THE APPRAISAL OF THE CURRENT PHYSICAL FITNESS STATUS OF EIGHTY-FIVE VOLUNTEER MALES OF THE OKLAHOMA STATE UNIVERSITY FACULTY AND ADMINISTRATION

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Submitted to the Faculty of the Graduate College
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in partial fulfillment of the requirements
for the Degree of
DOCTOR OF EDUCATION
May, 1976

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STATUS OF EIGHTY-FIVE VOLUNTEER MALES OF

THE OKLAHOMA STATE UNIVERSITY

FACULTY AND ADMINISTRATION

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ACKNOWLEDGMENTS

The author extends his appreciation to Dr. Aix B. Harrison, Dr. Betty Abercrombie, Dr. John Bayless, and Dr. Bill Elsom for their interest and helpful suggestions toward the completion of this manuscript. Special thanks is given to Dr. Aix B. Harrison for his counseling throughout the study. A note of thanks is also extended to my wife, Janice, for the initial typing of the thesis, and to Velda Davis, for making sure the final copy was properly prepared and submitted.

Special acknowledgment is expressed to my wife, Janice, and our children, Eddie and Amy, for their encouragement while the manuscript was being completed.

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CHAPTER I

INTRODUCTION

Currently, more and more occupational activities are being performed by machines and physical exertion has therefore become largely obsolete. Mounting evidence in pertinent literature has pointed out that lack of physical activity has and will continue to become an increasing problem in a mechanized society.[1,2]

Many authorities[3,4,5] have inferred that as a consequence of this reduction of essential physical exertion, there is a greater danger that the vitality of the human organism, which is readily adaptable to change in functional demands, may become seriously affected.

The association of physical inactivity with clinical disorders has been an increasing concern of the medical profession for more than a decade.[6] A primary interest is the apparent relationship between lack

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[1]P. O. Astrand, "Human Physical Fitness With Special Reference to Sex and Age," Physiological Review, XXXVI, Part III (July, 1956), p. 307.

[2]H. Kraus and W. Raab, Hypokinetic Disease (Springfield, Illinois, 1961), p. 3.

[3]P. O. Astrand, p. 310.

[4]B. Balke and R. W. Ware, "An Experimental Study of Physical Fitness of Air Force Personnel," United States Armed Forces Medical Journal, X (1959), p. 675.

[5]T. K. Cureton, The Physiological Effects of Exercise Programs on Adults (Springfield, Illinois, 1969), p. 37.

[6]F. V. Hein and A. J. Ryan, "The Contributions of Physical Activity to Phyiscal Health," Research Quarterly, XXXI (1960), p. 263.

of physical activity and the increased incidence of heart disease. In spite of various problems which make definite conclusions difficult, the overwhelming majority of published reports, based on statistical criteria and techniques, seem to lend strong support to the belief that a relationship between exercise habits and the susceptibility to functional and degenerative diseases of the myocardium may exist.[7,8]

Conversely, it is also a thesis that the cultivation of physical fitness leads to appreciably higher energy; better control of the body and relative freedom from handicapping strains, lethargy, and chronic ailments.[9] In many studies that have involved the examination of several thousands of middle-aged men, it has been found that the ones who have good circulatory fitness are those who have kept up a high degree of physical activity.[10] However, the social prestige associated with many professions involving largely indoor confinement has placed an emphasis upon sedentary pursuits which in effect may be to the detriment of the health of those involved.

Due to the increasing concern for the physical fitness of members of sedentary occupations, the focus of this study is on members of one such group, those of the educational profession. More specifically, it has been feasible to utilize members of the Oklahoma State University

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[7]F. V. Hein and A. J. Ryan, p. 263.

[8]Physical Fitness Research Digest. H. H. Clarke, editor, President's Council on Physical Fitness and Sports II (Washington, D. C., April, 1972), p. 1.

[9]H. Kraus and W. Raab, p. 57.

[10]T. K. Cureton, The Physiological Effects of Exercise Programs on Adults, p. 48.

faculty and administration since there was an ample physical education facility available at the institution. In view of this fact, it seems appropriate to inquire about the physical fitness status of this particular group of adult men.

Statement of the Problem

The purpose was to appraise the current physical fitness status of 85 volunteer males of the Oklahoma State University faculty and administration.

Subproblems

A. To describe and compare the results of the physiological measures within and among three age-grouped categories; namely, the age groups of 25-34, 35-44, and 45 and over.

B. To compare the results of the physiological measures employed in the study between the faculty group and the administrative group.

C. To compare the results of the physiological measures among faculty members of selected departments.

D. To categorize subjects into groups according to physical activity patterns and compare physical fitness levels according to the physiological measurements utilized.

E. To conduct a retest of 16 subjects who were tested during the previous academic year (1971-72) to determine if changes have occurred in the various physiological measurements.

F. To compare the results of the physiological measures employed in this study between smokers and non-smokers.

G. To determine the relationship of maximal oxygen intake in comparison with other physiological measurements utilized in the study.

Delimitations

The measurements specifically undertaken to ascertain the physical fitness of the subjects were: maximal oxygen consumption as predicted by treadmill performance, maximal breathing capacity, vital capacity, timed vital capacity, weight residual, percent body fat, resting and post exercise pulse rates, resting and post exercise systolic blood pressures, resting R and T amplitudes and rest/work ratio on the electrocardiograph, and post exercise pulse pressure.

Limitations

The following were limitations:

A. The recruiting of subjects was on a voluntary basis.

B. Only a rough estimate could be made in the categorization of subjects based on the intensity of their physical activity patterns.

C. There were no controls of diet, sleep, and other routines of the subjects.

Assumption

The physiological tests selected are among those considered to be a valid criteria of physical fitness.

Justification

It is generally observed that men lose their physical abilities as they age. It is probable that "disuse" is a great factor in such deterioration. Kraus and Raab have set forth the thesis of <u>hypokinetic disease</u> in which mention is made of many diseases that may be caused by lack of exercise which are both neuromuscular and circulatory-respiratory in nature.[11] Drawing information from many sources, Kraus and Raab indicated that coronary heart disease is twice as frequent in the sedentary as in the active; that 80 percent of low back pain in patients reporting to physiatrists is due to lack of physical activity; that the physically active show better adaptability to stress, less neuromuscular tension, and less fatigability; and that active individuals age later, do not tend toward obesity, have lower blood pressure, are stronger and more supple, and have greater breathing capacity and lower pulse rate. Based upon these contentions, exercise for adults appears to be extremely important, especially among desk-bound college professors and administrators and members of similar sedentary occupations.

There is little doubt that many physiological measurements in adult men can be improved by following an exercise program such as Cureton's[12] or Cooper's;[13] however, experience has indicated that adults are not generally receptive to participation in controlled and highly scheduled exercise sessions.

This study attempted to provide data as to whether or not individually selected physical activities and the participation in these activities by members in this study on an ad libitum basis would yield an appreciable state of physical fitness.

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[11] H. Kraus and W. Raab, p. 1.

[12] T. K. Cureton, The Physiological Effects of Exercise Programs on Adults.

[13] K. H. Cooper, The New Aerobics (New Uork, 1970).

Selection of Measurements

For this study, the measurements to assess the physical condition of the subjects were the Schneider Index, Balke Treadmill Test, skinfold tests, body circumferences, pulmonary functions, electrocardiogram, and post exercise pulse pressure. A brief rationale of each test is included in the following discussion.

Schneider Index

The Schneider Index has been widely used as a guide to physical condition.[14] Cureton indicates that it is perhaps the best mild test of circulatory efficiency known.[15] The exercise is so mild (five steps on a chair in fifteen seconds) that nearly any person can take the test, even if he is in very poor condition.

Six different cardiovascular responses are separately scored, giving a possible maximum composite score of 22 points. By this scheme, each item is equally weighted. The six responses included are: reclining pulse rate and blood pressure, standing pulse rate, pulse rate increase on standing, standing blood pressure compared with reclining, pulse rate change after exercise, and return of pulse to standing normal after exercise.

This test measures roughly the state of training of the autonomic nervous system, the blood, the heart, and the respiratory mechanism.

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

[15] T. K. Cureton, Physical Fitness Appraisal and Guidance (St. Louis, 1947), p. 300.

Balke Treadmill Test[16]

At the present time, appearances indicate that one of the best methods available for measuring physical fitness is the evaluation of maximum oxygen intake. The determination of maximum oxygen intake as a method of assessing the effects of various training programs on physical fitness has received general support throughout the studies in pertinent literature. Astrand,[17] Cureton,[18] Cooper,[19] and Balke[20] have shown that there is a better utilization of oxygen and consequently an increase in work efficiency. As fitness levels increase (as measured by maximal oxygen intake), the individual can maintain submaximal physical effort over longer periods with less stress than individuals who possess a smaller maximal oxygen intake capacity.

The Balke Treadmill Test was chosen as an evaluative tool because (1) it is a standardized test which can be used for men representing a wide range in age and physical fitness, (2) it it not a test which will bring an individual to a complete state of physical exhaustion as it uses a critical cut-off point shown to be a valid indicator of near maximal aerobic work capacity, (3) the test is one of gradually increasing work load and requires only walking skill, warm-up and training factors being minimal, (4) it has been used in other studies dealing with the assessment of aerobic work capacity in adult males,

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[16]B. Balke and R. W. Ware, p. 675.

[17]P. O. Astrand, p. 311.

[18]T. K. Cureton, Physical Fitness of Champion Athletes (Urbana, 1951), p. 157.

[19]K. H. Cooper, p. 16.

[20]B. Balke and R. W. Ware, p. 677.

and (5) ease of administration and interpretation together with norms ascribed to the test render it a desirable one.

Skinfold and Circumference Measurements of the Body

Many techniques have been developed for estimating the composition of the human body. The application of the Archimedean principle to the estimation of body fat as employed by Behnke et al. has been found to be quite accurate.[21] However, due to lack of facilities and the length of time in administering such a test, other devices have been employed with desirable outcomes. One such method is the formulation of multiple regression equations for the estimation of specific gravity from skinfold measurements.

The employment of skinfold measurements developed by Brozek and Keys was used in this study to determine the specific gravity of the subjects.[22]

Another procedure used in this study to estimate ideal body weight was the employment of eleven body circumference measurements developed by Behnke et al.[23] The body circumference technique has yielded accurate results on an age range from 14 to 93. This method of obtaining

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[21]A. R. Behnke, B. G. Feen, and W. C. Welham, "The Specific Gravity of Healthy Men," Journal of the American Medical Association, XVIII, No. 7 (February, 1942), p. 495.

[22]J. Brozek and A. Keys, "The Evaluation of Leanness-Fatness in Men: Norms and Interrelationships," British Journal of Nutrition, V (1951), p. 194.

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

anthropometric data can be done in minimal time and requires only a tape measure.

Pulmonary Function Measurements

Consolazio points out that many new pulmonary function tests have been devised but few have survived the test of time.[24] Thus far, no single test has been found satisfactory for a complete evaluation of the extent of pulmonary function impairment. But as Gray et al. state, "An important element in any battery of tests designed to analyze the functional status of an organ is a quantitative measure of the capacity of that organ to carry on its specific function."[25] Thus, the quantitative assessment of maximal breathing capacity, vital capacity, and timed vital capacity was employed in this study. Baldwin et al. have calculated normal values of these tests for various ages and statures.[26] (See Appendix, pp. 75-76.)

The Electrocardiogram

The electrocardiogram is a very important instrument for assessing the ability of the heart to transmit the cardiac impulse. It is generally contended that the electrocardiogram may be utilized under certain conditions for normal subjects to indicate a strong heart or

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[24] C. F. Consolazio, R. E. Johnson, and L. J. Pecora, *Physiological Measurements of Metabolic Functions in Man* (New York, 1963), p. 190.

[25] 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, Part I (1950), p. 677.

[26] E. F. Baldwin, A. Cournand, and D. W. Richards, "Pulmonary Insufficiency: Physiological Classification, Clinical Methods of Analysis, Standard Values in Normal Subjects," *Medicine*, XXVII (1948), p. 276.

one less strong by the height of the R and T waves. Very small T waves (below 2 mm) and R waves (below 5 mm) in all leads in the quiet state may be indicative of weak heart action. Cureton found that R and T wave amplitudes are of some value for indicating the circulatory fitness of individuals.[27]

Pulse Pressure

The pulse pressure is considered by many as an index of the stroke volume of the heart. The stroke volume output is the amount of blood pumped by the heart with each beat. If the stroke volume output is great, the pressure will rise and fall tremendously, thereby giving an extremely high pulse pressure. Many athletes have high pulse pressures and high diastolic pressures, both being moderately correlated with endurance with the high pressures presumably associated with strong hearts. In the resting state when there is relatively little vasodilation, the pressures are higher than average; however, during hard endurance work, a greater minute volume of blood can be delivered.

The pulse pressure greatly increases during exercise and since, during exercise, the diastolic pressure changes little and the systolic pressure rises considerably, the pulse pressure rather closely follows the fluctuations of the systolic pressure. Pulse pressure returns to normal more slowly as the exercise becomes more exhaustive and, in general, the better the physical condition of the subject, the more rapid the return to normal.

Pulse pressure readings were recorded at five minutes of recovery

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[27]T. K. Cureton, Physical Fitness of Champion Athletes, p. 151.

following the Balke Treadmill Test and these readings were utilized as one indicator of fitness.

Definition of Terms

Cardio-Respiratory Fitness: The ability to sustain prolonged activity in which the cardio-respiratory mechanisms are the primary limiting factors.

Maximum Breathing Capacity: The maximum volume of air that can be breathed per minute.

Maximal Oxygen Consumption or VO_2 max.: The point at which the cardio-respiratory system can no longer increase delivery of oxygen to the working muscles; thus, oxygen consumption becomes stable. At this point, the body must be able to metabolize carbohydrates to release energy to the muscles and to build up an oxygen debt.

Pulse Pressure: The pulse pressure is the arithmetical difference between the systolic and diastolic blood pressures and is generally taken as an index of the stroke volume of the heart.

R Wave: A part of the curves of the electrocardiograph that is caused by passage of the cardiac impulse through the ventricles.

T Wave: A part of the curves of the electrocardiograph that is caused by the return of ions into the ventricular muscle fiber at the end of the refractory period.

Systolic Blood Pressure: The pressure exerted on the walls of the arteries during the heart's pumping stroke.

Diastolic Blood Pressure: The pressure exerted on the walls of the arteries when the heart is at rest between strokes.

Vital Capacity: The maximum volume of air that can be expelled from the lungs following a maximum inspiration.

Timed Vital Capacity: The maximum volume of air that can be exhaled per unit of time. (As measured in a one-second interval.)

Rest/Work Ratio: The time from the end of the T wave to the beginning of the next ST segment (rest time) divided by the time of the ST interval (work time).

CHAPTER II

LITERATURE REVIEW

Physical Fitness

Much has been written about what physical fitness is and also what role exercise plays in its relationship to the prevention of certain types of diseases and degenerative processes of the human organism. Although physical fitness is generally recognized as a complex entity, a brief concept of its nature and some of the possible contributions of physical activity to the well-being of an individual are pointed out in the following review.

The term physical fitness appears to possess several meanings and any one definition may not be acceptable to all authorities. Many illustrations could be presented to point out the elusiveness of the terminology, but two examples should serve as a representative concept of physical fitness.

