additional research in aerobic fitness programs.

Cooper has made adjustments in his early point system and research can help determine whether the proposed 30 points a week are realistic or even over demanding with wasted effort.

It may be possible to elevate one's aerobic fitness to the good level, as indicated by Cooper, in fewer weeks than the 16 stressed by Cooper.[50]

Ribisl and Kachadorian feel that a longer run is needed to replace the 600-yard-run-walk test utilized by many physical education instructors in recent years. A more valid predictor of aerobic capacity would be the two-mile run. Such an extended run would force the runners to utilize their anaerobic processes rather than aerobic processes. Unlike a longer race, motivation would not become a factor in the performance of this test of aerobic capacity.[51].

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[49]Cooper, 1970, p. 16.

[50]Cooper, 1970, p. 51.

[51]Paul M. Ribisl and William A. Kachadorian, "Maximal O_2 Intake Prediction in Young and Middle-Aged Males," Journal of Sports Medicine, IX (1969), p. 20.

Additional emphasis upon research in this area would lend insight for the unanswered questions pertaining to the aerobic program best suited for universal acceptance.

CHAPTER III

METHOD AND PROCEDURE

The purpose of this study was to appraise the effects of participating in an aerobic training program over a two-year period by male faculty members and administrators at Oklahoma State University. The methods and procedures of the study are listed in this chapter.

Selection of Subjects

Eighty-five male subjects participated in this physiological investigation. Sixty-five men were re-test subjects with 20 subjects being tested for the first time. All of the subjects were volunteers from the Oklahoma State University faculty and administration.

The subjects ranged in age from 22 to 62 years. The physiological characteristics of the subjects ranged widely. The subjects varied in weight, height, age, level of fitness, and anthropometric measures.

Subjects in this study were involved in a fitness evaluation program during the 1972-1973 and 1973-1974 school years. During this period of time each subject recorded his weekly exercise pattern on a fitness evaluation form to be presented at the time of the evaluation. The evaluation took place in the physiology lab located in the Colvin Physical Education Center at a date convenient for both parties. Evaluations were thus given throughout the school year to collect data for the fitness evaluation program. The group of 85 subjects contains data collected for the 72-73 school year while the members of the 65 subject group contains data collected for the 72-73 and 73-74 school years, thus providing a base for making yearly comparisons.

Personal Data Collected

Each subject was interviewed to collect information concerning medical history, home address, phone, department, building, room, extension, age, physician, town, last medical examination data, contra-indications, smoking history, and activity patterns.

Apparatus and Equipment

The essential pieces of equipment used for this study were the Physiograph, Quinton motorized treadmill, Collins Respirometer, Tissot tank, Birtcher Electrocardiograph, sphygmomanometer, stethoscope, scales, stop watch, Lange skinfold fat calipers, Lufkin anthropometric tape, Texas Instruments calculator, and telemetry system.

Testing Procedure

Each individual dressed in tennis shoes and gym suit before entering the testing laboratory. Lab technicians then collected the personal data on the subject after an informed consent form was signed (see Appendix E).

The actual testing procedure was as follows. Upon arrival to the laboratory the individual was asked to remove his shirt and lie down on a padded bench near the Birtcher Electrocardiograph machine. Redux creme was placed on plate electrodes and attached to the subject's ankles and wrists with rubber straps. The subject was asked to lie quietly as the laboratory technician recorded a three standard lead EKG. The surface electrodes were then removed and all excess redux creme was cleaned from the subject's wrists and ankles.

The telemetry electrodes were then placed on the subject. The skin in the area of the electrodes was cleaned with an alcohol pad to help assure the bond between the electrode and the subject's skin. The surface electrodes were held in place by double-sided adhesive washers. The washers were placed on the electrode and the middle cup area was filled with redux creme which is a conductive element designed to assure the electrical contact between the electrode disc and body surface. The surface electrodes were then placed on the subject in the V-5 position with one electrode being placed over the sternum and one electrode being placed below and to the left of the left nipple.

The telemetry transmitter was readied by inserting the two batteries and placing a double-sized adhesive washer to the transmitter and placing it on the sternum approximately in the middle of the vertical axis. The electrodes were then plugged into the battery transmitter and the loose wires taped to the body to prevent excessive movement.

The telemetry receiver was tuned for proper reception. The signal was tested for clarity and the receiver was connected to the physiograph.

The blood pressure cuff was attached to the subject's arm and recordings made of lying blood pressure and heart rate as well as standing blood pressure and heart rate.

The subject was asked to step up and down on a 17 inch stool five times at a moderate pace. The post-exercise heart rate was recorded and rated by using the Schneider Index form (see Appendix B). All records were placed on the summary sheet (see Appendix A).

Height and weight measurements were then taken on the Fairbanks-Morse scale and results recorded on the summary sheet.

The subject was then tested for skinfold fat thickness with the use of the Lange skinfold calipers. Measurements were taken on the arm, chest, back, and abdomen. Per cent body fat was estimated by use of the Best Body Composition Nomogram utilizing the arm, chest, and abdominal measurements (see Appendix C).

Eleven body diameters of the subject were then measured with the use of a tape measure. Measurements were recorded from the shoulders, chest, abdomen, buttocks, right and left upper arm, right and left fore-arm, right and left wrist, right and left thigh, right and left knee, right and left calf, and right and left ankle. A predicted weight based on the Behnke formula was calculated from these measures (see Appendix D). The weight residual was then obtained by subtracting the Behnke predicted score from the actual weight of the subject.

Pulmonary function and closed circuit oxygen uptake were then measured on the Collins Respirometer. Tests included minute ventilation breathing, oxygen uptake, inspiratory capacity, expiratory reserve, vital capacity, and timed vital capacity. The results of all tests were calculated according to formulas provided by the Collins Respirometer Company.[1]

Maximum breathing capacity was recorded with a Collins 120 liter Tissot tank. The subject was asked to hyperventilate air into the tank in large forceful breaths for 15 seconds. The subject was given two

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[1]Warren E. Collins, Inc., <u>Clinical Spirometry</u> (Braintree, Mass., 1967).

trials with the best trial being used for calculation purposes. Maximum breathing capacity was then recorded and calculated from this sample and results of the computations recorded on the summary sheet.

The subject then was asked to step onto the treadmill for the treadmill walk. Safety precautions were given to insure against accidents. The test was an uphill walk at a constant speed of 3.5 miles per hour. The slope or grade at which the test was begun was level, 0%. The treadmill grade was increased one per cent each minute until the subject's heart rate reached 180 beats per minute or other signs appeared indicating that the test should be terminated. The subject was asked to terminate the treadmill walk if any irregularities were produced in the EKG in the form of arrythmias or S-T depression. The subject could step down from the treadmill before his heart reached 180 beats per minute in the case of voluntary exhaustion. The 180 heart rate was determined by the physiograph reading which was maintained throughout the walk and monitored during the last 15 seconds of each minute at each grade. When the heart rate reached 180, the subject was asked to step down and lie down on the table near the physiograph. The blood pressure cuff was placed on the individual's arm and records of the heart rate and blood pressure were taken each minute until five minutes had elapsed. The subject then went to the shower room while the results of all tests were analyzed and results recorded.

Upon return to the lab the results were explained to the subject and aerobic point charts were collected to analyze the individual's activity pattern.

Figuring Results

A summary sheet for all data was used to display the total data results. The procedure for figuring the results for each test was as follows:

Electrocardiogram - The EKG record tape was taken directly from the Birtcher EKG and measured with the use of the EKG ruler. The EKG measures included the amplitude of the T Wave, amplitude of the P Wave, amplitude of the R Wave, rest time, and the rest-work ratio.