Astrand and Darling[1,2] seem to agree that "Fitness consists of the ability of the organism to maintain the various internal equilibria as closely as possible to the resting state during strenuous exertion and

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[1] P. O. Astrand, "Human Physical Fitness With Special Reference to Sex and Age," Physiological Review, XXXVI, Part III (July, 1956), p. 307.

[2] R. C. Darling, "The Significance of Physical Fitness, Archives of Physical Medicine, XXVIII (1947), p. 140.

to restore promptly after exercise any equilibriums which have been disturbed."

Cureton's definition of physical fitness is broader: "Physical fitness is a great deal more than freedom from sickness or passing a medical inspection. In addition to freedom from germinal or chronic disease, possessing good teeth, good hearing, good eyesight, and normal mentality, physical fitness means an ability to handle the body well and the capacity to work hard over a long period of time without diminished efficiency."[3]

Although physical educators, physiologists, and medical personnel may take different approaches in defining physical fitness, it is generally agreed that a physically fit person is one who has the capacity for prolonged work. Thus, physical fitness may be primarily the fitness of the respiratory and circulatory systems. However, it is probably in error to put aside all other types of fitness and conclude that any one test measures all aspects. It is better to measure and interpret one test at a time and accept the philosophy that there are many fitnesses which are uniquely different from one another and should be tested for their particular representation.[4]

Exercise and Coronary Heart Disease

Probably one of the biggest factors causing middle-aged men to be concerned about the status of their physical fitness is the high rate

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[3] T. K. Cureton, Physical Fitness Appraisal and Guidance (St. Louis, 1947), p. 18.

[4] T. K. Cureton, "Interpretation of the Oxygen Intake Test--What Is It?" American Corrective Therapy Journal, XXVII, No. 1 (1973), p. 23.

of incidence of coronary heart disease. Clarke[5] points out that coronary heart disease is American's greatest killer, claiming the lives of over 700,000 persons annually. This disease is the cause of 40 percent of all deaths of men between the ages of 40 and 59.

Numerous studies have led to the identification of multiple factors which seem to predispose the individual to coronary disease, one of which is physical inactivity. To isolate one factor such as physical inactivity presents risks due to many other interrelationships of coronary risk factors. Nevertheless, Fox and Skinner believe considerable evidence does exist to indicate that physical inactivity is a risk factor in the occurrence of coronary heart disease.[6]

For many years, informed physicians have suggested that regular physical activity plays a major role in maintaining the organic soundness of the cardiovascular system. Only in recent times, however, have systematic studies been made in dealing with this problem. The proof now rests primarily on comparisons of occupational groups from which death certificates and company records have been examined to determine age and cause of death. Difficulties do exist in occupational comparisons; for instance, the types of individuals selected or assigned to various kinds of work and the nature and amount of off-the job exercise of the subjects are not assessed. Recognizing these and other deficiencies and lacking the completion of more thorough studies, the current evidence is the best available criteria for judging the role of physical

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[5]Physical Fitness Research Digest, H. H. Clarke, editor, President's Council on Physical Fitness and Sports, II (Washington, D. C., April, 1972), p. 1.

[6]S. Fox and J. S. Skinner, "Physical Activity and Cardiovascular Health," American Journal of Cardiology, XIV (1964), p. 131.

activity in the prevention of coronary attacks.

Most occupational studies support the concept that physically active individuals have less chance of sustaining coronary heart disease.

Perhaps one of the most widely publicized occupational studies relating to coronary heart disease was conducted by Morris and Raffle.[7]

Their study attempted to determine the incidence of coronary heart disease among 31,000 drivers and conductors between the ages of 35 and 64. Nearly all the work done by conductors was on double-decker vehicles which required a considerable amount of climbing and walking as opposed to the drivers' being relatively physically inactive. The total annual incidence of coronary attack per 1,000 was higher for drivers (2.7) than for conductors (1.9). The disease appeared at a younger age in the drivers' group; and, perhaps even more significant, the mortality rate was over twice as high for the sedentary drivers at three days, three months, and three years from the onset of the first medical indication of coronary heart disease.

Morris and Raffle also compared sedentary postal clerks with postmen who walked to deliver mail.[8] Among 100,000 subjects, a similar high proportion of fatal heart attacks was found among the sedentary clerks which concurred with the findings for the sedentary bus drivers in the previous study. Morris also analyzed data for 1930-32 records on over 2½ million skilled and semiunskilled workers.[9] It was again

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[7]J. N. Morris, J. Heady, and A. B. Raffle, "Physique of London Busmen," Lancet, Part II (1956), p. 569.

[8]Ibid., p. 570.

[9]W. H. Morris, Work and the Heart (New York, 1957), p. 117.

found that there was a greater incidence of fatal heart attacks among occupations involving little physical activity and the proportion of men who survived a first attack was more than twice as great among heavy-duty laborers as it was among men whose occupations required only slight physical exertion.

Morris and Heady analyzed 4,000 noncoronary heart disease deaths, using autopsies as a bases.[10] About twice as many heart scars indicating previous cardiac disease were found among men who were engaged in light occupations as were found for those whose work involved strenuous physical labor.

Hedley investigated deaths due to coronary occlusion of 5,116 men between 35 and 64 years of age.[11] Workers had a lower death rate than did professional men, business managers, and clerks. In another study, Yates found that laborers and farmers had lower incidence of heart disease in men aged 18 through 39 than did professional men and supervisors.[12] Taylor investigated the relationships of physical activity to coronary heart disease among men aged 40 to 64 in the railroad industry.[13] Among these workers, the death rate for clerks (the most sedentary) was

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[10] J. N. Morris and J. Heady, "Coronary Heart Disease and Physical Activity of Work," Lancet, 265 (1953), p. 1053.

[11] O. F. Hedley, "Analysis of 5,116 Deaths Reported as Due to Coronary Occlusion in Philadelphia," U. S. Weekly Public Health Reports, No. 54 (1959), p. 972.

[12] W. H. Yates, A. H. Traum, W. G. Brown, R. P. Fitzgerald, M. A. Geisler, and B. B. Wilcox, "Coronary Artery Disease in Men Eighteen to Thirty-Nine Years of Age," American Heart Journal, XXXVI (1948), p. 372.

[13] H. L. Taylor, E. Klepetar, A. Keys, W. Parlin, H. Blackburn, and T. Puchner, "Death Rates Among Physically Active and Sedentary Employees of the Railroad Industry," American Journal of Public Health and The Nation's Health, LII, Part II (1962), p. 1697.

significantly higher than for switchmen (moderately active) who in turn had a death rate significantly higher than section men (very active). Zukel studied new and recurring heart disease in North Dakota for a one-year period.[14] Of 228 heart attacks, the incidence of the more severe manifestations of the disease, myocardial infarction and death, was only half as great among farmers as in other less physically active occupational groups. Morris also studied heart diesease fatalities for farmers and nonfarmers in Indiana; his results were similar to Zukel's findings.[15] Fox and Haskell reported that individuals engaging in from one to two hours of daily heavy physical activity had only 18 percent incidence of heart attacks compared with those doing no physical work at all or that of less than one hour.[16]

In the Framingham, Massachusetts Study, men were classified according to habitual physical activity and subsequent incidence of coronary heart disease over a period of ten years.[17] In the ten years following the physical activity assessments, 207 men developed some type of coronary attack. These classified most sedentary in each age group had a coronary incidence almost twice that of those who were at least

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[14]W. J. Zukel, "A Short-Term Community Study of the Epidemiology of Coronary Heart Disease," American Journal of Public Health, XLIX (1959), p. 1630.

[15]W. H. Morris, p. 117.

[16]S. Fox and W. Haskell, "Physical Activity and the Prevention of Coronary Heart Disease," Bulletin of the New York Academy of Medicine (August, 1968), p. 958.

[17]W. B. Kannel, P. Sorlie, and P. McNamara, "The Relation of Physical Activity to Risk of Coronary Heart Disease: The Framingham Study," Coronary Heart Disease and Physical Fitness, O. A. Larsen and R. O. Malmborg, editors (Baltimore, 1971), p. 256.

moderately active. Paffenbarger utilized a large sample of San Francisco longshoremen in which 33 percent of the fatalities were from coronary heart disease.[18] It was found that men with jobs less physically active sustained death from coronaries one-third more frequently than those in more physically demanding cargo-handling positions. In post-mortem studies conducted over a ten-year period and involving sudden death from coronary occlusion, Spain found that men who had engaged in sedentary occupations tended to die suddenly from coronary heart disease at a younger age than those whose occupations involved considerable physical activity.[19] Frank reported that individuals classified as "least active" physically had an incidence rate for initial myocardial infarction greater than twice that experienced by individuals with physical activity classifications of "intermediate" and "most active."[20] Breslow and Buell found an association between physical activity and death from heart disease between the ages of 40 and 60.[21] Within this age range, workers in sedentary occupations had a 40 percent greater fatality rate from coronary attacks than did workers in occupations involving heavy physical activity. Hammond also

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[18]R. S. Paffenbarger, "Work Activity of Longshoremen as Related to Death from Coronary Heart Disease and Stroke," New England Journal of Medicine, XX (1970), p. 1109.

[19]D. M. Spain, "Occupational Physical Exertion and Coronary Artherosclerotic Heart Disease," Journal of Occupational Medicine (February, 1961), p. 60.

[20]C. W. Frank, "The Course of Coronary Heart Disease: Factors Relating to Prognosis," Bulletin of the New York Academy of Medicine, XLIV (1968), p. 900.

[21]L. Breslow and P. Buell, "Mortality from Coronary Heart Disease and Physical Activity of Work in California," Chronic Disease, II (1960), p. 425.

studied the relation of physical activity to frequency of deaths due to coronary heart disease.[22] Four exercise groups were formed in this study with degree of exercise rated as none, slight, moderate, and heavy. Over a 34-month period, it was found that even slight or moderate exercise was associated with the reduction of deaths from coronary heart disease.

Pedley reported higher death rates from coronary heart disease among business executives, lawyers, judges, and physicians than from among farmers, miners, and laborers.[23] Wilhelmsen and Tibblin studied 963 men born in 1913 in Sweden.[24] These men were first examined in 1963 at the age of 50 and were re-examined in 1967. At the time of the re-examination, they were interviewed concerning their physical activity both at work and during leisure time. It was found that high occupational physical activity was correlated to lower risk from heart attacks and that physical activity during leisure time was as important as during occupational work.

One of the studies which best supports the importance of exercise in preventing coronary heart disease was conducted by Brunner and Manelis in Israel.[25] This study appears to be especially significant

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[22] Physical Fitness Research Digest, p. 6.

[23] F. S. Pedley, "Coronary Disease and Occupation," Canadian Medical Association Journal, XL (1942), p. 147.

[24] L. Wilhelmsen and G. Tibblin, "Physical Inactivity and Risk of Myocardial Infarction: The Men Born in 1913 Study," Coronary Heart Disease and Physical Fitness, O. A. Larsen and R. O. Malmborg, editors (Baltimore, 1971), p. 251.

[25] D. Brunner and G. Manelis, "Physical Activity at Work and Ischemic Heart Disease," Coronary Heart Disease and Physical Fitness, O. A. Larsen and R. O. Malmborg, editors (Baltimore, 1971), p. 244.

due to the utilization of the Israeli kibbutzim, where a uniform mode of life is accepted. Occupations varied, but income and standard of living were not affected and members of the kibbutzim shared in eating the same types of food. Men were classified into sedentary and non-sedentary workers. No differences in serum cholesterol, serum triglycerides, and serum betacholesterol percentages were found between the two groups. Also, an almost equal distribution of overweight, normal weight, and underweight subjects were found in the two categories. The results indicated, nevertheless, that in all age brackets, sedentary workers had an incidence rate of heart attacks about two to four times as high as did nonsedentary workers.

Exercise and Blood Pressure

Boyer and Kasch have indicated that hypertension (high blood pressure) is the most frequent cardiovascular disorder found in the practice of medicine.[26] Generally, the use of exercise therapy has not been used by physicians in the treatment of hypertension. Some studies have been done, however, and a sampling is included in this review.

In an autopsy report of 4,000 non-coronary heart disease deaths, Morris and Heady found that hypertension was less frequent and occurred in later years among more active persons.[27] Miall and associates also

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[26] J. L. Boyer and F. W. Kasch, "Exercise Therapy in Hypertensive Men," Journal of the American Medical Association, CCXI, Part II (1970), p. 1671.

[27] J. N. Morris and J. Heady, p. 1057.

found less hypertension in physically active groups.[28] Morris found in his study of the London double-decker bus drivers and conductors that conductors from age 40 through 64 had lower blood pressure readings than did the drivers.[29] Brunner and Meshulam formed men between 55 and 71 years old into three physical fitness groups based on workloads performed on a bicycle ergometer.[30] It was found that subjects in two groups who had normal blood pressures at rest were able to perform more work than a group who had been classified as hypertensive. Pyorala studied managerial executives who were classified as having high blood pressure.[31] Two groups of 89 men were formed; one group participated in an exercise program three times per week for 18 months while the other group remained sedentary. Following this training period, the systolic and diastolic blood pressures showed decreases for the exercise group. Boyer and Kasch formed two groups; one included hypertensive men and the other non-hypertensive men.[32] Both groups of men took part in an exercise program twice a week for six months. Following the training period, the blood pressure in the hypertensive group decreased on the

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[28] W. Miall, "Factors Influencing Arterial Blood Pressure in the General Population," Clinical Science, XVII (1958), p. 409.

[29] J. N. Morris, J. Heady, and A. B. Raffle, p. 569.

[30] D. Brunner and M. Meshulem, "Physical Fitness of Trained Elderly People," Coronary Heart Disease and Physical Fitness, O. A. Larsen, and R. O. Malmborg, editors (Baltimore, 1971), p. 130.

[31] K. Pyorala, "A Controlled Study on the Effects of 18 Months' Physical Training in Sedentary Middle-Aged Men with Indices of Risk Relative to Coronary Heart Disease," Coronary Heart Disease and Physical Fitness, O. A. Larsen and R. O. Malmborg, editors (Baltimore, 1971), p. 261.

[32] J. L. Boyer and F. W. Kasch, p. 1668.

average of 13mm Hg., whereas there was no appreciable change in the normal group. Rudd and Day also indicated that above normal blood pressure could be lowered through an exercise program.[33] At the end of four and one-half months of their study, the average decreases in blood pressure readings were 12mm Hg. for systolic and 10mm Hg. for diastolic. Pederson-Bjergaard formed two groups of patients who had incurred a myocardial infarction.[34] The groups were matched in regard to age, time of infarction, and clinical symptoms. The experimental group exercised and the control group did not. At the end of six months of exercising three times per week, a significant decrease in heart rate and systolic blood pressure was noted in the trained group with no change in the untrained control group. Kiveloff and Huber also found desirable results in decreasing abnormally high blood pressure in subjects through physical training programs.[35]

Other Benefits of Exercise

There are functional mechanisms other than heart and circulatory systems on which physical activity appears to have an influence. It is well accepted that increasing the expenditure of energy through physical activity can be a successful way to reduce adiposity and to redistribute weight. Obesity not only shortens life but also

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[33] J. J. Rudd and W. G. Day, "A Physical Fitness Program for Patients with Hypertension," Journal of the American Geriatric Society, XV (1967), p. 373.

[34] O. Pedersen-Bjergaard, "The Effect of Physical Training in Myocardial Infarction," Coronary Heart Disease and Physical Fitness O. A. Larsen and R. O. Malmborg, editors (Baltimore, 1971), p. 115.

[35] B. Kiveloff and O. Huber, "Brief Maximal Isometric Exercise in Hypertension," Journal of American Geriatric Society, XIX (1971), p. 1009.

contributes to the development of degenerative diseases. The list of diseases to which the obese seem statistically prone is impressive: gallstones, nephritis, cirrhosis of the liver, and heart and artery diseases.[36] Life insurance statistics as well as clincial observations of thousands of obese patients testify to these facts.[37]

Certain studies that lend support to the relationship between exercise and weight loss are mentioned in the following paragraphs. When Taylor and associates conducted exercises for one hour per day over a ten-week period, the subjects who completed the program showed an average weight loss of seven pounds per person.[38] Evans et al. reported a group of overweight college students not only lost statistically significant amounts of weight over a ten-month experimental period but also showed considerable gains in muscular strength and power.[39] Mann and associates reported that when daily exercise is vigorous enough, gains in weight could be prevented even when subjects ate more than 6,000 calories daily.[40] A makred increase in weight followed when exercise was stopped, indicating that excess calories had

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[36] J. Mayer, "Genetic, Traumatic and Environmental Factors in the Etiology of Obesity," Physiological Review, XXXIII (1953), p. 472.

[37] L. I. Dublin, The Facts of Life from Birth to Death (New York, 1951), p. 15.

[38] E. D. Taylor and A. N. Hanson, "Weight Reducing Effects of Certain Induced Rhythmic Motions," Medical Times, LXXXV (1957), p. 1118.

[39] J. Evans, L. Ellison, and E. Casper, "The Effects of Exercise on the Reduction of Body Weight," Journal of Physical and Mental Rehabilitation, XII (1958), p. 56.

[40] G. V. Mann, K. Teel, O. Hayes, A. McNally, and D. Bruno, "Exercise in the Disposition of Dietary Calories: Regulation of Serum Lipoprotein and Cholesterol in Human Subjects," New England Journal of Medicine, 253 (1955), p. 1354.

been burned in exercise. Brozek studied the effect on obesity of regular participation in physical recreation by comparing healthy active and inactive businessmen.[41] The active men had heavier fat-free body weights, a lower percentage of body fat, and less of the disuse atrophy usually associated with aging. It is further indicated by authorities that change in fat content is probably more important than body weight. It is possible to decrease the body fat by an exercise program and yet not lose weight. Conversely, the inactive person loses muscle tissue and it is possible to lose weight and yet increase fat stores.

The Council on Foods and Nutrition of the American Medical Association recognized that one of the factors associated with weight gain experienced by many as they grow older is their decreased physical activity.[42] Perhaps the solution to obesity was best summarized when Mayer inferred that individuals will either have to step up their physical activity or be hungry all their lives.[43]

Due to the complexity of assessing physical fitness, many investigators have used the maximal oxygen consumption test in an attempt to better determine fitness. Since physical working capacity is dependent upon an individual's capacity to supply oxygen to the working muscles, it also assesses directly or indirectly the following components of physical fitness: cardiovascular function, respiratory function, muscular coordination, muscular strength, muscular endurance, and obesity.

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[41] J. Brozek and A. Keys, "The Evaluation of Leanness-Fatness in Men: Norms and Interrelationships," British Journal of Nutrition, V (1951), p. 194.

[42] H. Pollack, "Metabolic Demands as a Factor in Weight Control," Journal of the American Medical Association, 167 (1958), p. 216.

[43] J. Mayer, p. 478.

The significance of this method of determining levels of physical fitness is summed up by Astrand:

> For every liter of oxygen consumed in combustion 4.7-5.05 kilogram calories are liberated. Measurement of oxygen uptake during work thus estimates the amount of aerobic energy transfer. The greater the oxygen transport capacity (aerobic work capacity), the greater the potential energy output. A high oxygen transport capacity also implies that a given energy output can be accomplished with relatively less physiological strain.[44]

A reduction in maximal oxygen consumption will restrict an individual's ability to engage in severe physical work, cause an older sedentary individual to work close to his maximum VO_2; that is, at a decreased reserve capacity, and generally contribute to fatigue. Balke determined that individuals classified as poor to very poor in maximum oxygen consumption indicates that these individuals, when subjected to severe physical stress, would have a poor chance of surviving cardiovascular failure.[45]

The preceding brief discussion of maximal oxygen consumption is included to point out its importance to physical fitness and the fact that, fortunately, this quality can be improved through a physical training program. Various studies have shown that there is better utilization of oxygen as a result of training with a consequent increase

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[44] P. O. Astrand, T. E. Cuddy, B. Saltin, and J. Stenberg, "Cardiac Output During Submaximal and Maximal Work," Journal of Applied Physiology, XIX (1964), p. 268.

[45] B. Balke and R. W. Ware, "An Experimental Study of Physical Fitness of Air Force Personnel," United States Armed Forces Medical Journal, X (1959), p. 675.

in work efficiency[46] and that maximum oxygen consumption can be increased through training.[47,48,49,50,51]

Summary

It may be seen from the preceding discussion that physical activity plays an extremely important part in man's life. When an individual succumbs to the ease and comfort of modern living, it is indicated that he pays an often supreme price through decreased efficiency in body organisms. It also appears that when physical activity is removed from life, atrophy of both size and function occur in the organism. Exercise directly involves the skeletal muscles of the arms, the trunk, and the legs; the effects on the circulatory and respiratory systems, however, are equally important. The physiological effects of exercise on the human organism are many and complex, but it is easy to see why man may create serious problems for himself and, consequently, for others when he ignores the implications of exercise. Evidence points out that exercise should become an essential and constant element in the pattern of one's life.

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[46]P. O. Astrand, p. 335.

[47]T. K. Cureton, Physical Fitness of Champion Athletes, p. 145.

[48]J. V. Durnin, J. M. Brockway, and H. W. Whiteher, "Effects of a Short Period of Training of Varying Severity on Some Measurements of Physical Fitness," Journal of Applied Physiology, XV (1960), p. 161.

[49]C. A. Knehr, D. B. Dill, and W. Neufeld, "Training and Its Effects on Man at Rest and at Work," American Journal of Physiology, 136 (1942), p. 1006.

[50]P. V. Karpovich, Physiology of Muscular Activity, 5th edition (Philadelphia, 1959), p. 151.

[51]J. H. Mitchell, B. J. Sproule, and C. B. Chapman, "Factors Influencing Respiration During Heavy Exercise," Journal of Clinical Investigation, XXXVII (1958), p. 1693.

CHAPTER III

PROCEDURES

The procedures followed during the course of this study are organized under the following headings: (1) selection of subjects; (2) personal data collected; (3) test administration; and (4) description of instruments.

All testing was undertaken at the Oklahoma State University Colvin Physical Education Center Laboratory.

Selection of Subjects

The selection of the subjects was on a voluntary basis; some of the men had been involved previously as subjects in an aerobics study and were utilizing the Colvin Physical Education Center for their physical activity. Notices were also published in the institution's newspaper and a meeting was conducted for those who wished to start an exercise program. As a result of these factors, the subjects were 85 male volunteers from the Oklahoma State University faculty and administration between the ages of 25 and 58 with a mean age of 40.3 years.

Personal Data Collected

The personal data collected from each subject was gathered through an interview before each test session. Each subject was questioned in order to collect information concerning his age, medical history, and present recreational and physical activities. Height and weight were also recorded prior to testing. The subjects were asked to give the frequencies per week, the type of activity, and the time involved per session of their physical activity endeavors. All pertinent information gathered in the interview was recorded on individual forms (see Appendix, p. 77).

Test Administration

Prior to the arrival of the subject at the laboratory, all testing equipment was checked and made readily accessible.

The subject arrived at the laboratory dressed in shorts, socks, and gym shoes. The sequence of events was as follows: (A) the administration of an electrocardiogram, (B) the Schneider Index Test, (C) the skinfold measurements,(D) the body circumference measurements, (E) the pulmonary function measurements, (F) the Balke Treadmill Test, and (G) the post exercise pulse pressure measure.

The Electrocardiogram

The subject was asked to lie on a table and relax for five minutes. During this time test procedures were explained to the subject and the telemetry electrodes and transmitter were attached to his chest. Following this, a Birtcher Electrocardiograph 335 was utilized to record the electrocardiogram. The leads used were as follows: lead 1, from right arm to left arm; lead 2, from right arm to left leg; and lead 3, from left arm to left leg. The primary interest in this study was concerned with the amplitude of the R and T waves and the rest/work ratio. An example of these measures is shown in the Appendix, p. 78.

The Schneider Index

After a quiet laying period of five minutes, each subject's reclining pulse rate was telemetered; and the pulse rate and systolic and diastolic blood pressures were recorded on the physiograph; then the same measures were taken immediately upon standing to determine any difference between the measurements in the reclining and standing positions. The subject was next instructed to step upon a 20-inch stool at a cadence of five steps in 15 seconds; the heart rate was again measured immediately after the exercise and each 30 seconds thereafter until the heart returned to the standing normal rate. Cureton's modified scoring procedure was used and is shown in the Appendix, p. 79.

Skinfold Measurements

The Lange Skinfold Caliper was utilized to obtain skinfold thicknesses at three sites; the abdomen, chest, and arm. More specifically, the measurements of the chest were taken at a midpoint between the anterior crease of the axilla and the nipple; the abdominal measurements were taken on the right side at the umbilical level; and the arm measurement was taken at the midposterior point between the tip of the acromion and the tip of the olecranon. All skinfold measurements were made on the right side of the body by grasping the skinfolds between the thumb and index finger and applying the calipers about 1 cm. from the fingers holding the skinfold and at a depth equal to the thickness of the fold. The figures obtained were then utilized in the Brozek-Keys nomogram for conversion of skinfold fat to specific gravity and percent of body fat[1] (see Appendix, p. 80).

Body Circumference Measurements

The analysis of body build and assessment of ideal body weight of each subject were done by using a Lufkin 6-feet woven anthropometric tape for certain body circumference measurements. Circumference measurements were first taken of the shoulders, chest, abdomen, buttocks, left and right wrists, forearms, and biceps. The subject then stood on a stool in order that measurements could be taken more easily of both right and left thighs, knees, calves, and ankles. Each measurement was recorded in centimeters and the average for each measurement of the extremeties was computed. These values were entered in the table[2] and calculations were made to determine the predicted weight of each subject (see Appendix, p. 82). The difference between the predicted weight and actual weight was then computed to determine the weight residual.

Pulmonary Function Measurements

The Collins Respirometer was prepared for testing the vital capacity and timed vital capacity by filling the cannister with oxygen, inserting marking pens for the recordings, and connecting a mouthpiece to the valve system. The speed of the rotating drum was set at 32 mm/min. The subject was instructed as to how to breathe through the

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[1] J. Brozek and A. Keys, "The Evaluation of Leanness-Fatness in Men: Norms and Interrelationships," British Journal of Nutrition, V (1951), p. 198.

[2] Herbert A. DeVries, Laboratory Experiments in Physiology of Exercise (Dubuque, Iowa, 1971), p. 123.

apparatus and a nose clip was placed on the subject prior to beginning the test. After a period of adjustment to allow for a pattern of normal breathing, the subject was instructed to inhale as much air as possible and then exhale as much air as possible to measure his vital capacity. Each subject's recording was obtained from the kymograph reading by subtracting the initial figure from the maximal figure for the exhaling phase. This score was then multiplied by a correction factor to express the volume in BTPS (body temperature, air pressure, and saturation with water). The figure of 1.085 (for 23 degrees C) was used as the temperature correction factor for the readings.

Sample calculation: Initial kymograph reading = 1425; Final reading = 5425; Difference = 4000

4000 x 1.085 = 4340 or 4.3 L (BTPS)

The obtained vital capacity (BTPS) was then compared with Kory's expected norm to determine the residual[3] (see Appendix, p. 83).

After completion of the vital capacity test and after several normal breaths, the subject was asked to take a maximum inspiration and hold; the respirometer was switched to a drum speed of 1920 mm/min. and the subject was simultaneously instructed to force as much air out as fast as he could. This procedure was employed to measure the timed vital capacity for a one-second interval. The timed vital capacity reading was also corrected to (BTPS) and compared to the prediction in the nomogram to determine the residual (see Appendix, p. 83).

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[3]Ross C. Kory, Robert Callahan, Hollis G. Boren, and James C. Syner, "The Veterans Administration-Army Cooperative Study of Pulmonary Function: Clinical Spirometry in Normal Men," American Journal of Medicine, XXX (1961), 243-258.

The maximal breathing capacity test was administered by employing a one-way breathing valve and the Collins 110 Liter Tissot tank to collect the expired air. Each subject was instructed to breathe forcefully and deeply into the mouthpiece at a rate of about one time per second. The subjects were also told not to try to breathe as deeply or as rapidly as possible but to try to compromise between the rate and depth of breathing. The test was given in the standing position and prior to the test a nose clip was attached to the subject's nose. Two trials of 15 seconds each were allowed and the best score was recorded.

The maximal breathing capacity volume was expressed as liters per minute (BTPS). Each subject's recording was obtained by computing the vertical difference between the initial reading and the final reading on the kymograph drum. The obtained score was multiplied by a correction factor of 1.332 for the Tissot tank and this product was then multiplied by 4 to obtain liters for one minute. The liters per minute quantity was then multiplied by 1.085 to obtain the corrected liters per minute (BTPS).

Sample calculation: $250 \times 4 \times 1.332 = 1332$ or 133.2 L/min.

$133.2 \times 1.085 = 144.52$ L/min. (BTPS)

The obtained maximal breathing capacity volume (BTPS) was then compared with the expected norm for individuals of comparable height and age to determine the residual (see Appendix, p. 83).

Balke Treadmill Test

The treadmill was started and the subject was instructed to grasp the side rails of the treadmill and place his right foot on and off to get the "feel" of the moving belt. The subject then started walking the treadmill and when at ease he was instructed to release his grasp and continue in a normal walking stride. The treadmill speed was set at 3.4 miles per hour and the incline of the treadmill was raised two percent after the first minute and one percent each minute thereafter until the subject's heart rate reached a predetermined target rate. Balke has determined the target rate to be 180 beats per minute for healthy young men; however, precautions were taken in order that the test could be terminated prior to achieving the target rate.[4] Electrocardiogram readings were taken after the subject's heart rate reached 150 and if unusual depressions or elevations of the ST segment appeared or if two or more arhythmias occurred in a ten-second interval, the test was terminated. At the termination, the length of time the subject walked and the corresponding treadmill angle were recorded together with the final heart rate.

The predicted maximal oxygen intake in ml/kg/min. was determined by the corresponding treadmill angle from Balke's regression equation[5] and this score was entered into Cooper's chart for age-adjusted fitness categories to determine the subject's level of fitness (see Appendix, p. 84).

Post Exercise Pulse Pressure

Following the Balke Treadmill Test, the subject was asked to lie down for the recovery period. The blood pressure was taken at the

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[4]B. Balke and R. W. Ware, "An Experimental Study of Physical Fitness of Air Force Personnel," United States Armed Forces Medical Journal, X (1959), p. 681.

[5]B. Balke, Health and Fitness in the Modern World (Chicago, Illinois, 1961), p. 84.

five-minute mark of recovery to determine the pulse pressure. An adult-size occluding cuff was placed around the upper arm of the subject and the physiograph was used to record the blood pressure.