Heart Rate and Blood Pressure - These readings were taken directly from the pen markings on the physiograph.

Fitness Rating - The fitness rating was calculated by referring the oxygen consumption in ml/kg/min as determined by the treadmill walk to Cooper's age adjusted scale (see Appendix G).

Treadmill - The results of the treadmill walk were analyzed with the use of the Balke Treadmill Chart which converts the walk time in minutes to maximum oxygen intake in ml/kg/min. The Balke Chart also converts the walk time on the treadmill into a fitness rating for each subject (see Appendix F).

Cooper Fitness Scale - The oxygen consumption in ml/kg/min was analyzed with reference to age by using Cooper's Fitness Scale[2] and placing each subject in a fitness category (see Appendix G).

Treatment of Data

The program for the statistical analysis of the data collected in this study was run at the Oklahoma State University Computer Center.

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[2]Cooper, 1970, p. 28.

The statistical treatment was organized to analyze the data as presented in separate categories listed as objectives.

Objective 1. Objective one in the statistical analysis was to measure the means and standard deviations of a list of variables in the study contrasting year one and year two in an attempt to ascertain if change had occurred. A paired comparison test was used to analyze the change. Analysis of variance was used to determine if there were any differences between years on the selected variables. The "F" test was used to determine if there were any significant differences between years at the .01 and .05 per cent level on the selected variables. Objective one concerned only the 65 re-test subjects in the study.

Objective 2. Objective two in the statistical analysis was to calculate product moment correlations to determine the relationship of each subject's aerobic points per week and a selected list of variables in this study. Objective two involved all 85 subjects participating in the second year of the study.

Objective 3. Objective three of the investigation reported in this paper was to determine which activity was more advantageous in producing or changing fitness. The subjects were grouped in three separate segments composed of joggers, racquetball players, and other activities. Analysis of variance was used to determine if there were any differences between groups on the selected variables. The "t" test was used to determine if there were any significant differences between groups at the .01 and .05 per cent level on the selected variables.

Objective 4. Objective four in the statistical analysis was to calculate analysis of covariance to examine whether the linear regressions of aerobic points gained per week are the same on a selected list of variables in this study. The "F" test was used to determine if there were any significant differences between years at the .01 and .05 per cent level on the selected variables. Objective four concerned only the 65 re-test subjects in the study.

CHAPTER IV

RESULTS

The purpose of the investigation reported in this paper was to appraise the effects of participating in an aerobic training program over a two-year period by male faculty members and administration at Oklahoma State University. The results of the study are herein recorded.

The complete statistical analysis was undertaken at the Oklahoma State University Computer Center under the direction of Dr. Robert Morrison.

Since the names of all variables were abbreviated prior to being programmed into the computer, it is necessary to define all such abbreviated variables before explanation is undertaken concerning each statistical objective. Table I is a list of all abbreviated variables with a full explanation of the abbreviation.

TABLE I

EXPLANATION OF ABBREVIATIONS

Abbreviation	Definition
Wt	Weight
BSA	Body surface area
Day-Wk	Days per week that subject exercises

TABLE I (CONTINUED)

Abbreviation	Definition
Tim-Ses	Amount of time spent during each daily exercise session
Aero-Wk	Aerobic points gained per week
Mo-Pat	Number of months on exercise pattern
Scn-Indx	Schneider Index Score
Puls-Lyn	Pulse lying
Puls-Stn	Pulse standing
BPL-S	Blood pressure lying systolic
BPL-D	Blood pressure lying diastolic
BPS-S	Blood pressure standing systolic
BPS-D	Blood pressure standing diastolic
O_2-In	Oxygen intake
Min-Vent	Minute ventilation
V-Eq	Ventilation equivalent
TVC	Timed vital capacity
VC	Vital capacity
Pct-VC	Per cent of predicted vital capacity
MBC	Maximum breathing capacity
Pct-MBC	Per cent of predicted maximum breathing capacity
Pul-Rate	Pulse rate as seen in the EKG
Amp-P	Amplitude of P wave as seen in the EKG
Amp-R	Amplitude of the R wave as seen in the EKG
Amp-T	Amplitude of the T wave as seen in the EKG
Re-Work	Rest work ratio from EKG
Behnke	Behnke optimal predicted weight

TABLE I (CONTINUED)

Abbreviation	Definition
Wt-Res	Weight residual
Arm Fat	Arm fat
Chest Fat	Chest fat
Gut Fat	Abdomen fat
Back Fat	Subscapular fat
Pct-Fat	Per cent fat
SP-Gr	Specific gravity
Pct-180	Per cent of treadmill grade at 180 heart rate
Ml-Kg	Milliliters per kilogram
Hr-Rec-5	Heart rate after five minutes recovery from treadmill walk
Syst-5	Systolic blood pressure after five minutes recovery from treadmill walk
Dias-5	Diastolic blood pressure after five minutes recovery from treadmill walk

Objective one in the statistical analysis was to measure the means and standard deviations of a list of variables in the study contrasting year one and year two in an attempt to ascertain if change had occurred. A paired comparison test was used to analyze the change. The results of the "F" test applied to each variable for both years are shown in Table II.

TABLE II

SUMMARY OF YEAR ONE - YEAR TWO DATA ON PAIRED COMPARISON TEST (N=65)

Variable		Year 1 Mean	Year 2 Mean	Difference	SD	Significance Level
Wt	(lbs)	179.323	178.677	.646	4.37	
BSA	(Sq.M)	2.016	1.989	.027	.60	
Day-Wk	(Days)	2.476	3.108	.632	1.37	.05
Tim-Ses	(Min)	18.185	36.477	18.292	23.11	.01
Aero-Wk	(Pts)	17.831	22.339	4.508	10.21	.05
Sch-Indx	(Pts)	13.108	13.369	.262	1.94	
Puls-Lyn	(BPM)	66.477	64.369	2.108	6.47	
Puls-Stn	(BPM)	77.815	74.985	2.83	7.56	.05
BPL-S	(mm hg)	123.923	124.938	1.015	7.58	
BPL-D	(mm hg)	75.338	75.631	.293	6.69	
BPS-S	(mm hg)	126.738	128.815	2.077	8.15	
BPS-D	(mm ng)	79.754	82.407	2.653	6.94	
O_2-In	(ml/kg/min)	36.613	37.428	.815	6.78	
MIN-VENT	($L/min/m^2$)	5.504	5.440	.064	1.21	
V-EQ		3.029	2.975	.054	.84	
TVC	(% in 1 sec)	79.369	81.846	2.477	4.93	.01
VC	(L)	4.861	4.984	.123	.22	.01
PCT-VC	(%)	118.262	122.276	4.014	7.26	.01
MBC	(L/min)	161.916	162.322	.406	16.03	
PCT-MBC	(%)	126.523	126.569	.046	12.21	
PUL-RATE	(EKG)	69.800	67.385	2.415	7.86	
AMP-R	(mm)	10.915	10.826	.089	1.72	

TABLE II (CONTINUED)

Variable	Year 1 Mean	Year 2 Mean	Difference	SD	Significance Level
AMP-T (mm)	3.026	2.843	.183	.68	
RE-WORK (EKG)	2.024	2.196	.172	.28	.01
PRED-WT (lbs)	169.445	168.862	.583	5.41	
WT-RES (lbs)	9.538	9.462	.076	3.19	
ARM FAT (mm)	11.585	11.138	.447	2.05	
CHEST FAT (mm)	13.415	14.431	1.016	2.69	
ABDOMINAL FAT(mm)	17.831	17.631	.2	3.71	
SUBSCAPULAR FAT (mm)	16.523	21.415	4.892	3.86	.01
PCT-FAT (%)	11.862	11.308	.554	1.95	
SP-GR	1.075	1.076	.001	.14	
PCT-180 (min)	16.631	17.082	.431	1.80	
Hr-Rec-5 (min)	86.677	91.622	4.945	18.99	
Syst-5-Rec(mm Hg)	119.246	131.646	12.4	29.53	.05
Dias-5-Rec(mm Hg)	62.215	76.923	14.708	16.85	.01

$^{x}P < .01$

$^{xx}P < .05$

There was a significant increase from 18.18 minutes to 36.47 minutes ($P < .01$) in the time spent exercising during each session. There was also a significant increase from 2.47 to 3.10 ($P < .05$) in the number of days spent exercising per week. A similarly significant increase from 17.83 to 22.33 ($P < .05$) existed in the number of aerobic points gained per week.