Utilization of Data

The data was analyzed primarily through the use of the Chi Square test to determine possible significant differences in physical fitness measurements in the various categories. A contingency coefficient was then computed to measure the extent of association between two sets of attributes.

The age categories selected for comparison were arbitrarily set at 25-34, 35-44, and 45 years of age and over. The distinction between faculty and administrators was determined on the basis of credit hours taught; those with one-half or less teaching load were classified as administrators and those with more than one-half teaching load were classified as faculty. Subjects were also classified according to physical activity patterns to determine the relationship between physical exercise and the physiological measurements attained. Cooper's aerobic point scale was utilized to aid in the classification of subjects; those who earned 28 points or more per week were classified as "active," those earning between 16 and 27 points per week were classified as "moderate," and the "light" category included those subjects earning 15 points or less each week.

In areas of comparison of academic departmental personnel where the number of subjects did not warrant the use of Chi Square, means were computed as a method of comparison. The departments in which several subjects were tested and were subsequently compared were those of agriculture; education; geography; and health, physical education and recreation. Means and percentages of change were used in the comparisons of 16 subjects who were re-tested. These subjects had been part of a study conducted during the previous year and some of the same physiological measurements were employed; thus, the opportunity was taken to compare the same measurements to determine if changes had occurred during the elapsed time. The data was also utilized to compare possible differences between smokers and non-smokers. Subjects who had quit smoking for at least one month were classified as non-smokers in this study.

Description of Instruments

Numerous instruments were utilized to obtain the physiological measurements of the subjects and the following is a brief description of the instruments employed along with names of the manufacturers.

One-Way Breathing Valve: A device which enabled the subjects to inhale atmospheric air and then expire the air into a Tissot tank for measurement of the maximal breathing capacity. (Model - Triple "J" valve; Warren E. Collins, Inc., 220 Wood Road, Baintree, Massachusetts)

Physiograph: An apparatus that was used to monitor and record heart rate during rest, work, and recovery; it was also used to record reclining and standing blood pressure. (Type PMP-4A-Four Channels; E and M Instrument Company, Inc., Houston, Texas)

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 F.M. 1100-7; E and M Instrument Company, Inc., Houston, Texas)

Quinton Motorized Treadmill: An apparatus with a continuously moving belt which may be made to run at various speeds and inclinations, thus standardizing work loads. (Model 642; Speed Range, 1.5-25 miles per hour; Elevation (percent grade), 0-40; Seattle, Washington)

Tissot Tank: A large stainless steel tank which was used for collecting volumes of expired air during the maximal breathing capacity test. (Capacity - 120 liters; Serial No. 1440; Warren E. Collins, Inc., 555 Huntington Avenue, Boston, Massachusetts)

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

Blood Pressure Cuff: An inflatable occluding cuff, adult size, Part No. 712-0016, was used for indirect measurement of systolic and diastolic pressures by the ausculatory method.

Skinfold Calipers: A device for the measurement of skinfold thickness designed whereby the jaw surfaces are always parallel and the spring tension is always constant regardless of the degree to which the calipers are open. (Lange Skinfold Caliper, Cambridge Scientific Industries, Inc., Cambridge, Maryland)

Linen Tape: A measuring tape marked in centimeters that was used to obtain data related to body part circumferences. (Lufkin 6-feet Woven Tape 3176 ME)

Collins Respirometer: A pulmonary functional test unit that measures various respiratory capacities. This unit was employed in testing vital capacity and timed vital capacity. (Collins 9 Liter Respirometer, Serial No. 2555; Warren E. Collins, Inc., 220 Wood Road, Baintree, Massachusetts)

Electrocardiograph: The Birtcher Electrocardiograph was the instrument used to assess the ability of the heart to transmit the cardiac impulse. By placing electrodes on the arms and legs and connecting these to the recording instrument, the impulse generated during each heart beat was recorded. (Birtcher Electrocardiograph 335, Medical Specialty Company, Fort Worth, Texas)

Electrolyte Solutions: An electrolyte that emulsifies skin oil and provides a conductive medium between the skin and the electrodes was used with the Birtcher Electrocardiograph and the telemetry system. (Redux Creme, Part No. 651-1021, Hewlett-Packard, Waltham, Massachusetts)

CHAPTER IV

ANALYSIS OF DATA AND DISCUSSION OF RESULTS

The purpose of this study was to appraise the physical fitness status of 85 volunteer males of the Oklahoma State University faculty and administration. This chapter relates to the findings of the physiological measurements utilized and discusses implications of the results.

Means and Standard Deviations for Selected Test Items

Table I, page 40, lists the mean scores of the physiological measurements employed in this study.

Literature pertaining to resting heart rate for adult males generally indicated the average rate of approximately 72 beats per minute. The subjects utilized in this study showed a mean of 65.65 in resting heart rate. Thus, faculty and administrators at Oklahoma State University who took part in this investigation demonstrated a lower mean score in resting heart rate than average. Lower resting heart rates are generally interpreted as a desirable component of physical fitness because the cardiac muscle does not have to contract as many times while at rest.

Generally, investigations concerning blood pressure readings recorded during a quiet reclining position indicate a range of 110 to

TABLE I

MEANS AND STANDARD DEVIATIONS FOR SELECTED TEST ITEMS

Test Item	N	Mean	Standard Deviation
Resting Heart Rate (Beats Per Minute)	85	65.65	4.46
Resting Systolic Blood Pressure (Millimeters Mercury)	85	122.5	10.28
Resting Diastolic Blood Pressure (Millimeters Mercury)	85	73.94	8.26
Schneider Index	85	13.38	3.55
Vital Capacity (Liters)	85	4.82	.76
Vital Capacity Residual (Liters)	85	-.06	.64
Timed Vital Capacity (Liters)	85	4.19	.71
Timed Vital Capacity Residual	85	.25	.62
Maximal Breathing Capacity (Liters Per Minute)	85	169.9	30.28
Maximal Breathing Capacity Residual (Liters Per Minute)	85	-4.54	28.93
R Wave Amplitude (Millimeters)	80	11.13	3.93
T Wave Amplitude (Millimeters)	80	3.08	1.63
Rest/Work Ratio	80	2.12	.34
Weight (Pounds)	85	177.43	24.41
Weight Residual (Pounds)	85	8.85	5.76
Percent Body Fat	85	11.67	5.02
O_2 Intake (Ml/Kg./Min.)	85	39.52	7.69
O_2 Intake Classification (K. H. Cooper)	85	3.69	.85
Post Exercise Heart Rate (5 Min.)	79	95.78	9.92
Post Exercise Systolic Blood Pressure (5 Min. Millimeters Mercury)	50	131.62	10.0
Post Exercise Pulse Pressure (5 Min. Millimeters Mercury)	50	62.64	11.23

135 mm Hg. for systolic and 60 to 90 mm Hg. for diastolic. A person's blood pressure may be considered to be normal if it comes within the minimum-maximum range, provided the relative pulse pressure is maintained. The subjects employed in this study fell well within the range of normal limits of blood pressure readings.

Heart rates and blood pressures were further employed to obtain additional information relating to the fitness of subjects through the use of the Schneider Index Test. The test incorporates heart rates and blood pressures taken from a quiet reclining position with measurements again obtained immediately upon changing to a standing position and recordings taken at intervals following an exercise period. Through the scoring system of this test, a composite score of 22 is possible. It is generally considered that subjects should score at least 12 points on the test to be deemed functionally fit. The mean score of subjects in this study was 13.38, indicating that the group was slightly above the acceptable level of fitness for the test.

The pulmonary function measurements employed in this study generally indicated the subjects to be somewhat below the expected norms in vital capacity and maximal breathing capacity. The results of the timed vital capacity shown in pertinent literature generally reflect a value of 4.8 liters to 5.0 liters; the subjects in the study demonstrated a mean of 4.82 liters. As the measurements relate to timed vital capacity, it has generally been observed that normal subjects expire 83 percent of the vital capacity from 0 to 1 second. Subjects in this study exhibited an average of 86 percent; they were therefore slightly above the normal value. Normal maximal breathing capacity values generally range from 135 to 175 liters per minute. Subjects in the study possessed a mean of 169.9 liters per minute.

Pulmonary functional measurements per se can often be misleading. With this factor in mind, the pulmonary functional measurements were related to body surface area in order to become a more meaningful index. Each subject was compared with his own expected norm and the difference between the actual observed score and the expected norm yielded the residual. The residual perhaps represents the true fitness measures in these tests. The mean residuals of the subjects were as follows: vital capacity resitual, -.06 liters; timed vital capacity residual, .25 liters; and maximal breathing capacity residual, -4.54 liters per minute. Thus, when subjects were compared with their own norms, they were below the norm in vital capacity and maximal breathing capacity and slightly above in the timed vital capacity breathing capacity and slightly above in the timed vital capacity quantity.

An electrocardiograph was utilized to obtain certain measures relative to the heart. Of interest in this particular study was the compilation of information concerning the condition of the heart by utilizing the measurements of the heights of the R and T waves and also through determining the rest/work ratio (for example, dividing work time into rest time). As stated previously, it is a thesis that the height of R and T waves may indicate the strength of the heart. Cureton[1] in his work with young males found a mean of 13.19 mm for the R wave and a mean of 4.2 mm for the T wave. Other studies involving young college males at Oklahoma State University who were OSU

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[1]T. K. Cureton, Physical Fitness Appraisal and Guidance (St. Louis, 1947).

Physiology of Exercise students indicated a mean of 11.8 mm for the R wave and 3.8 mm for the T wave.[2] The subjects utilized in the study demonstrated a mean of 11.13 mm for the R wave and 3.08 mm for the T wave and would be considered to be in the average range on these two measures. The rest/work ratio is an indicator of how much time the heart has to work in proportion to the time spent relaxing. The higher figure generally indicates a more efficient heart. The young males whom Cureton[3] studied possessed a mean of 2.55 mm and young male college students at Oklahoma State University previously mentioned demonstrated a mean of 2.2 mm for rest/work ratio. Again, considering the age and activities of the subjects employed in the study, the obtained mean score of 2.12 mm would indicate a normal value.

To estimate ideal body weight for each subject, an anthropometric tape was utilized at selected sites on the body. In order to determine the percent body fat for each man, the Lange Skinfold Caliper was employed. The results of the anthropometric tape measurements yielded a mean of 8.85 pounds overweight for the subjects. The skinfold measurements indicated a mean of 11.67 percent body fat. Pertinent literature generally indicated that adult males should be lower than 14 percent body fat. The 11.67 percent body fat would indicate that the subjects contained less fat than normal but were overweight. As may be seen from the results of the overweight and percent body fat data, there is some discrepancy. This discrepancy may be that the regression equation for predicting percent body fat norms employed in

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[2] A. B. Harrison, "Norms of Physiological Measurements for Oklahoma State University Physical Education Majors" (Unpublished, 1971).

[3] T. K. Cureton, Physical Fitness Appraisal and Guidance.

the study was obtained from younger males than were utilized in the study. Underwater weighing of male subjects 40 to 50 years of age in other studies tended to uphold this belief; however, this technique is believed to be adequate when comparing subjects within the same study.

The predicted maximal oxygen intake of the subjects employed in the study yielded a mean of 39.52 ml./kg./min. This figure places the subjects between the "fair" and "good" categories on Balke's fitness scale (see Appendix, p. 85). When the maximal oxygen intake scores were compared with Cooper's age adjusted scale which indicates fitness based on maximal oxygen intake rather than showing the actual oxygen intake measures (see Appendix, p. 84), the mean was 3.69 which again placed the subjects between the "fair" and "good" classifications. Indications of the maximal oxygen intake results, then, were that when considered as mean per se or age adjusted, the subjects rated better than fair but slightly less than good for this component of fitness.

Three measurements were taken following exercise: the post exercise heart rate, the post exercise systolic blood pressure, and the post exercise pulse pressure. These measurements were taken five minutes after the subject's treadmill test during which the heart rate reached 180 beats per minute or a previously determined target rate. The general indicators of fitness to be observed in these measurements were those of determining if, after five minutes rest, the heart rate was still above 100 beats per minute; determining if the systolic blood pressure remained 15 millimeters mercury or more above a previous recording taken during a pre-exercise quiet resting period, and determining if there was a deviation of 20 millimeters mercury or more between the pre-exercise pulse pressure and the five-minute post exercise recovery period. All three recordings could be considered within the average range; the mean post exercise heart rate was 95.78, the systolic blood pressure was 131.62 as compared to the pre-exercise mean of 122.5 millimeters mercury, and the post exercise pulse pressure was 62.64 as compared to 48.36 millimeters mercury.

Correlation Between Physical Activity Patterns and Selected Physiological Measurements

Table II, page 46, shows the Chi Square values with the significance of the scores indicated. Table II also illustrates the extent of association between physical activity patterns and the selected physiological measurements.

Several of the physiological measurements showed a strong association with the subjects' physical activity patterns with the physically active group possessing the strongest positive relationships. These measurements were resting heart rate, vital capacity, timed vital capacity, T wave amplitude, rest/work ratio, percent body fat, and maximal oxygen intake. All were significantly different at the .05 level of probability.

To determine the relationship between physical activity and resting heart rate, the subjects were classified as "active," "moderate," and "light" according to the amount of physical exercise each was obtaining. Each was placed in one of two categories for resting heart rate; those with 60 beats per minute or less and those with 61 beats per minute or more. The results of these comparisons yielded a Chi Square value of 8.82 which was significant at the .05 level. This finding substantiated what is generally stated in the literature relating to exercise and

TABLE II

CORRELATIONS BETWEEN PHYSICAL ACTIVITY PATTERNS AND SELECTED PHYSIOLOGICAL MEASUREMENTS

Test Item	Physical Activity Categories Active N	Moderate N	Light N	Chi Square Value	Degrees of Freedom	Contingency Coefficient
Resting Heart Rate (Beats Per Min.)	25	33	27	8.82*	2	.31
Resting Systolic Blood Pressure (Millimeters Mercury)	25	33	27	1.9	2	.15
Schneider Index	25	33	27	4.57	4	.23
Vital Capacity Residuals (Liters)	25	33	27	10.53*	2	.33
Timed Vital Capacity Residuals (Liters)	25	33	27	8.63*	2	.31
Maximal Breathing Capacity Residuals (Liters Per Minute)	25	33	27	.33	2	.06
R Wave Amplitude (Millimeters)	23	32	25	.35	2	.07
T Wave Amplitude (Millimeters)	23	32	25	7.46*	2	.29
Rest/Work Ratio	23	32	25	6.35*	2	.27
Weight Residual (Pounds)	25	33	27	4.81	4	.23
Percent Body Fat	25	33	27	6.31*	2	.26
Maximal O_2 Intake (Ml./Kg./Min.)	25	33	27	19.66*	2	.44
Post Exercise Heart Rate (5 Min. Millimeters Mercury)	23	31	25	5.0	2	.24
Post Exercise Systolic Blood Pressure (5 Min. Millimeters Mercury)	16	18	16	.11	2	.05
Post Exercise Pulse Pressure (5 Min. Millimeters Mercury)	16	18	16	1.05	2	.14

*Significantly Different at .05 Level

significant relationship between physical activity patterns and rest/work ratio of the heart. There exists, then, a possibility that regular exercise may have influenced the efficiency of the hearts of subjects in this study.

In determining the relationship between physical activity patterns and percent body fat, the subjects were categorized in one of two groups, those who showed 10 percent or less body fat and those who possessed 11 percent or more body fat. The same physical activity patterns were employed as previously stated. Even though pertinent literature generally indicates 14 percent body fat as being average in adult males, 10 percent was decided upon as the dividing point due to the technique employed in assessing body fat in the study. As indicated in Table II, there was a significant relationship between physical activity patterns and percent body fat for subjects employed in the study.

The strongest correlation between physical activity patterns and a component of physical fitness was found in maximal oxygen intake as related to physical activity. Table II shows a Chi Square value of 19.66 and a contingency coefficient of .44 which indicates the extent of association between exercise and maximal oxygen intake. The subjects were classified by using Cooper's age adjusted chart.[4] They were divided into two groups, those who obtained a rating of 4 or better and those who scored 3 or less on the fitness scale based on O_2 intake. Exercise appeared to have a marked influence in the relationship between maximal oxygen intake ratings and whether subjects

[4] K. H. Cooper, The New Aerobics (New York, 1970), p. 28.

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[4]K. H. Cooper, The New Aerobics (New York, 1970), p. 28.

utilized in this study were classified as being in "good" or "fair" physical condition.

Physiological measurements not showing a significant degree of association with physical activity patterns of the subjects employed in the study are briefly discussed in the following paragraphs.

All tests employing some assessment of blood pressure failed to show a significant relationship between the two attributes. In determining the relationship between physical exercise and resting systolic blood pressure, the same activity pattern categories were used and systolic blood pressure classifications of 129 millimeters mercury or less and 130 millimeters mercury or more were used. The failure to show a significant relationship between the two in this study could have been due to the fact that the great majority showed systolic blood pressure readings of less than 130 mm mercury, the mean being 122.5 mm mercury for this group. Studies also generally indicate that abnormally high systolic blood pressures may many times be lowered following a systematic exercise program, although pressures already considered normal are affected very little. Since there were few cases in this study that could have been classified as abnormally high, this could have been another factor contributing to the failure to show an association. The Schneider Index test incorporates blood pressures in its scoring system, which may have also led to failure to show an association.

In assessing post exercise systolic blood pressure after five minutes of rest, the dividing point for determining acceptable levels was set at 15 mm mercury or more above the pre-exercise reading or 14 mm mercury or less from the pre-exercise reading. The failure to show a significant relationship with physical activity patterns may have been due to the level of 15 mm mercury used as the dividing point being set too high. The pulse pressure division was 20 mm mercury or more above pre-exercise and 19 mm mercury or less from the pre-exercise reading. The setting of 20 mm mercury above the pre-exercise recording may have been too high or perhaps subjects who possessed normal blood pressures were less affected than those who indicated abnormal resting blood pressures.

To obtain the data for maximal breathing capacity, subjects were compared with their own expected norms and divided into two categories; those who showed plus residuals forming one group and those who demonstrated a minus residual forming the other group. The failure of maximal breathing capacity to correlate significantly with physical activity patterns verified what many previous investigators had found.[5,6,7] Even though maximal breathing capacity is valuable in evaluating pulmonary function impairment, it generally does not correlate highly with other aspects of physical fitness.

The failure of the R wave amplitude to show a significant relationship with physical activity patterns at first may appear to be unusual since the T wave did indicate a significant relationship. But the

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[5] E. F. Baldwin, A. Cournand, and D. W. Richards, "Pulmonary Insufficiency: Physiological Classification, Clinical Methods of Analysis, Standard Values in Normal Subjects," Medicine, XXVII (1948), p. 31.

[6] C. F. Consolazio, R. E. Johnson, and L. J. Pecora, Physiological Measurements of Metabolic Functions in Man (New York, 1963).

[7] T. K. Cureton, Physical Fitness Appraisal and Guidance.

categorization lines of 10 mm or higher and 9 mm or lower may have been a contributing factor. The mean of this group for this measurement was 11.13; but since the interest of the study was more concerned with what would be considered at least average for the employed age group, the figure of 10 mm was utilized.

Two other components which did not show significant relationships with physical activity patterns were weight residuals and post exercise heart rate. The lack of significant relationship may have been due to the categorization of subjects. To determine a dividing line for weight residuals, the subjects were divided according to those who were 7 pounds or less overweight, 8 to 14 pounds overweight, and 15 or more overweight. If the subjects had been classified only as being 15 pounds or more overweight, a significant relationship probably would have been obtained. The division for subjects concerning post exercise heart rate taken after five minutes of rest was 100 beats per minute or above for one group and 99 beats per minute or less for the other group. Table II shows a Chi Square value of 5, but a result of 5.99 was needed to be significant at the .05 level.

Comparisons of Physiological Measurements Between Faculty and Administrators

Selected physiological tests utilized to determine if there were any marked differences between faculty members and administrators who were employed in the study. The particular interest was to investigate the possible effects that the nature of one's occupational duties might have on physical fitness measurements used in the study. As indicated in Table III, page 52, there was no significant difference between the

TABLE III

COMPARISONS OF PHYSIOLOGICAL MEASUREMENTS
BETWEEN FACULTY AND ADMINISTRATORS

	Faculty N = 59	Administrators N = 26	
Test Item	Chi Square Value	Degrees of Freedom	Contingency Coefficient
Resting Heart Rate (Beats Per Minute)	3.08	1	.19
Resting Systolic Blood Pressure (Millimeters Mercury)	.01	1	.0001
Schneider Index	1.78	2	.14
Vital Capacity Residual (Liters)	.06	1	.03
Timed Vital Capacity Residual (Liters)	1.12	1	.11
Maximal Breathing Capacity Residual (Liters)	1.68	1	.14
R Wave Amplitude (Millimeters)	.11	1	.01
T Wave Amplitude	.84	1	.10
Rest/Work Ratio	5.68*	1	.26
Weight Residual (Pounds)	.38	2	.07
O_2 Intake Classification (K. H. Cooper)	.64	1	.01
Percent Body Fat	.27	1	.06
Post Exercise Heart Rate (5 Minutes)	2.1	1	.16
Post Exercise Systolic Blood Pressure (5 Minutes Millimeters Mercury)	.51	1	.10
Post Exercise Pulse Pressure (5 Minutes Millimeters Mercury)	.31	1	.08

*Significantly Different at .05 Level

two groups on the measurements employed except for the rest/work ratio of the heart. There appeared to be no valid reason for this one difference and may be only a chance occurrence. It may be concluded in this study that the nature of a faculty member's or an administrator's duties have no apparent effect on the physiological measurements employed.

Results of Sixteen Test and Re-Test Subjects On Selected Physiological Measurements

Sixteen subjects employed in this study had previously served as subjects in another study occurring one year before this study, and some of the same physiological measurements had been used. As these subjects had been exercising regularly since the first study, it was of interest to determine whether or not changes had taken place in the selected measurements during the one-year interval. As can be noted from Table IV, page 54, all the measurements except percent body fat were improved. In attempting to determine if improvement of these selected physiological measurements may have been due to accelerated physical activity patterns, there was no certainty that this was the chief contributing factor. Subjects who had previously earned enough points to be classified either "moderately active" or "active" in the previous study appeared to be exercising in approximately the same pattern. However, it was noted in the interviews of the subjects that they could jog previous distances in less time and it may have been that they were increasing the stress of their activity gradually. Since it is generally believed that the method to be used to bring physiological improvement is that of the "overload principle" (that is, progressively

TABLE IV

MEAN SCORES OF SIXTEEN TEST AND RE-TEST SUBJECTS FOR SELECTED PHYSIOLOGICAL MEASUREMENTS

Test Item	Pre-Test	Post-Test	Percent Change
Resting Heart Rate (Beats Per Minute)	64.38	59.56	-8
Resting Systolic Blood Pressure (Millimeters Mercury)	128.88	121.19	-6
Resting Diastolic Blood Pressure (Millimeters Mercuty)	79.81	74.63	-7
Schneider Index	14.63	14.75	1
Vital Capacity (Liters)	4.62	4.66	1
Timed Vital Capacity (Liters)	3.94	4.01	2
Maximal Breathing Capacity (Liters Per Minute)	144.7	160.39	10
R Wave Amplitude (Millimeters)	10.56	11.66	9
T Wave Amplitude (Millimeters)	3.19	3.25	2
Rest/Work Ratio	2.15	2.21	3
Percent Body Fat	11.25	12.13	7
O_2 Intake (Ml./Kg./Min.)	40.66	42.19	4
Age Adjusted O_2 Intake Classification (K. H. Cooper)	3.81	4.06	6
Post Exercise Heart Rate (5 Minutes)	98.75	95.63	-3

increasing resistance), this may explain why these subjects experienced an overall improvement.

Results of Physiological Measurements for Selected Departmental Personnel

Another concern of this study was to compare the results of the physiological measurements among various academic departmental personnel. The departments of agriculture; education; geography; and health, physical education and recreation contained enough subjects in this study to warrant comparisons. Table V, page 56, shows the mean scores of the selected physiological measurements for each department. It was interesting to note that the mean scores on eight physiological variables were best for the health, physical education and recreation department. It should be noted, however, that the mean age for members of this department was younger than for the others. There were not enough members in the departments to utilize the Chi Square statistical technique in attempting to determine what effects physical activity patterns may have played on the results obtained.

The mean scores for the department of health, physical education and recreation were better than the mean for the entire group of subjects employed in the study for all measurements except the maximal breathing capacity results. The agriculture department was next, ranking better on ten of the eighteen measurements when compared to the entire group. The education department had better mean scores on seven of the tests when compared to the group and the geography department only contained six mean scores that were better. As a result of the scores obtained, the members of the health, physical education and

TABLE V

MEAN SCORES OF ACADEMIC DEPARTMENTAL PERSONNEL FOR SELECTED TEST ITEMS

Test Item	Departments: Agriculture $\bar{X}$ Age = 42.4 N = 10	Education $\bar{X}$ Age = 37.29 N = 7	Geography $\bar{X}$ Age = 38.6 N = 10	HPER $\bar{X}$ Age = 34.57 N = 7
Resting Heart Rate (Beats Per Minute)	64.7	57.86	69.4	60.86
Resting Systolic Blood Pressure (Millimeters Mercury)	123.1	122.14	126.4	119.57
Resting Diastolic Blood Pressure (Millimeters Mercury)	75.3	75.71	72.7	71.0
Schneider Index	11.9	15.57	12.9	14.29
Vital Capacity (Liters)	5.16	4.52	5.05	5.01
Vital Capacity Residual (Liters)	.24	-.15	.01	.05
Timed Vital Capacity (Liters)	4.36	3.92	4.18	4.42
Timed Vital Capacity Residual (Liters)	.26	.14	.12	.43
Maximal Breathing Capacity (Liters Per Minute)	162.5	187.07	146.68	163.51
Maximal Breathing Capacity Residual Liters Per Minute)	-2.20	22.35	-23.62	-7.62
R Wave Amplitude (Millimeters)	13.2	9.36	8.65	11.5
T Wave Amplitude (Millimeters)	2.9	4.5	2.42	3.43
Rest/Work Ratio	2.18	2.34	2.09	2.29
Weight Residual (Pounds)	10.3	9.43	7.5	6.29
Percent Body Fat	13.0	12.29	12.5	11.14
O_2 Intake (Ml./Kg./Min.)	42.15	38.36	41.45	45.17
Age Adjusted O_2 Intake Classification (K. H. Cooper)	4.0	3.29	4.0	4.14
Post Exercise Heart Rate (5 Minutes)	95.4	96.0	96.6	93.43

recreation department ranked better in physical fitness when compared to members of the departments of agriculture, education, and geography.

Correlations Between Smokers and Non-Smokers for
Selected Physiological Measurements

Table VI, page 58, shows the results of the determination of the relationship between smokers and non-smokers and selected physiological measurements. As the results indicated, there was no significant relationship shown in any measurement. Many studies have indicated that smoking has a detrimental effect on most components of physical fitness and while this was generally observed in the physiological measu ements selected, these changes were not of such magnitude as to demonstrate a significant relationship. A possible contributing factor in the failure to show any significant relationship between smoking and fitness levels could be in the manner in which subjects were classified. All subjects who had quit smoking were categorized as non-smoking, even though some had not stopped smoking for a period of more than one month.

Correlations Between Age and Selected
Physiological Measurements

Subjects were classified into the following three age groups: 25 to 34 years of age, 35 to 44 years, and 45 years and over. It was then determined by the Chi Square statistical technique if significant relationships existed between age and results of physiological measurements attained by subjects in this study. The results, as shown in Table VII, page 59, indicated no significant relationships existing between age and the results of physiological measurements on the

TABLE VI

CORRELATIONS BETWEEN SMOKERS AND NON-SMOKERS FOR SELECTED PHYSIOLOGICAL MEASUREMENTS

Test Item	Smoker N	Non-Smoker N	Chi Square Value	Degrees of Freedom	Contingency Coefficient
Resting Heart Rate (Beats Per Minute)	22	63	3.23	1	.19
Resting Systolic Blood Pressure (Millimeters Mercury)	22	63	.08	1	.03
Vital Capacity Residual (Liters)	22	62	.05	1	.02
Timed Vital Capacity Residual (Liters)	22	62	.41	1	.07
Maximal Breathing Capacity Residual (Liters Per Minute)	22	63	1.23	1	.12
R Wave Amplitude (Millimeters)	22	57	.22	1	.05
T Wave Amplitude (Millimeters)	22	57	1.88	1	.15
Rest/Work Ratio (Millimeters)	22	57	.36	1	.06
Maximal O_2 Intake (Ml./Kg./Min.)	22	63	2.48	2	.17
Post Exercise Heart Rate (5 Minutes)	20	59	.05	1	.03
Post Exercise Systolic Blood Pressure (5 Minutes Millimeters Mercury)	16	34	.15	1	.05
Post Exercise Pulse Pressure (5 Minutes Millimeters Mercury)	16	34	.25	1	.07

TABLE VII

CORRELATIONS BETWEEN AGE AND SELECTED MEASUREMENTS

Test Item	Age Categories 25-34 N	35-44 N	45+ N	Chi Square Value	Degrees of Freedom	Contingency Coefficient
Resting Heart Rate (Beats Per Min.)	26	34	25	.06	2	.03
Schneider Index	26	34	25	4.68	4	.23
Vital Capacity Residual (Liters)	26	33	25	.53	2	.08
Timed Vital Capacity Residual (Liters)	26	34	25	.37	2	.07
Maximal Breating Capacity Residual (Liters Per Minute)	26	34	25	1.27	2	.12
R Wave Amplitude (Millimeters)	26	33	24	3.77	2	.21
T Wave Amplitude (Millimeters)	26	33	24	.55	2	.08
Rest/Work Ratio	26	33	24	.62	2	.09
Weight Residual (Pounds)	25	34	25	.77	4	.10
Percent Body Fat	25	34	25	2.07	2	.16
Post Exercise Heart Rate (5 Min.)	23	31	25	.96	2	.11
Post Exercise Systolic Blood Pressure (5 Min. Millimeters Mercury)	15	21	14	.36	2	.08
Post Exercise Pulse Pressure (5 Min. Millimeters Mercury)	15	21	14	.84	2	.13

subjects utilized in the study. Many studies indicate that physical fitness declines with age, while others point out this decline with age can be slowed by remaining physically active. Since subjects in this study were probably considered to be somewhat above average in the amount of physical activity they obtained, this may have been a factor in the failure to show any significant relationships between age and physical fitness components. It was pointed out earlier that there were differences in physical fitness component results in this study when compared with physical activity patterns. It appeared that the aging process had no significant effect on physical fitness components of subjects utilized in the study.