There was a significant decrease from 77.81 to 74.98 ($P < .05$) in standing pulse; however, the lying pulse differential did not prove to be significantly changed.

The heart rate is a valuable predictor of cardiovascular fitness. Medical literature generally cites 72 as the average heart rate for adult men. The subjects in this study had a lower average heart rate than either listed as normal thus indicating higher fitness.

The blood pressure is not as valuable in predicting cardiovascular fitness but may also be lowered by aerobic training.

There was a significant increase from 79.36 to 81.84 ($P < .01$) in timed vital capacity, from 4.86 to 4.98 ($P < .01$) in vital capacity, and from 118.26 to 122.27 ($P < .01$) in per cent of predicted vital capacity. A significant difference was not seen in resting O_2 intake, minute ventilation, and maximum breathing capacity. A significant favorable change in vital capacity measures is observed in all single breath functions as indicated by vital capacity and timed vital capacity, while multiple breath functions do not seem to be affected.

There was a significant increase from 2.02 to 2.19 ($P < .01$) in rest-work ratio. This indicates that the heart is resting longer in proportion to the time it is working and is indicative of a favorable relationship. While there was no significant difference observable in the pulse rate, the decrease of 2.4 beats per minute coordinated with the decrease in the pulse rate as seen on the physiograph would be indicative of function. There was no significant difference observable in the amplitude of the R wave in the EKG or the T wave in the EKG.

There was a significant increase from 16.52 to 21.41 ($P < .01$) in subscapular fat; however, triceps fat, chest fat, abdominal fat and per cent body fat did not change significantly. No significant difference was observed in the Behnke predicted weight, weight residual and specific gravity. The per cent body fat calculation does not include the subscapular fat measure. The body fat is thus seen to be shifting from the upper body and arms to the back region. This may be due to lack of adequate exercise for this body region. Exercising with the arms may produce more muscle to replace fatty tissue. The previously collected data concerning body fat in studies conducted at the Oklahoma State University physiology lab would place the study group mean per cent body fat readings in a lower than average rating for such a group. It is apparent that while the Best nomogram for predicting body fat may be valid for young men it is not so for the present older study age group. Data from other studies at Oklahoma State University indicate that this nomogram predicts approximately eight per cent lower than readings for adult males in older age groups such as involved in this study. The higher readings were obtained by the underwater weighing method.

Subjects walked an average of 10-17 minutes on the treadmill giving them a predicted O_2 intake of 37.021 ml/kg/min indicating an average fitness rating on the Balke score sheet.

There was an increase in the time spent exercising and the number of aerobic points gained per week with no corresponding increase in O_2 capacity. Dr. Cooper[1] states the need to gain 30 aerobic points per

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[1] Cooper, 1970, p. 19.

week to create a gain in cardiovascular fitness and this bears this out. Twenty-two points per week is not enough to make a gain in aerobic capacity. Twenty-two points per week would be enough to maintain present levels of fitness.

There was a significant increase from 119.26 to 131.64 ($P < .05$) in the systolic blood pressure after five minutes recovery from the treadmill walk. There was a significant increase from 62.21 to 79.93 ($P < .01$) in the diastolic blood pressure after five minutes recovery from the treadmill walk. There was little difference between recovery and pre-exercise blood pressure and no real significance can be attached to such readings. The heart rate after five minutes recovery and per cent of treadmill grade at 180 did not have any significant change.

Objective two in the statistical analysis was to calculate product moment correlations to determine the relationship of each subject's aerobic points per week and a selected list of variables in the study. Table III presents the correlations between aerobic points and the various variables for the 85 second year program participants.

TABLE III

CORRELATIONS

Criterion Value	Variables	r's
Aerobic points per week	O_2-In	.120
Aerobic points per week	Sch-Indx	.187
Aerobic points per week	MBC	.089
Aerobic points per week	Puls-Lyn	-.190

TABLE III (CONTINUED)

Criterion Value	Variables	r's
Aerobic points per week	Amp-T	$.244^{xx}$
Aerobic points per week	Amp-R	.089
Aerobic points per week	Re-Work	.113
Aerobic points per week	Wt-Res	$-.239^{xx}$
Aerobic points per week	Pct-Fat	$-.245^{xx}$
Aerobic points per week	BPL-S	-.035
Aerobic points per week	Hr-Rec-5	$-.100^{x}$
Aerobic points per week	Syst-5	.014

$^{x}P < .01$

$^{xx}P < .05$

Table IV presents the mean, standard deviation, minimum value, and maximum value for each of the variables concerned with objective two.

TABLE IV

SUMMARY OF MEAN, STANDARD DEVIATION, MINIMUM VALUE, AND MAXIMUM VALUE

Variable	N	Mean	SD	Minimum Value	Maximum Value
O_2-In	85	32.776	6.549	19.000	55.000
Sch-Indx	85	13.376	3.535	1.000	20.000
MBC	85	159.908	30.113	77.030	231.000

TABLE IV (CONTINUED)

Variable	N	Mean	SD	Minimum Value	Maximum Value
Puls-Lyn	85	64.176	10.668	45.000	96.000
Amp-T	85	2.871	1.014	1.000	5.500
Amp-R	85	10.767	4.191	1.500	22.000
Re-Work	85	1.892	.395	.500	2.800
Wt-Res	85	9.965	4.936	.000	22.000
Pct-Fat	85	11.424	4.799	3.000	22.000
BPL-S	85	124.659	13.589	105.000	170.000
Hr-Rec-5	85	92.071	10.072	50.000	120.000
Syst-5	85	131.859	14.248	100.000	170.000
Aero-Wk	85	21.435	15.039	.000	77.000

There was a significant relationship ($P < .05$) between aerobic points per week and amplitude of the T wave in the EKG, weight residual, and per cent body fat. While these correlations are relatively low, they do show some indication that those having more exercise and gaining more aerobic points per week will increase the amplitude of the T wave, lower their weight residual, and lower their per cent body fat reading, indicating a favorable change. Cureton[2] has engaged in extensive research to substantiate the fact that exercise will increase fitness and the previously mentioned findings support such research.

[2]Thomas K. Cureton, Jr., Physical Fitness of Champion Athletes, (Urbana, Illinois, 1951), p. 253.

There was no significant relationship ($P < .01$) or ($P < .05$) between aerobic points and any other variable. This may be attributed to the fact that 12 of the 14 individuals in the study that recorded zero aerobic points also recorded a score of at least 35 ml/kg/min of O_2 on the treadmill walk and were rated in the fair fitness category on the maximum oxygen intake nomogram. Eight of these individuals scored in the good fitness rating with a score of 40 ml/kg/min of O_2. One subject scored in the very good fitness category and the top individual rated in the excellent fitness category. Such high O_2 intake scores by individuals recording no aerobic points, supports the possibility of O_2 intake capacity as being an inherited physiological characteristic as supported by Cureton.[3] If this is true, the individual that has inherited a large O_2 intake capacity would score high in this reading even though he does not gain the required number of aerobic points per week. On the other hand, some individuals, gaining large amounts of aerobic points may score lower in the area of O_2 intake due to a lower inherited capacity.