Correlations Between Maximal Oxygen Intake and Selected Physiological Measurements

Advocates of the maximal oxygen intake test such as Balke, Cooper, and Astrand believe it to be one of the best single fitness tests available in that it not only assesses the individual's capability of supplying oxygen to the working muscles but also tests directly or indirectly such components of fitness as cardiovascular function, respiratory function, muscular strength, muscular endurance, and obesity. It was of interest to determine whether or not there was a significant relationship between measurements obtained on maximal oxygen intake and other selected measurements employed in the study. As shown in Table VIII, page 61, maximal oxygen intake correlated significantly in the study with the Schneider Index test, R wave amplitude, rest/work ratio, and post exercise heart rate. Tests involving cardiovascular function correlated well with the maximal

TABLE VIII

CORRELATIONS BETWEEN MAXIMAL O_2 INTAKE AND SELECTED MEASUREMENTS

Test Item	Chi Square Value	Degrees of Freedom	Contingency Coefficient
Schneider Index	18.81*	2	.43
Vital Capacity Residual (Liters)	.49	1	.08
Maximal Breating Capacity Residual (Liters Per Minute)	.36	1	.07
R Wave Amplitude (Millimeters)	5.0*	1	.24
T Wave Amplitude (Millimeters)	2.0	1	.16
Rest/Work Ratio	8.21*	1	.31
Weight Residual (Pounds)	2.64	4	.18
Percent Body Fat	3.9	2	.21
Post Exercise Heart Rate (5 Minutes)	6.31*	1	.27
Post Exercise Systolic Blood Pressure (5 Minutes)	.43	1	.09

*Significantly Different at .05 Level

oxygen intake test in the study while there was no significant relationship shown with seven other components of fitness. As Cureton[8] has indicated, maximal oxygen intake correlates poorly with a wide range of physical performance tests. The results of these correlations again point out the specificity of physical fitness and it is perhaps better to measure components of fitness separately and interpret each test for itself.

Summary

The subjects utilized in this study demonstrated average or above average ratings in fitness on most of the physiological measurements employed. Exceptions to the average expectations were noted in vital capacity, maximal breathing capacity, and ideal body weight measurements.

In assessing the relationship between physical activity and physiological measurements utilized in the study, significant relationships were obtained among the following: resting heart rate, vital capacity, timed vital capacity, T-wave from the electrocardiogram, rest/work ratio of the heart, percent body fat, and maximal oxygen intake. Most other physiological measurements showed a positive association with physical activity patterns, although not enough to demonstrate a significant relationship.

Several comparisons utilized in the study failed to show significant relationships. Faculty and administrators showed no significant relationship between scores achieved on the physiological tests and

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[8]T. K. Cureton, "Interpretation of the Oxygen Intake Test: What Is It?" American Corrective Therapy Journal, XXVII, No. 1 (1973), p. 20.

their particular occupations. Additionally, no significant relationship was demonstrated by scores obtained between smokers and non-smokers on the tests in this study. Physiological measurements obtained from different age categories failed to show a significant relationship in the study. Subjects who were re-tested one year later showed improvement in a majority of the physiological tests; however, no significant differences were shown from one year to the next.

In the assessment of correlations between maximal oxygen intake and the other physiological measurements employed in the study, it was found that maximal oxygen intake correlated significantly with tests involving cardiovascular function only and not with other test items in the study.

In the final analysis, the testing results may be thus summarized: (1) In the study, the subjects demonstrated above average fitness; (2) there was a strong association between some physiological tests and physical activity, a particularly strong association was shown between maximal oxygen intake and physical activity; (3) there was no significant relationship demonstrated between age and the results of physiological measurements of the subjects utilized in the study; (4) physiological tests do not necessarily correlate well with each other; and (5) each test should be interpreted separately.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The purpose of this study was to appraise the current physical fitness status of 85 volunteer males of the Oklahoma State University faculty and administration. The results of the physiological tests administered to the subjects in the study indicated the following conclusions:

1. Subjects utilized in this study demonstrated a slightly lower resting heart rate than average.

2. Blood pressure recordings fell within the range of normal limits.

3. Results of the Schneider Index Test indicated the subjects were slightly above the acceptable level of fitness for the test.

4. When subjects were compared with their own expected norms in pulmonary functional measurements, they were below the norm in vital capacity and maximal breathing capacity and slightly above in timed vital capacity measurements.

5. The electrocardiograph measurements reflected normal values for the subjects relative to the heart; namely, the height of the R and T waves and the rest/work ratio value.

6. The measuring techniques utilized in the study indicated a normal value for percent body fat for the subjects.

7. The subjects employed in the study rated between "fair" and "good" for maximal oxygen intake on both the Balke and Cooper scales of fitness.

8. The post exercise measurements of heart rate, systolic blood pressure, and pulse pressure showed normal values.

9. A significant association was shown between physical activity patterns and the physiological measurements of resting heart rate, vital capacity, timed vital capacity, T wave amplitude, rest/work ratio, percent body fat, and maximal oxygen intake.

10. In general, there was no difference between faculty and administrators shown in the physiological measurements.

11. After one year of regular exercise, sixteen re-test subjects showed improvement in most of the physiological measurements.

12. No significant relationship between smoking and the physiological measurements utilized in the study was shown.

13. There was no significant relationship between age and the physical fitness components employed in the study.

14. The maximal oxygen intake test correlated poorly with most of the fitness tests administered in the study.

Recommendations

The primary concern of this study was to assess the physical fitness of subjects who were employed in a sedentary occupation; namely, teaching or educational administration. Since this group represents a highly educated segment of the population, it would be of importance to administer the same tests on a yearly basis in order to detect any changes that may be detrimental to health. Of particular interest would be any changes that may lead to cardiovascular or cardiorespiratory impairment in order for each subject to be advised accordingly.

An attempt was made in this study to determine the relationship between exercise and the results obtained on the physiological tests; however, exercise patterns were determined through personal interviews. A study should be done with more rigid control of exercise as it relates to frequency and intensity to better determine any possible relationship between exercise and the same physiological measurements utilized in the study.

Questions often asked are those involving the number of times per week an individual should exercise, the length of time each exercise period should be, and the types of activity which produce the best results. In order to gain insight into these questions, a study should be done involving subjects in the educational profession whereby a control group and three experimental groups, each employing different physical activities, frequencies, and intensities, are utilized.

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APPENDIX

PREDICTED **VITAL CAPACITY** — MALES

HEIGHT IN CENTIMETERS

Age	146	148	150	152	154	156	158	160	162	164	166	168	170	172	174	176	178	180	182	184	186	188	190	192	194
16	3765	3820	3870	3920	3975	4025	4075	4130	4180	4230	4285	4335	4385	4440	4490	4540	4590	4645	4695	4745	4800	4850	4900	4955	5005
18	3740	3790	3840	3890	3940	3995	4045	4095	4145	4200	4250	4300	4350	4405	4455	4505	4555	4610	4660	4710	4760	4815	4865	4915	4965
20	3710	3760	3810	3860	3910	3960	4015	4065	4115	4165	4215	4265	4320	4370	4420	4470	4520	4570	4625	4675	4725	4775	4825	4875	4930
22	3680	3730	3780	3830	3880	3930	3980	4030	4080	4135	4185	4235	4285	4335	4385	4435	4485	4535	4585	4635	4685	4735	4790	4840	4890
24	3635	3685	3735	3785	3835	3885	3935	3985	4035	4085	4135	4185	4235	4285	4330	4380	4430	4480	4530	4580	4630	4680	4730	4780	4830
26	3605	3655	3705	3755	3805	3855	3905	3955	4000	4050	4100	4150	4200	4250	4300	4350	4395	4445	4495	4545	4595	4645	4695	4740	4790
28	3575	3625	3675	3725	3775	3820	3870	3923	3970	4020	4070	4115	4165	4215	4265	4310	4360	4410	4460	4510	4555	4605	4655	4705	4755
30	3550	3595	3645	3695	3740	3790	3840	3890	3935	3985	4035	4080	4130	4180	4230	4275	4325	4375	4425	4470	4520	4570	4615	4665	4715
32	3520	3565	3615	3665	3710	3760	3810	3855	3905	3950	4000	4050	4095	4145	4195	4240	4290	4340	4385	4435	4485	4530	4580	4625	4675
34	3475	3525	3570	3620	3665	3715	3760	3810	3855	3905	3950	4000	4045	4095	4140	4190	4225	4285	4330	4380	4425	4475	4520	4570	4615
36	3445	3495	3540	3585	3635	3680	3730	3775	3825	3870	3920	3965	4010	4060	4105	4155	4200	4250	4295	4340	4390	4435	4485	4530	4580
38	3415	3465	3510	3555	3605	3650	3695	3745	3790	3840	3885	3930	3960	4025	4070	4120	4165	4210	4260	4305	4350	4400	4445	4495	4540
40	3385	3435	3480	3525	3575	3620	3665	3710	3760	3805	3850	3900	3945	3990	4035	4085	4130	4175	4220	4270	4315	4360	4410	[illegible]	[illegible]
42	3360	3405	3450	3495	3540	3590	3635	3680	3725	3770	3820	3865	3910	3955	4000	4050	4095	4140	4185	4230	4280	4325	4370	4415	4460
44	3315	3360	3405	3450	3495	3540	3585	3630	3675	3725	3770	3815	3860	3905	3950	3995	4040	4085	4130	4175	4220	4270	4315	4360	4405
46	3285	3330	3375	3420	3465	3510	3555	3600	3645	3690	3735	3780	3825	3870	3915	3960	4005	4050	4095	4140	4185	4230	4275	4320	4365
48	3255	3300	3345	3390	3435	3480	3525	3570	3615	3655	3700	3745	3790	3835	3880	3925	3970	4015	4060	4105	4150	4190	4235	4280	4325
50	3210	3255	3300	3345	3390	3430	3475	3520	3565	3610	3650	3695	3740	3785	3830	3870	3915	3960	4005	4050	4090	4135	4180	4225	4270
52	3185	3225	3270	3315	3355	3400	3445	3490	3530	3575	3620	3660	3705	3750	3795	3835	3880	3925	3970	4010	4055	4100	4140	4185	4230
54	3155	3195	3240	3285	3325	3370	3415	3455	3500	3540	3585	3630	3670	3715	3760	3800	3845	3890	3930	3975	4020	4060	4105	4145	4190
56	3125	3165	3210	3255	3295	3340	3380	3425	3465	3510	3550	3595	3640	3680	3725	3765	3810	3850	3895	3940	3980	4025	4065	4110	4150
58	3080	3125	3165	3210	3250	3290	3335	3375	3420	3460	3500	3545	3585	3630	3670	3715	3755	3800	3840	3880	3925	3965	4010	4050	4095
60	3050	3095	3135	3175	3220	3260	3300	3345	3385	3430	3470	3500	3555	3595	3635	3680	3720	3760	3805	3845	3885	3930	3970	4015	4055
62	3020	3060	3110	3150	3190	3230	3270	3310	3350	3390	3440	3480	3520	3560	3600	3640	3680	3730	3770	3810	3850	3890	3930	3970	4020
64	2990	3030	3080	3120	3160	3200	3240	3280	3320	3360	3400	3440	3490	3530	3570	3610	3650	3690	3730	3770	3810	3850	3900	3940	3980
66	2950	2990	3030	3070	3110	3150	3190	3230	3270	3310	3350	3390	3430	3470	3510	3550	3600	3640	3680	3720	3760	3800	3840	3880	3920
68	2920	2960	3000	3040	3080	3120	3160	3200	3240	3280	3320	3360	3400	3440	3480	3520	3560	3600	3640	3680	3720	3760	3800	3840	3880
70	2890	2930	2970	3010	3050	3090	3130	3170	3210	3250	3290	3330	3370	3410	3450	3480	3520	3560	3600	3640	3680	3720	3760	3800	3840
72	2860	2900	2940	2980	3020	3060	3100	3140	3180	3210	3250	3290	3330	3370	3410	3450	3490	3530	3570	3610	3650	3680	3720	3760	3800
74	2820	2860	2900	2930	2970	3010	3050	3090	3130	3170	3200	3240	3280	3320	3360	3400	3440	3470	3510	3550	3590	3630	3670	3710	3740

Baldwin, E. DeF., Cournand, A., and Richards, D. W., Jr., Pulmonary Insufficiency I, Physiologic Classification, Clinical Methods of Analysis, Standard Values in Normal Subjects Medicine, 27:243, 1948.

PREDICTED **MAXIMAL BREATHING CAPACITY** — MALES

BODY SURFACE AREA

Age	1.40	1.42	1.44	1.46	1.48	1.50	1.52	1.54	1.56	1.58	1.60	1.62	1.64	1.66	1.68	1.70	1.72	1.74	1.76	1.78	1.80	1.82	1.84	1.86	1.88	1.90	1.92	1.94	1.96	1.98	2.00	2.02	2.04	2.06	2.08	2.10
16	110	111	113	114	116	118	119	121	122	124	125	127	129	130	132	133	135	136	138	140	141	143	144	146	147	149	151	152	154	155	157	158	160	162	163	165
18	108	110	111	113	115	116	118	119	121	122	124	125	127	128	130	132	133	135	136	138	139	141	143	144	146	147	149	150	152	153	155	156	158	159	161	163
20	107	108	110	111	113	114	116	118	119	121	122	124	125	127	128	130	131	133	135	136	137	138	140	142	143	145	146	148	150	151	153	154	156	157	159	160
22	105	107	108	110	111	113	114	116	117	119	120	122	123	125	126	128	129	131	132	134	135	137	138	140	141	143	144	146	147	149	150	152	153	155	156	158
24	104	105	107	108	110	111	113	114	116	117	119	120	122	123	125	126	128	129	131	132	134	135	137	138	139	141	142	144	145	147	148	150	151	153	154	156
26	102	104	105	107	108	110	111	112	114	115	117	118	120	121	123	124	126	127	128	130	131	133	134	136	137	139	140	142	143	145	146	147	149	150	152	153
28	101	102	104	105	107	108	109	111	112	114	115	117	118	120	121	122	124	125	127	128	130	131	132	134	135	137	138	140	141	143	144	145	147	148	150	151
30	99	101	102	104	105	107	108	109	111	112	114	115	116	118	119	121	122	124	125	126	128	129	131	132	133	135	136	138	139	141	142	143	145	146	148	149
32	98	99	101	102	104	105	106	108	109	111	112	113	115	116	118	119	120	122	123	125	126	127	129	130	132	133	134	136	137	139	140	141	143	144	146	147
34	96	98	99	101	102	103	105	106	107	109	110	112	113	114	116	117	119	120	121	123	124	125	127	128	130	131	132	134	135	136	138	139	141	142	143	145
36	95	96	98	99	100	102	103	104	106	107	108	110	111	113	114	115	117	118	119	121	122	123	125	126	127	129	130	131	133	134	136	137	138	140	141	142
38	93	95	96	97	99	100	101	103	104	105	107	108	109	111	112	113	115	116	117	119	120	121	123	124	125	127	128	129	131	132	133	135	136	137	139	140
40	92	93	95	96	97	99	100	101	102	104	105	106	108	109	110	112	113	114	116	117	118	120	121	122	124	125	126	127	129	130	131	133	134	135	137	138
42	91	92	93	94	96	97	98	99	100	102	103	105	106	107	109	110	111	113	114	115	116	118	119	120	122	123	124	126	127	128	129	131	132	133	135	136
44	89	90	92	93	94	95	97	98	99	100	102	103	104	106	107	108	109	111	112	113	114	116	117	118	120	121	122	123	125	126	127	128	130	131	132	134
46	88	89	90	91	93	94	95	96	98	99	100	101	103	104	105	106	108	109	110	111	113	114	115	116	118	119	120	121	123	124	125	126	128	129	130	131
48	86	87	88	90	91	92	93	95	96	97	98	100	101	102	103	105	106	107	108	109	111	112	113	114	116	117	118	119	121	122	123	124	125	127	128	129
50	85	86	87	88	89	91	92	93	94	95	97	98	99	100	101	103	104	105	106	108	109	110	111	112	114	115	116	117	118	120	121	122	123	124	126	127
52	83	84	85	86	88	89	90	91	92	94	95	96	97	98	99	101	102	103	104	105	107	108	109	110	111	112	114	115	116	117	118	120	121	122	123	124
54	82	84	85	86	87	88	89	90	91	92	93	94	96	97	98	99	100	101	103	104	105	106	107	108	110	111	112	113	114	115	117	118	119	120	121	122
56	80	81	82	84	85	86	87	88	89	91	92	93	94	95	96	97	99	100	101	102	103	104	105	107	108	109	110	111	112	113	115	116	117	118	[illegible]	[illegible]
58	79	80	81	82	83	84	85	87	88	89	90	91	92	93	94	96	97	98	99	100	101	102	103	105	106	107	108	109	110	111	112	114	115	[illegible]	[illegible]	[illegible]
60	77	78	79	80	82	83	84	85	86	87	88	89	90	91	93	94	95	96	97	98	99	100	101	102	104	105	106	107	108	109	110	111	112	114	115	116
62	76	77	78	79	80	81	82	83	84	85	86	87	89	90	91	92	93	94	95	96	97	98	99	100	102	103	104	105	106	107	108	109	110	111	112	113
64	74	75	76	77	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	98	99	100	101	102	103	104	105	106	107	108	109	110	111
66	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	97	98	99	100	101	102	103	104	105	106	107	108	109
68	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	96	97	98	99	100	101	102	103	104	105	106	107
70	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
72	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	102
74	67	68	69	70	71	72	73	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	92	93	94	95	96	97	98	99	100
76	65	66	67	68	69	70	71	72	73	74	75	76	77	78	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	92	93	94	95	96	97	98

Baldwin, E. DeF., Cournand, A., and Richards, D. W., Jr., Pulmonary Insufficiency 1, Physiologic Classification, Clinical Methods of Analysis, Standard Values in Normal Subjects/Medicine, 27:243, 1948.

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.______

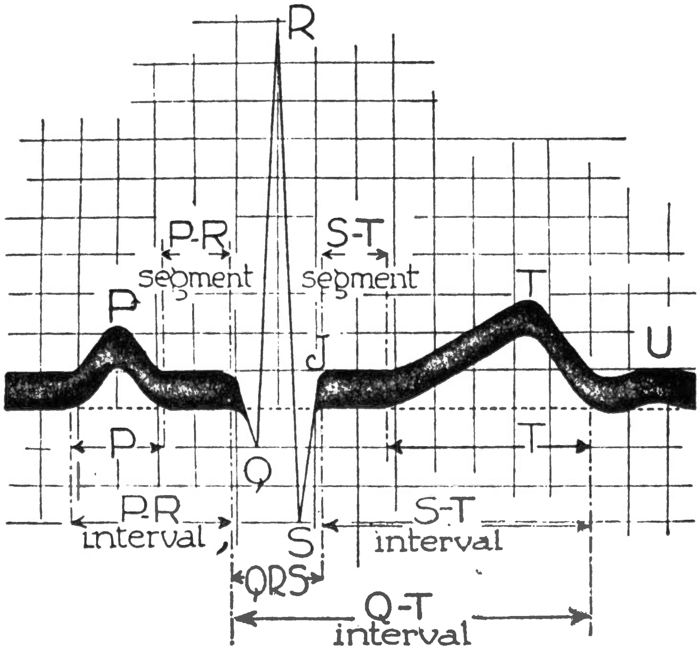
EXERCISE TEST: ASTRAND BICYCLE: HEART RATE____ PRED. OXYGEN INTAKEL____ ML/KG____
BALKE TREADMILL: % GRADE AT 180______ PRED. OXYGEN L______ ML/KG___ CLASS___
OPEN CIRCUIT MEASURES: OXYGEN INTAKE AT___ HR OXYGEN INTAKE AT______ HR
PRED. MAXIMAL OXYGEN INTAKE L______ ML/KG______
MEASURED MAXIMAL OXYGEN 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:

SAMPLE: ELECTROCARDIOGRAM



Nomenclature of electrocardiographic deflections and intervals. P Q R S T nomenclature was devised by Nobel Laureate Einthoven. P wave is produced by atrial activity; QRS by ventricular activation; T wave reflects ventricular recovery; (U signifies an after-potential).

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

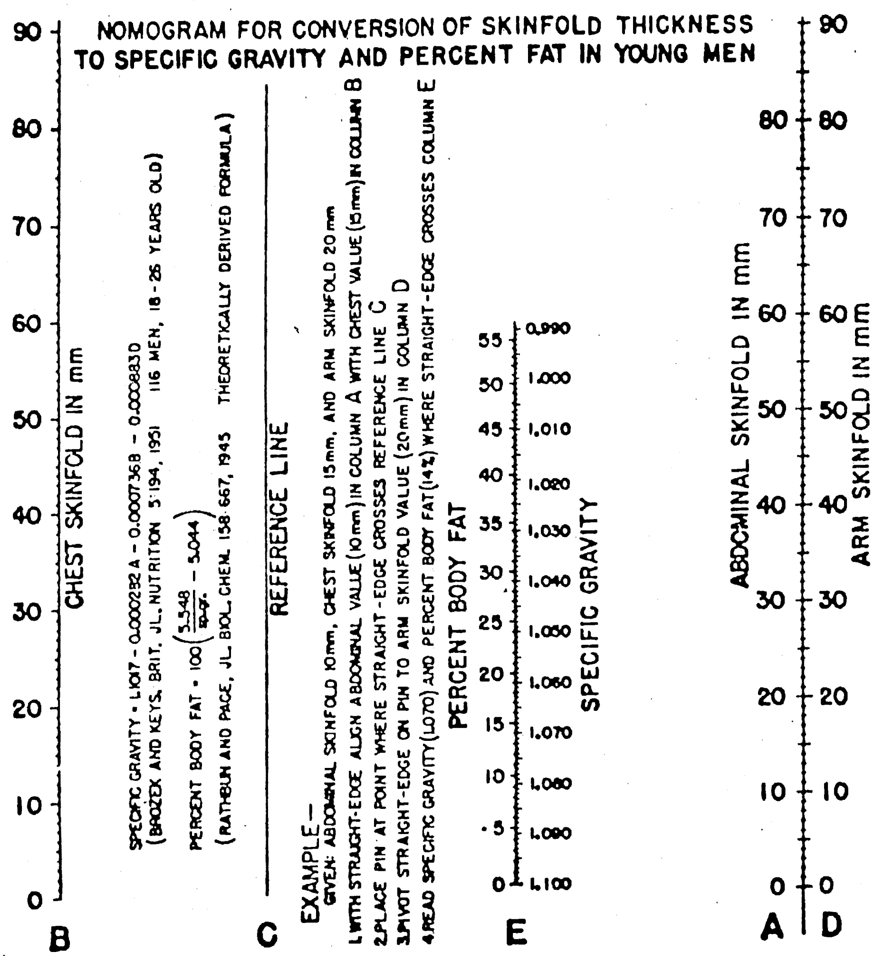
C. Standing Pulse Rate		D. Pulse Rate Change Immediately After Exercise				
Rate	Points	0-10	11-20	21-30	31-40	41-50
51-60	4	4	4	3	2	1
61-70	3	3	3	2	1	0
71-80	3	3	3	2	0	0
81-90	2	3	2	1	0	-1
91-100	1	2	1	0	-1	-2
101-110	1	1	0	-1	-2	-3
111-120	0	1	-1	-2	-3	-3
121-130	0	0	-2	-3	-3	-3
131-140	-1	0	-3	-3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

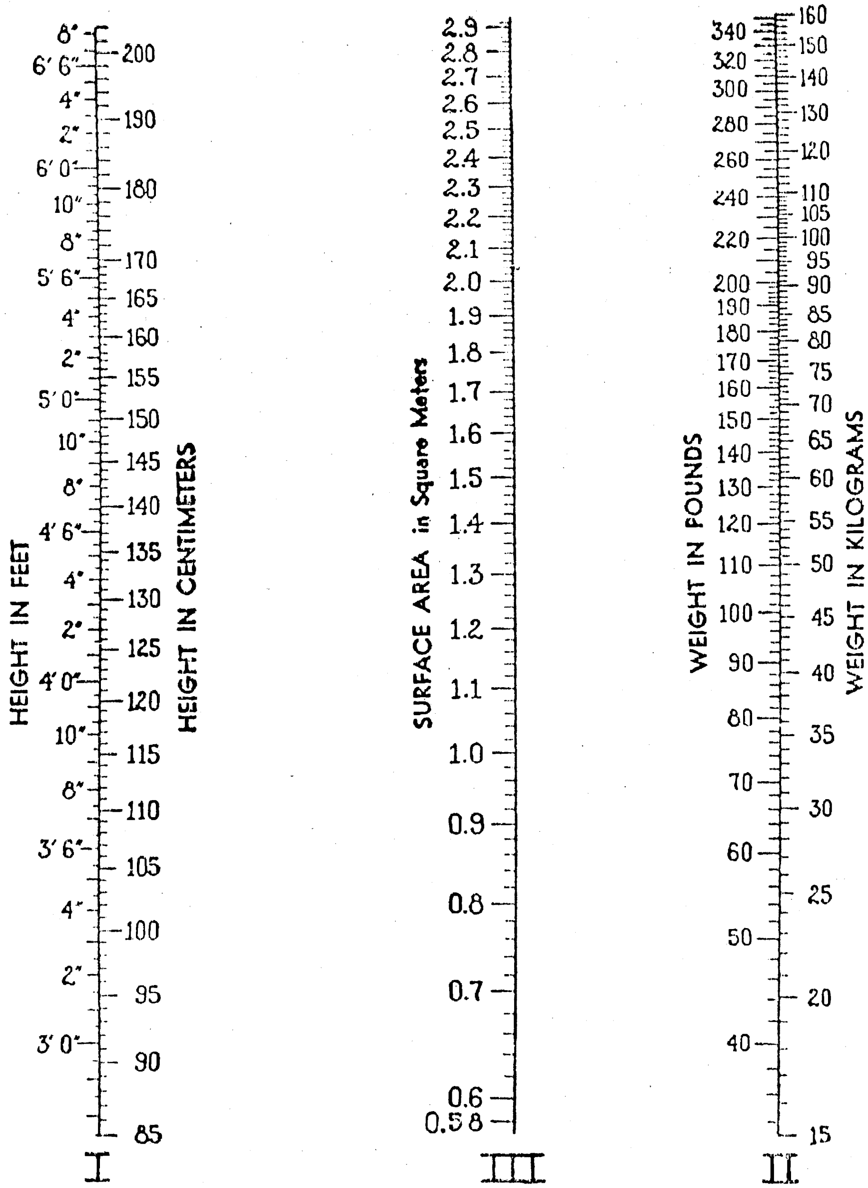
Change in Millimeters	Points
Rise 30 and more	-2
Rise 21 to 30	-1
Rise 16 to 20	0
Rise 11 to 15	1
Rise of 6 to 10	2
No rise greater than 5	3
Fall of 6 to 10	2
Fall of 11 to 15	1
Fall of 16 to 20	0
Fall of 21 to 25	-1
Fall of 26 and more	-2



NOMOGRAM FOR CONVERSION OF SKINFOLD THICKNESS TO SPECIFIC GRAVITY AND PERCENT FAT IN YOUNG MEN
B
CHEST SKINFOLD IN mm
0 10 20 30 40 50 60 70 80 90
SPECIFIC GRAVITY = 1.1017 - 0.000282 A - 0.000736 B - 0.000883 D
(BROZEK AND KEYS, BRIT. JL. NUTRITION 5:194, 1951 116 MEN, 18-26 YEARS OLD)
PERCENT BODY FAT = 100(5.548/sp.gr. - 5.044)
(RATHBUN AND PACE, JL. BIOL. CHEM. 158:667, 1945 THEORETICALLY DERIVED FORMULA)
C
REFERENCE LINE
EXAMPLE—
GIVEN: ABDOMINAL SKINFOLD 10mm, CHEST SKINFOLD 15mm, AND ARM SKINFOLD 20mm
1. WITH STRAIGHT-EDGE ALIGN ABDOMINAL VALUE (10mm) IN COLUMN A WITH CHEST VALUE (15mm) IN COLUMN B
2. PLACE PIN AT POINT WHERE STRAIGHT-EDGE CROSSES REFERENCE LINE C
3. PIVOT STRAIGHT-EDGE ON PIN TO ARM SKINFOLD VALUE (20mm) IN COLUMN D
4. READ SPECIFIC GRAVITY (1.070) AND PERCENT BODY FAT (14%) WHERE STRAIGHT-EDGE CROSSES COLUMN E
E
PERCENT BODY FAT
0 5 10 15 20 25 30 35 40 45 50 55
1.100 1.090 1.080 1.070 1.060 1.050 1.040 1.030 1.020 1.010 1.000 0.990
SPECIFIC GRAVITY
A
ABDOMINAL SKINFOLD IN mm
0 10 20 30 40 50 60 70 80 90
D
ARM SKINFOLD IN mm
0 10 20 30 40 50 60 70 80 90

DUBOIS BODY SURFACE CHART

(As prepared by Boothby and Sandiford of the Mayo Clinic)



DIRECTIONS

To find body surface of a patient, locate the height in inches (or centimeters) on scale I and the weight in pounds (or kilograms) on Scale II and place a straight edge (ruler) between these two points which will intersect Scale III at the patient's surface area.