The weight residual of the individuals recording no aerobic points was two pounds higher than the mean score of the individuals in the study gaining 30 or more aerobic points per week. This points to the beneficial effects of gaining a minimum of 30 aerobic points per week in maintaining a desirable weight residual score. It would seem that there should be a greater difference than two pounds between these two groups; however, it is likely that there were some extremely lean individuals that recorded no aerobic points per week as well as some

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[3]Thomas K. Cureton, "Interpretation of the Oxygen Intake Test. What is It?" American Corrective Therapy Journal, XXVII (1973), pp. 17-23.

extremely overweight individuals that scored a large number of aerobic points per week.

Table V presents an intercorrelation matrix of variables to show the relationships between all of the variables concerned with objective two.

A coefficient of correlation of .450 was found between rest work ratio and Schneider Index. This was significant at the .01 level of confidence. This is a favorable correlation indicating that as rest work ratio goes up the Schneider Index increases. Both scores are an index of cardiovascular fitness.

A coefficient of correlation of .561 was found between the per cent body fat and weight residual. This was significant at the .01 level of confidence. This indicates that the more fit individual will have a lower weight residual as well as a lower per cent body fat reading.

A coefficient of correlation of .327 was found between lying systolic blood pressure and lying pulse. This was significant at the .01 level of confidence. This correlation indicates that as resting systolic blood pressure falls, the pulse rate also falls, which is a normal relationship. Those individuals that are more fit have lower pulse rates and lower blood pressure.

A coefficient of correlation of .396 was found between the heart rate after five minutes of recovery from the treadmill walk and lying pulse. This was significant at the .01 level of confidence. This correlation indicates that individuals with higher resting heart rates will also have higher recovery heart rates.

A coefficient of correlation of .233 was found between the heart

TABLE V

INTERCORRELATION MATRIX OF VARIABLES

		1	2	3	4	5	6	7	8	9	10	11	12	13
O_2-In	1 –	1.000												
Sch-Indx	2 –	$-.286^{x}$	1.000											
MBC	3 –	–.014	–.039	1.000										
Puls-Lyn	4 –	$.233^{xx}$	$-.767^{x}$	–.097	1.000									
Amp-T	5 –	–.127	.151	.187	–.178	1.000								
Amp-R	6 –	.095	$-.341^{x}$	.016	$.391^{x}$	.100	1.000							
Re-Work	7 –	.046	$.450^{x}$	.029	$-.487^{x}$	.146	–.150	1.000						
Wt-Res	8 –	.104	–.046	–.087	.100	–.184	–.112	–.008	1.000					
Pct-Fat	9 –	.022	–.106	–.077	.015	–.090	–.090	–.101	$.561^{x}$	1.000				
BPL-S	10 –	.083	$-.213^{xx}$	.018	$.327^{x}$	–.058	.148	–.153	.121	.036	1.000			
Hr-Rec-5	11 –	.029	$-.353^{x}$	.017	$.396^{x}$	–.056	$.233^{xx}$	$-.229^{xx}$	.098	–.027	.083	1.000		
Syst-5	12 –	.116	–.209	–.105	.193	.081	.153	$-.233^{xx}$	.121	.156	$.590^{x}$	$.244^{xx}$	1.000	
Aero-Wk	13 –	–.102	.188	.090	–.190	$.225^{xx}$	.089	.114	$-.239^{xx}$	$-.245^{xx}$	–.035	–.100	.015	1.000

$^{x}P < .01$

$^{xx}P < .05$

rate after five minutes of recovery from the treadmill walk and the amplitude of the R wave. This was significant at the .05 level of confidence. This correlation indicated the R wave amplitude may not be a good measure of fitness.

A coefficient of correlation of .391 was found between the amplitude of the R wave and lying pulse. This was significant at the .01 level of confidence. This correlation indicates that the R wave amplitude may not be a good measure of fitness. If it was a measure of fitness as some suspect the lying pulse should be lower with a higher R wave amplitude. Cureton[4] feels that the R and T wave amplitudes are of some value for indicating the circulatory fitness of subjects.

A coefficient of correlation of .233 was found between lying pulse and O_2 intake. This was significant at the .05 level of confidence. This correlation is opposite of the desired relationship between the two variables where O_2 intake rises as the lying pulse decreases.

A coefficient of correlation of .590 was found between systolic blood pressure after five minutes recovery from the treadmill walk and lying systolic blood pressure. This was significant at the .01 level of confidence. This is a normal relationship meaning that the higher the blood pressure before exercise, the higher it will be after exercise.

A coefficient of correlation of .244 was found between systolic blood pressure after five minutes of recovery from the treadmill walk and heart rate after five minutes recovery from the treadmill walk. This was significant at the .05 level of confidence. This correlation would be expected since both heart rate and systolic blood pressure

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[4]Cureton, 1951, p. 151.

would be elevated after exercise.

A coefficient of correlation of .255 was found between aerobic points per week and amplitude of the T wave. This was significant at the .05 level of confidence. This would seem predictable that the more aerobic points an individual gained, the higher the T wave would become, thus pointing to the T wave as a possible good indicator of fitness.

A negative correlation of -.286, significant at the .01 level of confidence, was revealed between O_2 intake and Schneider Index. This correlation is opposite of a desired relationship between the two variables.

A negative correlation of -.767, significant at the .01 level of confidence, was revealed between lying pulse and Schneider Index. This high negative correlation indicates the high degree of reliability in the use of lying pulse as an indicator of cardiovascular fitness.

A negative correlation of -.341, significant at the .01 level of confidence, was found between the amplitude of the R wave and Schneider Index score. This is an opposite correlation with respect to the desired relationship and indicates that the R wave amplitude may not be a valid predictor of cardiovascular fitness.

A negative correlation of -.487, significant at the .01 level of confidence, was found between the rest work ratio and lying pulse. This correlation points to the use of rest work ratio as a valid indicator of cardiovascular fitness.

A negative correlation of -.213, significant at the .05 level of confidence, was found between lying systolic blood pressure and the Schneider Index score. This is a good relationship since as lying systolic blood pressure goes down, the Schneider Index score goes up.

A negative correlation of -.353, significant at the .01 level of confidence, was found between the heart rate after five minutes recovery from the treadmill walk and the Schneider Index score. This correlation indicates that as the recovery heart rate for the treadmill walk decreases, the Schneider Index score increases. This further substantiates the validity of the Schneider Index as a fitness index.

A negative correlation of -.229, significant at the .05 level of confidence, was found between heart rate after five minutes of recovery from the treadmill walk and rest work ratio. This correlation reflects upon the validity of the rest work ratio as a valid predictor of cardiovascular fitness.

A negative correlation of -.233, significant at the .05 level of confidence, was found between systolic blood pressure after five minutes recovery from the treadmill walk and the rest work ratio. This expected relationship reinforces the use of the rest work ratio as a valid predictor of cardiovascular fitness.

A negative correlation of -.239, significant at the .05 level of confidence, was found between aerobic points per week and weight residual. This means that the more exercise as indicated by the more aerobic points gained is helpful in taking off body fat.

A negative correlation of -.245, significant at the .05 level of confidence, was found between aerobic points per week and per cent body fat. This again indicates that the increased amount of exercise as indicated by the increased amount of aerobic points is helpful in losing body fat.

Tavle VI presents a list of correlation coefficients for objective two ranked in order from the highest to the lowest correlation.

TABLE VI

CORRELATION COEFFICIENTS RANKED FROM HIGHEST TO LOWEST

Correlation Coefficients	Variables		
-.767	PULS-LYN	&	SCH-INDX
.590	SYST-5	&	BPL-S
.561	PCT-FAT	&	WT-RES
-.487	RE-WORK	&	PULS-LYN
.450	RE-WORK	&	SCH-INDX
.396	HR-REC-5	&	PULS-LYN
.391	AMP-P	&	PULS-LYN
-.341	AMP-R	&	SCH-INDX
.327	BPL-S	&	PULS-LYN
-.286	SCH-INDX	&	O_2-IN
-.245	AERO-WK	&	PCT-FAT
.244	HR-REC-5	&	SYST-5
-.239	AERO-WK	&	WT-RES
.233	PULS-LYN	&	O_2-IN
-.233	SYST-5	&	RE-WORK
.233	HR-REC-5	&	AMP-R
-.229	HR-REC-5	&	RE-WORK
.225	AERO-WK	&	AMP-T
-.213	BPL-S	&	SCH-INDX

Objective three of the investigation reported in this paper was to determine which activity is more advantageous in producing or changing fitness. The subjects were grouped in three separate segments composed of joggers, racquetball players, and other activities. Analysis of variance was used to determine if there were any differences between groups concerning six selected variables. The results of the "t" test in the study are shown in Table VII.

TABLE VII

SUMMARY OF YEAR TWO EXPERIMENTAL DATA FOR THE "t" TEST APPLIED TO OBJECTIVE THREE

VARIABLE ACTIVITY	AERO-WK	N	O_2-IN	SCH-INDX	PULS-LYN	WT-RES	PCT-FAT	BPL-S
MEANS-JOG	26.5	10	35.1	13.1	64.9	7.4	10.5	119.6
MEANS-OTHER	26.5	10	34.9	14.0	61.6	10.5	11.0	128.0
MEANS-RB	26.5	10	29.7	11.8	65.4	10.4	10.6	123.3
"t" JOG-OTH			.02	-.9	3.3	3.1	-.5	-8.4
"t" JOG-RB			5.4	1.3	-.5	3.0	.1	3.4
"t" OTH-RB			5.2	2.2	3.8	.1	.4	4.7

$^{x}P < .01$

$^{xx}P < .05$

Although there were no significant differences at the (P <.01) and (P <.05) levels between the three groups on any of the variances, one group consistently scored highest on the majority of the variables. The jogging group scored first in weight residual, oxygen intake, per cent body fat, and lying systolic blood pressure, with second place finishes in Schneider Index and lying pulse. Since all groups were gaining identical amounts of aerobic points per week while exercising with their distinct program, such consistently high scores on all variables indicates the beneficial use of jogging as a means of producing cardiovascular fitness.

Objective four in the statistical analysis was to calculate analysis of covariance to examine whether the linear regressions of aerobic points gained per week from year one to year two were the same on a selected list of variables in the study. Table VIII presents an analysis of variance for objective four in which the covariable is aerobic points per week.

There is evidence that a change in aerobic points per week would result in a change in standing pulse ($P < .05$). This would lend support to the hypothesis that additional exercise resulting in additional aerobic points would have beneficial results in the form of a lowered standing pulse. Since resting pulse is known to be a valid predictor of cardiovascular fitness, this lowered figure is a highly desirable result of regular exercise.

There is evidence ($P < .01$) that the slope of the regression lines of ventilation equivalent and per cent of treadmill grade at a heart rate of 180 beats per minute on aerobic points per week are not parallel for both years implying that the linear relationship between aerobic points per week and the two variables is different between years.

There is evidence ($P < .05$) that the slope of the regression lines

TABLE VIII

ANALYSIS OF VARIANCE FOR OBJECTIVE FOUR IN WHICH THE COVARIABLE IS AEROBIC POINTS PER WEEK

Source	df	O_2 INTAKE	SCH-INDX	BPL-S	BPS-S	BPL-D	BPS-D	PULS-STN	PULS-LYN	V-EQ	TVC	MBC	AMP-R
Total	129												
Members	64												
Aero-Wk													
Common Slope	1	27.61	6.39	10.61	80.36	0.00	9.13	236.79^{xx}	28.55	0.17	51.07	803.11	4.79
Parallelism	1	1.62	1.10	78.1	16.35	21.18	2.18	26.99	72.17	4.61^{x}	8.83	4.38	3.85
Quadradic Curvature	1	49.91	0.63	218.77	153.64	0.15	40.21	8.44	0.86	1.34	0.21	0.05	0.33
Same Curvature	1	20.51	9.29	62.79	6.34	29.63	73.63	4.31	1.80	1.08	30.57	5.88	0.00
Error	60	41.52	3.76	55.22	66.68	46.95	49.30	56.43	42.99	0.64	24.52	2.94	0.49
Source	df	AMP-T	RE-WORK	WT-RES	ARM FAT	CHEST FAT	GUT FAT	BACK FAT	PCT-FAT	PCT-180	HR-REC-5	SYST-5	DIAS-5
Total	129												
Members	64												
Aero-Wk													
Common Slope	1	0.29	0.13	45.98	0.25	20.08	31.63	81.03	7.74	22.81	0.68	665.36	160.13
Parallelism	1	0.01	0.40^{xx}	0.05^{xx}	3.56	13.23	12.91	18.28^{xx}	1.17	1.54^{x}	77.43	49.56	11.74
Quadradic Curvature	1	0.33	0.02	1.41	10.10	0.89	20.45	15.93	3.55	0.65	189.31	244.95	311.42
Same Curvature	1	0.00	0.01	4.16	3.23	17.80	0.44	6.86	3.74	1.85	515.31	555.63	104.03
Error	60	0.49	0.07	10.01	4.23	6.83	13.66	13.87	3.79	3.02	371.68	905.24	

$^{x}P < .01$

$^{xx}P < .05$

of rest work ratio, weight residual, and back fat on aerobic points per week are not parallel for both years implying that the linear relationship between the three variables and aerobic points per week is different between years.

Summary of Results

Although subjects in this study made improvements on some of the variables tested, analysis of results must be undertaken with caution due to the fact that the non-exercising group scores were figured along with the active group scores.

Among the more significant findings of the investigation was the finding pointing to the increased time spent exercising and in the number of aerobic points per week gained with no corresponding increase in O_2 capacity. Since the average aerobic points gained per week for the study group was 22, it would point to the fact that this number of points is not enough to make a gain in aerobic capacity. Twenty-two points per week would be enough points to maintain present levels of fitness but Dr. Cooper's prediction of the need for 30 points per week will be necessary to create a gain in cardiovascular fitness. Study findings pointed to the jogging group as being superior to all exercise groups analyzed, as a means of developing higher levels of cardiovascular fitness. The high negative correlation between lying pulse and Schneider Index indicates the high degree of reliability in using lying pulse as a valid indicator of cardiovascular fitness. The Schneider Index was proven to be a reliable indicator of cardiovascular fitness in many instances in the study. The study did help motivate participants to spend more time exercising and in the development of a higher degree of personal fitness for the overall group.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The results of this study must be interpreted in relation to the intact population. Inference to the general population can not be made from this study as this was a voluntary sample of university-affiliated men.

The primary purpose of this study was the appraisal of the current physical fitness of 85 males of the Oklahoma State University faculty and administration, 65 of which were retest subjects.

This problem was surrounded by various sub-problems which made the study even more interesting.

The means and standard deviations of a list of variables in the study contrasting year one and year two were analyzed with the use of a paired comparison test. Analysis of variance was used to determine if there were any differences between years on the selected variables. The "F" test was used to determine if there were any significant differences between years at the .01 and .05 per cent level on the selected variables. This statistical analysis involved only the 65 retest subjects in the study.

Product moment correlations were calculated to determine the relationship of each subject's aerobic points per week and a selected list of variables. This statistical analysis involved all 85 subjects participating in the second year of the study.

To determine which activity is more advantageous in producing or changing fitness, the subjects were grouped into three separate segments composed of joggers, racquetball players, and other activities. Analysis of variance was used to determine if there were any differences between groups on the selected variables. The "t" test was used to determine if there were any significant differences between groups at the .01 and .05 per cent level on the selected variables.

Analysis of covariance was used to examine whether the linear regressions of aerobic points gained per week were the same on a selected list of variables in the study. The "F" test was used to determine if there were any significant differences between years at the .01 and .05 per cent level on the selected variables. This statistical analysis involved only 65 retest subjects in the study.

The review of literature included materials from nine main areas. These areas were electrocardiogram studies, Schneider Index, skinfold and circumference measurement, ventilation studies, blood pressure studies, heart rate studies, treadmill studies, cardiovascular fitness, and effect of training.

Chapter III outlined the method and procedure of the study. This chapter included selection of subjects, list of personal data collected, explanation of apparatus and equipment, testing procedure outline, explanation of how results were figured, and an explanation of the treatment of data.

In Chapter IV all of the results of the study were reported in tables or figures and were discussed as they related to the data for each statistical objective.

Conclusions

From the data collected in this study, the following conclusions have been drawn.

1. The current status of the group under observation pointed toward average to above fitness levels. The group did appear to be overweight as determined by weight residual; otherwise all other test results were in the average range.

2. The mean time spent exercising during each session, per cent of predicted vital capacity, timed vital capacity, vital capacity, rest-work ratio in the EKG, subscapular fat, and diastolic blood pressure after five minutes of recovery from the treadmill walk all increased significantly ($P < .01$) from year one to year two.

3. The mean number of days spent exercising per week, aerobic points per week, and systolic blood pressure after five minutes of recovery from the treadmill walk increased significantly ($P < .05$) from year one to year two.

4. The mean standing pulse decreased significantly (P .05) from year one to year two.

5. There was a significant correlation ($P < .01$) between Schneider Index and oxygen intake, amplitude of the R Wave in the EKG and lying pulse, rest-work ratio in the EKG and Schneider Index, rest-work ratio in the EKG and lying pulse, per cent body fat and weight residual, lying systolic blood pressure and lying pulse, heart rate after five minutes of recovery from the treadmill walk and lying pulse, heart rate after five minutes of recovery from the treadmill walk and Schneider Index, systolic blood pressure and lying systolic blood pressure, lying pulse and Schneider Index.

6. There was a significant correlation ($P < .05$) between lying pulse and oxygen intake, lying systolic blood pressure and Schneider Index, heart rate after five minutes of recovery from the treadmill walk and amplitude of the R wave in the EKG, heart rate after five minutes of recovery from the treadmill walk and rest-work ratio in the EKG, systolic blood pressure after five minutes of recovery from the treadmill walk and rest-work ratio in the EKG, systolic blood pressure after five minutes of recovery from the treadmill walk and heart rate after five minutes of recovery from the treadmill walk, aerobic points per week and amplitude of the T Wave in the EKG, aerobic points per week and weight residual, aerobic points per week and per cent body fat.

7. The jogging group scored highest on a majority of the variables with reference to which activity produced the highest level of cardio-vascular fitness.

8. There is evidence that a change in aerobic points per week would result in a change in standing pulse ($P < .05$).

9. There is evidence ($P < .01$) that the slope of the regression lines of ventilation equivalent and per cent of treadmill grade at a heart rate of 180 beats per minute on aerobic points per week are not parallel for both years implying that the linear relationship between aerobic points per week and the two variables is different between years.

10. There is evidence ($P < .05$) that the slope of the regression lines of rest-work ratio, weight residual, and back fat on aerobic points per week are not parallel for both years implying that the linear relationship between the three variables and the aerobic points per week is different between years.

Recommendations

1. The data from the summary sheet should be transferred to the computer form immediately after the summary sheet is completed.

2. The individual social security number should be recorded for each subject and placed on the computer card for easy reference.

3. Follow-up studies should be made every year using the same subjects to indicate the lasting effects of the exercise habits of the subjects.

4. Similar studies should be conducted with different age groups, varied occupations and with female as well as male subjects.

5. The formulas used in calculating the results of all tests in the laboratory should be standardized and a step by step procedure filed for reference by all new lab technicians.

6. The procedure for each test should be standardized and a step by step procedure filed for reference by all new lab technicians.

Discussion

The purpose of this study was to appraise the current physical fitness of 85 males of the Oklahoma State University faculty and administration, 65 of which were retest subjects. The literature that was cited dealt extensively with the increasing public problem in our society concerning the lack of physical exercise and the degenerative effects of such neglect. Various fitness testing areas were analyzed with reference to gaining a deeper understanding of the background of physiological testing in each. The literature generally supported the premise that there is a need for research in aerobics fitness programs.

Physiological variables were analyzed with reference to the total group of exercisers and non-exercisers combined. The subjects in the study were not hand picked for the study nor were they discouraged from participating due to undesirable or desirable activity patterns.

In the analysis of activities best suited to the development of cardiovascular fitness, this study overwhelmingly favored jogging over all activities analyzed. Less strenuous forms of exercise producing less of a training effect were proven to be less beneficial in the production of a sound cardiovascular system with reference to the adequate utilization of oxygen by the body.

The results of this study help reinforce the findings of previous research in the area of physical fitness testing. Such research points to the positive aspect of regular exercise programs for the development of sound cardiorespiratory fitness. Individuals that participate regularly in such training programs will make fundamental strides toward the development of sound physical fitness.

The ultimate goal of such a research project is the education of the populous concerning the need for such physical fitness programs. Specific test results help reinforce the view of the researcher when stressing such a need. It is my hope that this study will help develop interest in the area of aerobic fitness and serve as a motivating device to those interested in upgrading personal fitness levels.

The continuing research of Dr. A. B. Harrison in the Adult Physical Fitness Testing Program at Oklahoma State University will serve as a guidepost in the development of interest in the area of personal physical fitness.

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APPENDIX A

SUMMARY SHEET

OKLAHOMA STATE UNIVERSITY
PHYSIOLOGY OF EXERCISE LABORATORY
PHYSICAL FITNESS SUMMARY SHEET

DATE__________ FACULTY______ ADMIN.______ OTHER__________

NAME__________ HOME ADDRESS__________ PHONE______

DEPT.__________ BLDG. ROOM__________ EXT.______

AGE______ HEIGHT (NO SHOES)________ WEIGHT (NO SHOES)____ BSA___

PHYSICIAN__________ TOWN__________

LAST MEDICAL EXAM (DATE)__________ CONTRAINDICATIONS__________

SMOKING: NON SMOKER_____ QUIT_____ YEARS SMOKED_____ TYPE AND AMOUNT_____
SMOKER______ TYPE_____ YEARS SMOKED_____ AMOUNT________

ACTIVITY PATTERN: TYPE OF ACTIVITY__________
FREQUENCY__________ AMOUNT__________
AVERAGE AEROBIC PTS./WEEK______ TIME ON THIS PATTERN___

RESTING: PULSE RATE-SITTING______ LYING______ STANDING______

BLOOD PRESSURE: SITTING______ LYING______ STANDING______

SCHNEIDER INDEX________ ICE WATER______ CHANGE________

OXYGEN INTAKE: CLOSED______ OPEN______ MIN. VOL VENT______

VENT EQUIV.________ OXYGEN SAT.________ TVC________

VITAL CAP.________ % OF NORM_____ MBC_____ % OF NORM______

EKG: PULSE RATE______ AMP. P_____ AMP. R______ AMP.T______
WORK TIME______ REST TIME_____ REST/WORK_____ ST. DEPRESSION__
Q-IHS______ ARRHYTHMIA__________

ANTHROPOMETRIC: PREDICTED WT. BEHNKE 4 MEAS._____ BEHNKE 11 MEAS.___ RES.___
CURETON SKELETAL______ MUSCULAR________ R. WRIST DIAM.______
SKINFOLD FAT: ARM______ CHEST________ ABDOM.________
SUBSCAPULAR________ ILLIAC________
% BODY FAT________ SP GR.________

EXERCISE TEST: ASTRAND BICYCLE: HEART RATE___ PRED. OXYGEN INTAKEL___ ML/KG___
BALKE TREADMILL: % GRADE AT 180_____ PRED. OXYGEN L_____ ML/KG__ CLASS__
OPEN CIRCUIT MEASURES: OXYGEN INTAKE AT___ HR OXYGEN INTAKE AT_____ HR
PRED. MAXIMAL OXYGEN INTAKE L______ ML/KG________
MEASURED MAXIMAL OXYGEN INTAKE L______ ML/KG______ HR______
OXYGEN DEBT REPAID:______ LITERS IN________ MIN.

EXERCISE EKG CHANGES:

RECOVERY EKG CHANGES:

RECOVERY TIME: 1 2 3 4 5

HEART RATE:

BLOOD PRESSURE:

APPENDIX B

SCHNEIDER INDEX SCORE SHEET

Name________________________________Date__________Schneider Index

OBSERVATIONS

Lying Position: Pulse Rate______Systolic BP______Diastolic BP__________

Standing Position: Pulse Rate______Systolic BP______Diastolic BP________

STEP EXERCISE (5 steps - chair 20" high): Pulse Rate Immediately After Exercise____

Pulse Rate After Exercise: 30 sec.______60 sec.______90 sec.______120 sec.______

SCORING TABLE

A. Reclining Pulse Rate		B. Pulse Rate Increase on Standing				
Rate	Points	0-10	11-18	19-26	27-34	35-42
41-50	4	4	4	3	2	1
51-60	3	3	3	2	1	0
61-70	3	3	2	1	0	-1
71-80	2	3	2	0	-1	-2
81-90	1	2	1	-1	-2	-3
91-100	0	1	0	-2	-3	-3
101-110	-1	0	-1	-3	-3	-3

C. Standing Pulse Rate		D. Pulse Rate Change Immediately After Exercise				
Rate	Points	0-10	11-20	21-30	31-40	41-50
51-60	4	4	4	3	2	1
61-70	3	3	3	2	1	0
71-80	3	3	3	2	0	0
81-90	2	3	2	1	0	-1
91-100	1	2	1	0	-1	-2
101-110	1	1	0	-1	-2	-3
111-120	0	1	-1	-2	-3	-3
121-130	0	0	-2	-3	-3	-3
131-140	-1	0	-3	-3	-3	-3

E. Return of Pulse Rate to Standing Normal after Exercise

Seconds	Points
0-30	3
31-60	2
61-90	1
91-120	0
After 120 2-10 beats Above normal	-1
After 120 11-30 Above normal	-2

F. Standing Systolic B.P. Compared with Reclining Systolic B.P.

Change in Millimeters	Points
Rise 30 and more	-2
Rise 21 to 30	-1
Rise 16 to 20	0
Rise 11 to 15	1
Rise of 6 to 10	2
No rise greater than 5	3
Fall of 6 to 10	2
Fall of 11 to 15	1
Fall of 16 to 20	0
Fall of 21 to 25	-1
Fall of 26 and more	-2

APPENDIX C

BEST BODY COMPOSITION NOMOGRAM

Table 19-1
Data Collection for Estimation of Body Composition from Skinfold Measurement

Name ________ Age ________ Ht. ____ in. ____ cm. Wt. ____ lbs. ____ kg.

Date ____________________

Skinfold	Observer 1			Observer 2		
	First	Second	Mean	First	Second	Mean
1. Chest						
2. Abdominal						
3. Arm						

Specific Gravity ____________ Specific Gravity ____________

Percent Body fat ____________ Percent Body fat ____________

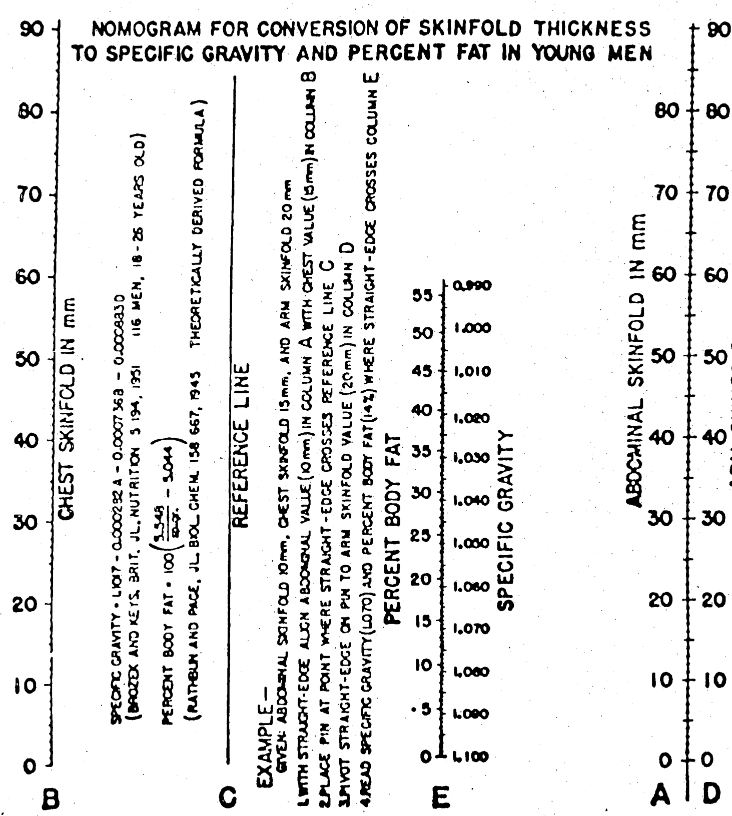


Figure 19-2. Nomogram for conversion of skinfold thickness to specific gravity and percent fat in young men. (From W.R. Best USAMRNL Report no. 113. August, 1953.).

APPENDIX D

BEHNKE BODY BUILD ANALYSIS SHEET

ANALYSIS OF BODY BUILD

Table 21-2
Data Collection for Analysis of Body Build by Method of A.R. Behnke

Name__________ Wt.____ lbs.____ kg. Ht.____ in.____ dm.

(1)		(2)			(3)	(4)	(5)	(6)
Body Segment		Circumference			Male k Value	Female k Value	d Value	Equiv Wt (kg) $d^2 \times H$
		L.	R	Av.				
1	Shoulder				55.4	52.0		
2	Chest				45.9	44.5		
3	Abdomen				40.6	38.7		
4	Buttocks				46.7	50.8		
5	Thighs				27.4	30.1		
6	Biceps				15.4	14.4		
7	Forearm				13.4	13.0		
8	Wrist				8.2	8.2		
9	Knee				18.3	18.8		
10	Calf				17.9	18.4		
11	Ankle				10.8	11.1		
Σ								
M								

Predicted Wt. as Mean of Equiv. Wts. (col. 6) ____________________

Predicted Wt. as $\frac{C}{K} = \frac{\text{Sum (col. 2)}}{300}$ ____________________

APPENDIX E

INFORMED CONSENT SHEET

OKLAHOMA STATE UNIVERSITY

PHYSIOLOGY OF EXERCISE LABORATORY

INFORMED CONSENT FORM

Subject's name____________________ Date_______________

I hereby authorize Dr. A. B. Harrison and/or such assistants as may be selected by him to perform the following procedure (s) and investigation (s):

A laboratory physical fitness evaluation including electrocardiogram, phonocardiogram, pulse waves, blood pressure, weight analysis, respiratory capacities and function and a treadmill walking test to predict maximal oxygen intake capacity,

on________________________.
Subject

The procedure (s) and investigation (s) has (have) been explained to me by Dr. A. B. Harrison or his assistant.

I understand that the procedure (s) and investigation (s) involve the following possible risks and discomforts:

All tests except the treadmill walk are resting tests and involve no unusual risk or discomfort. The treadmill test involves walking at a gradually increasing grade up to a target heart rate. The target heart rate is determined by age level, medical and physical condition. The EKG is monitored during the treadmill walk and the test is terminated upon signs of cardiac distress. The subject is free to terminate the test at any time at his own discretion.

I also understand that all test records will be kept confidential and will not be released to anyone without permission of myself or family. Test results will be tabulated for research purposes as group data and in no case will a subject's personal identity be associated with his test results without his express permission.

I understand that the potential benefits of the investigation are as follows:

The results of the test battery will give the subject an in depth view of his current fitness status. Test results will be explained and interpreted to the subject. Guidance concerning exercise programs will be given. Subjects will be encouraged to engage in a systematic exercise program to produce favorable changes in test scores. Subjects will be offered the opportunity for a re-evaluation annually.

I understand that I may terminate my participation in the study at any time.

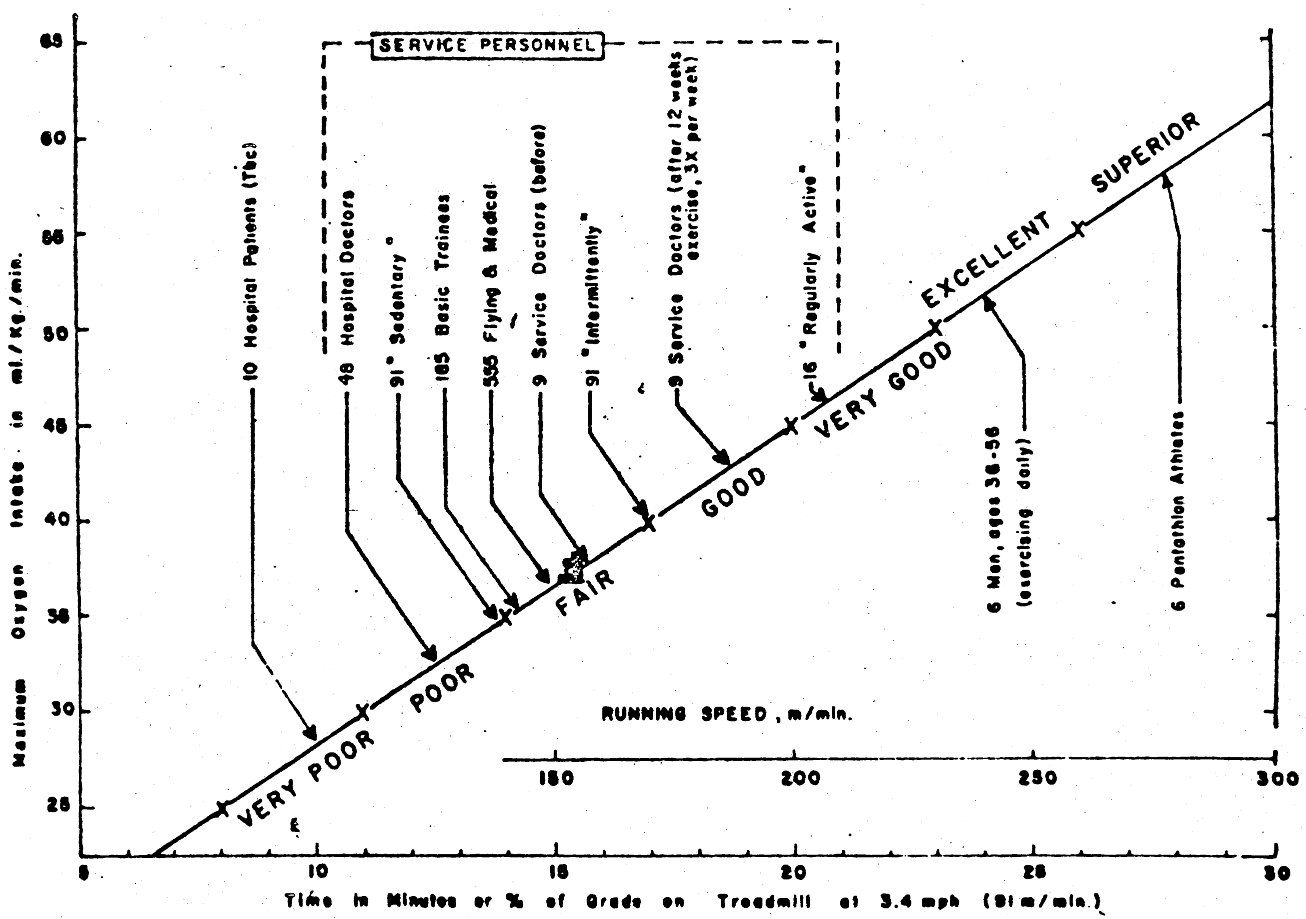
Subject's signature________________________

Witness______________________________

APPENDIX F

MAXIMUM OXYGEN INTAKE NOMOGRAM

Maximum Oxygen Intake as Criterion of Functional Potential



APPENDIX G

COOPER'S AEROBIC FITNESS RATING SCALE

TABLE IX

COOPER'S AEROBIC FITNESS RATING SCALE

Fitness Category		Oxygen Consumption (ml/kg/min)			
		Under 30	30-39	40-49	50+
I.	Very poor	< 25.0	< 25.0	< 25.0	
II.	Poor	25.0-33.7	25.0-30.1	25.0-26.4	< 25.0
III.	Fair	33.8-42.5	30.2-39.1	26.5-35.4	25.0-33.7
IV.	Good	42.6-51.5	39.2-48.0	35.5-45.0	33.8-43.0
V.	Excellent	51.6+	48.1+	45.1+	41.1+

VITA

Danny LeRoy Thomas

Candidate for the Degree of

Doctor of Education

Thesis: THE EFFECTS OF PARTICIPATING IN AN AEROBIC TRAINING PROGRAM ON MALE FACULTY MEMBERS AND ADMINISTRATORS AT OKLAHOMA STATE UNIVERSITY

Major Field: Higher Education Minor Field: Health, Physical Education and Recreation

Biographical:

Personal Data: Born in Nevada, Missouri, September 10, 1942, the son of LeRoy M. and Lilas M. Thomas.

Education: Graduated from Nevada High School, 1960; received the Bachelor of Science degree in Education from Kansas State College of Pittsburg, with a major in Physical Education, in June, 1964; received the Master of Science degree from Kansas State College of Pittsburg, with a major in Physical Education, in June, 1965.

Professional Experience: Taught and coached four years in the public schools of Pittsburg, Kansas, 1965-1969; taught and coached in the public schools of Springfield, Missouri, 1969-1971; taught and coached in the public schools of Buffalo, Missouri, 1971-1972; taught and coached in the public schools of Stillwater, Oklahoma, 1972-1973; Director of Oklahoma State University Athletic Dormitory, 1973-1976.