FIG. 9

Cat. No. P-456

Data Collection for Analysis of Body Build by Method of A.R. Behnke

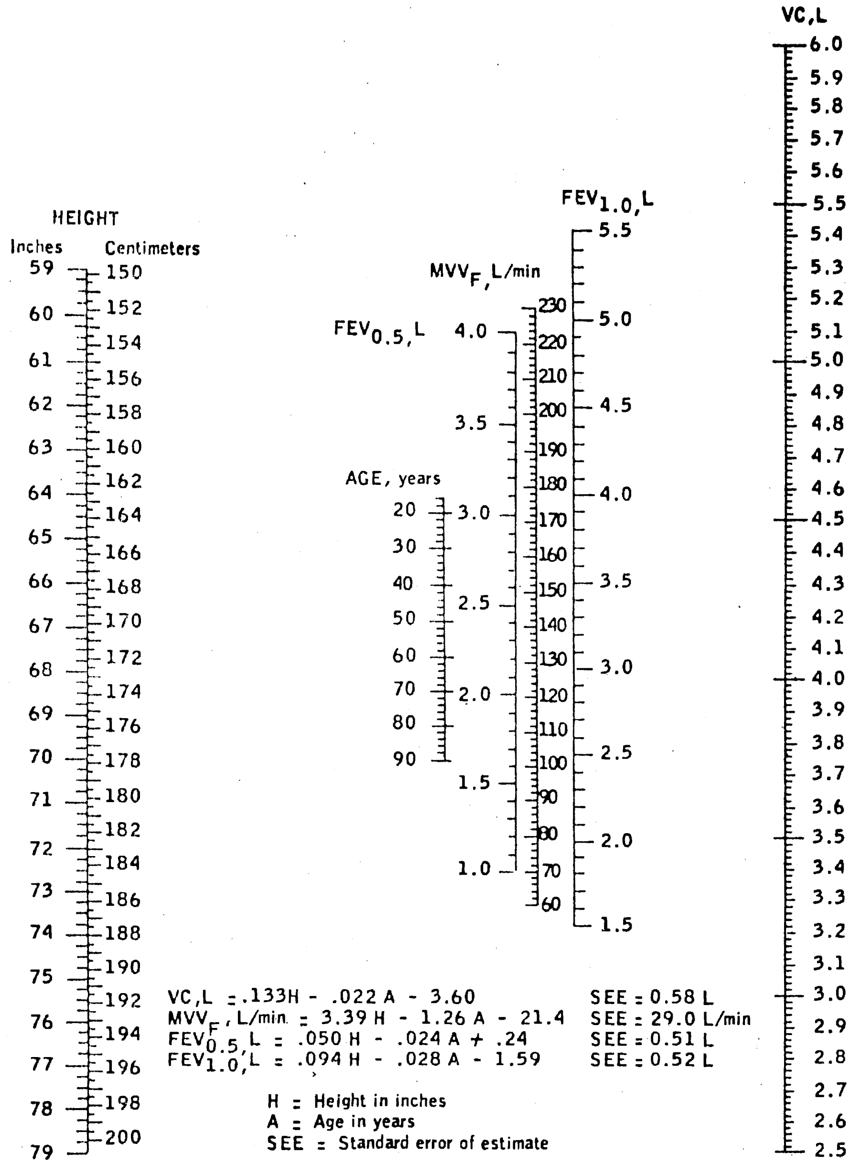
Name____________________Wt._____ lbs._____kg.   Ht._____in._____dm.

(1) Body Segment		(2) Circumference			(3) Male k Value	(4) Female k Value	(5) d Value	(6) 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 $\frac{C}{K} = \frac{\text{Sum (col. 2)}}{300}$ ____________________

NOMOGRAM FOR PREDICTION OF VITAL CAPACITY, TIMED VITAL CAPACITY AND MAXIMAL BREATHING CAPACITY



These prediction formulas along with their respective "R" values* and standard errors of estimate (S.E.E.) are as follows:

VC, liters = .052 H_{cm} − .022 A − 3.60 (R = .64)
= (.133 H_{in} − .022 A − 3.60) (S.E.E. = .58)
$FEV_{0.5}$, liters = .020 H_{cm} − .024 A + .24 (R = .52)
= (.050 H_{in} − .024 A + .24) (S.E.E. = .51)
$FEV_{1.0}$, liters = .037 H_{cm} − .028 A − 1.59 (R = .63)
= (.094 H_{in} − .028 A − 1.59) (S.E.E. = .52)
MVV_F, L./min. = 1.34 H_{cm} − 1.26 A − 21.4 (R = .53)
= (3.39 H_{in} − 1.26 A − 21.4) (S.E.E. = .29)

where H_{cm} = height in cm.; H_{in} = height in inches; and A = age in years.

* Where more than one variable is present, multiple correlation (R) is used

Nomogram for prediction of VC, $FEV_{0.5}$, $FEV_{1.0}$ and MVV_F from age and height. Points representing the observed heights in inches (or centimeters) and the observed age in years are located on the height and age scales. A straight line passing through these points intersects points on the $FEV_{0.5}$, $FEV_{1.0}$, MVV_F, and VC scales corresponding to their predicted values.

AGE ADJUSTED MAXIMAL OXYGEN INTAKE CATEGORIES

	Oxygen Intake (Ml./Kg./Min.)			
FITNESS CATEGORY	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+	43.1+

Cooper, K. H., The New Aerobics, p. 28.

Maximum Oxygen Intake as Criterion of Functional Potential

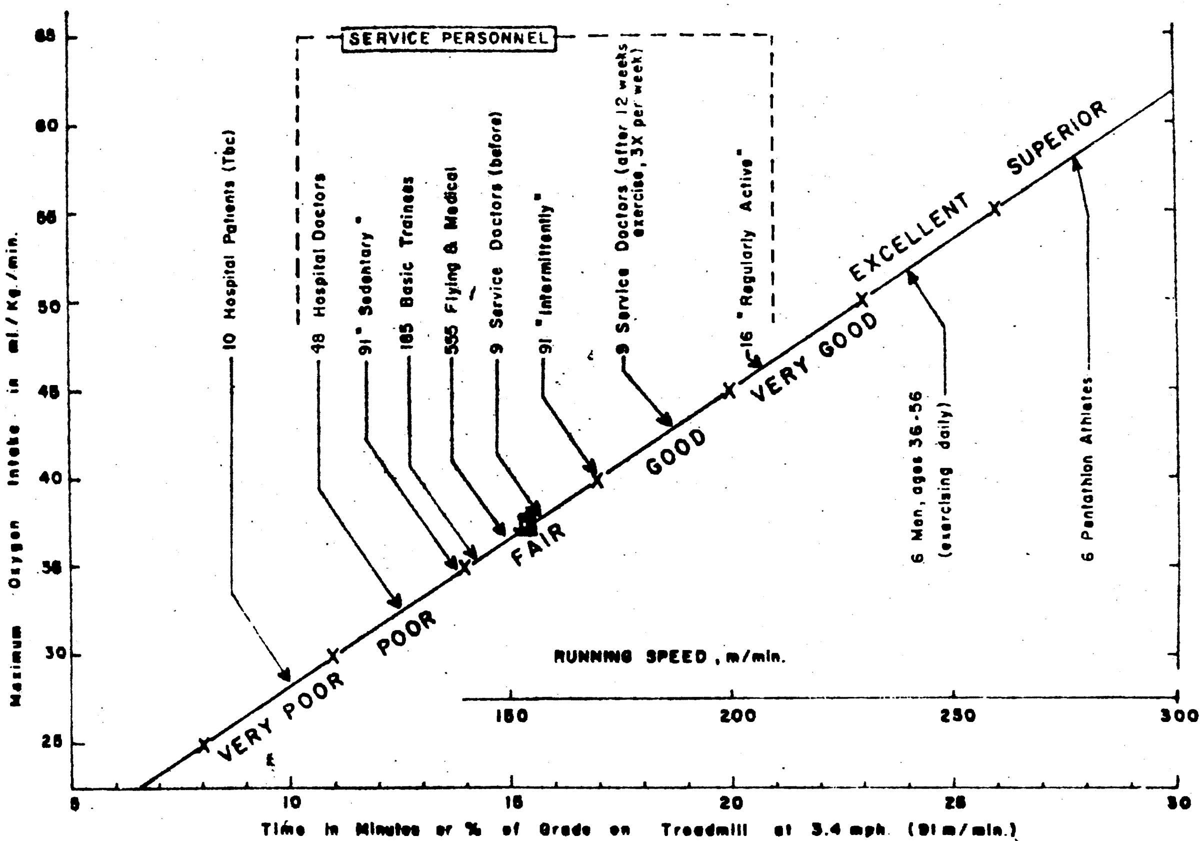


FIG. 2—The diagonal line relates oxygen intake per Kg of body weight (on the ordinate) to work intensity (on the abscissa), the latter depending either on the slope at a given walking speed or on the running speed. The arrows pointing at this line indicate the average values of maximum oxygen intake attained by groups of men varying in degree of physical condition.

SUBJECT	AGE	DEPT.	FACULTY OR ADMN.	HT.	WT.	BSA	PHYSICAL ACTIVITY PATTERN	RESTING HEART RATE	RESTING B.P. SYSTO-LIC	DIASTO-LIC	SCHNEIDER INDEX
1.	33	Library	A	73 "	154	1.94	Moderate	66	112	65	13
2.	34	Educ.	A	65.5"	181	1.9	Moderate	60	130	80	13
3.	30	A & S	A	67.5"	124	1.66	Light	60	105	65	15
4.	45	Educ.	A	71.5"	204	2.13	Light	60	125	75	14
5.	28	HPER	A	75 "	230	2.34	Moderate	54	120	80	14
6.	44	A & S	A	68 "	156	1.84	Active	66	105	60	14
7.	61	Research	A	71 "	204	2.12	Moderate	57	145	80	16
8.	57	Cent.Mail	A	71 "	176	2.0	Light	48	120	62	19
9.	43	Comp.Sci.	A	71.5"	176	2.03	Active	54	120	75	15
10.	57	Extn.	A	71 "	172	1.98	Moderate	66	115	70	6
11.	26	HPER	A	69.5"	175	1.95	Moderate	72	120	70	10
12.	56	Library	A	68.25"	177	1.92	Light	60	135	82	17
13.	54	Housing	A	70.25"	186	2.05	Moderate	60	135	95	17
14.	41	Graph.Arts	A	75 "	236	2.33	Light	54	116	76	16
15.	43	Extn.	A	68 "	179	1.95	Active	54	105	65	17
16.	51	Ag.Econ.	A	67 "	170	1.88	Active	48	118	70	18
17.	28	HPER	A	68.5 "	164	1.88	Active	60	125	50	15

	VITAL CAPACITY		TIMED VITAL CAPACITY		MBC		EKG		
SUBJECT	ACTUAL	RESIDUAL	ACTUAL	RESIDUAL	ACTUAL	RESIDUAL	AMP. R	AMP.T	REST/ WORK
1.	5.48	.0	5.1	.7	147.34	-37.66	16.0	2.5	2.00
2.	4.20	-.16	3.73	.13	241.64	83.64	10	3	1.86
3.	3.36	-1.38	3.6	.02	141.64	-28.36	11.5	2.5	2.26
4.	4.94	.02	4.6	.8	215.6	51.6	7	2.5	2.78
5.	6.62	.86	5.6	1.0	167.64	-24.36	15	5.5	2.5
6.	4.72	.26	4.3	.8	132.9	-19.1	9.5	4.0	2.55
7.	4.58	.08	4.3	.9	153.19	11.19	12	3.5	2.20
8.	2.85	-1.73	3.15	-.35	66.48	-79.52	6	4.5	2.7
9.	5.85	.87	5.1	1.2	129.9	-36.1	8.5	3.0	2.46
10.	4.99	.39	4.45	.95	130.07	-15.93	11	4.0	2.17
11.	4.99	-.19	4.6	.4	184.99	2.99	11.5	2.5	2.15
12.	4.12	-.12	3.65	.45	138.74	.74	7.5	2.0	2.36
13.	5.32	.78	4.3	.8	138.74	-9.26	10	2.0	2.00
14.	5.61	.32	4.98	.66	194.8	9.8	10.5	2.5	2.0
15.	4.23	-.27	3.6	.01	172.27	18.27	11.0	5.5	2.62
16.	4.18	-.01	3.4	.1	112.7	-28.3	17.0	3.0	2.44
17.	3.80	-1.1	3.62	-.38	150.31	-25.69	21.5	3.0	2.13

SUBJECT	PREDICTED WEIGHT	WEIGHT RESIDUAL	PER CENT BODY FAT	O_2 INTAKE ML/KG	O_2 INTAKE CLASS	POST EXERCISE H. R. 5 MIN.	POST EXERCISE SYSTOLIC 5 MIN.	POST EXERCISE PULSE PRESSURE 5 MIN.
1.	148	6	8	35	3	96		
2.	179	2	14	28	1	112		
3.	124	0	5	38.5	3	96	110	50
4.	191	13	19	37	4	96	134	74
5.	220	10	16	43.7	4			
6.	149	7	9	50	5	96	116	46
7.	182	22	23	38.5	4	72	130	55
8.	169	7	9	37	3	72		
9.	169	7	7	40	4	84	125	55
10.	160	12	10	21	1	108		
11.	166	9	11	42	4	108		
12.	160	17	10	34	4	102		
13.	175	11	17	35	4	96		
14.	228	8	19	37	4	96	148	88
15.	165	14	14	42	4	90	120	60
16.	159	11	10	50	5	78	140	70
17.	155	9	8	53	5	84		

SMOKERS

SUBJECT	SMOKER	NON-SMOKER
1.		X
2.		X
3.	X	
4.		X
5.		X
6.	X	
7.	X	
8.		X
9.		X
10.		X
11.		X
12.		X
13.		X
14.		X
15.		X
16.		X
17.		X

SUBJECT	VITAL CAPACITY ACTUAL	VITAL CAPACITY RESIDUAL	TIMED VITAL CAPACITY ACTUAL	TIMED VITAL CAPACITY RESIDUAL	MBC ACTUAL	MBC RESIDUAL	EKG AMP. R	EKG AMP.T	EKG REST/ WORK
18.	4.3	-.6	4.0	.1	164.76	-2.24	8.0	2.0	1.57
19.	4.9	-.53	4.5	.2	161.8	-20.2	11.5	4.5	2.61
20.	4.58	-.1	4.15	.55	159.5	7.5	2.5	2.5	2.39
21.	6.4	1.18	6.0	1.8	196.5	21.5	8.0	3.0	2.14
22.	4.12	-.6	3.77	-.03	156.09	-7.91	7.0	2.0	2.21
23.	5.10	.3	4.25	.45	156.09	-5.91	13.5	1.0	2.0
24.	3.66	-.54	3.2	0	124.29	-13.71	7.0	3.0	2.36
25.	5.3	.4	4.5	.6	144.52	-25.48	9.0	4.0	2.67
26..	4.37	-.69	3.65	-.25	153.19	-12.81	10.5	3.0	1.73
27.	4.20	.06	3.6	.4	156.09	18.09	15	4	2.35
28.	5.02	-.10	3.65	-.55	190.76	11.76	17.5	14.0	2.87
29.	4.67	-.18	3.4	-.5	182.10	12.10	10	3	2.4
30.	5.6	.64	4.9	.9	141.6	-28.4	12.0	4.0	2.13
31.	5.53	.53	4.9	.1	190.76	26.76	17.0	3.0	2.43
32.	5.37	.17	4.4	.3	167.64	-9.36	19.0	2.5	2.0
33.	5.27	-.33	4.54	.04	134.7	-53.3	11.0	2.0	2.5
34.	5.51	.55	4.93	.73	176.31	2.31	17	3.0	2.12

SUBJECT	AGE	DEPT.	FACULTY OR ADMN.	HT.	WT.	BSA	PHYSICAL ACTIVITY PATTERN	RESTING HEART RATE	RESTING B. P. SYSTOLIC	RESTING B. P. DIASTOLIC	SCHNEIDER INDEX
18.	39	VP	A	70.5"	194	2.1	Light	84	140	80	9
19.	38	Mech.Engr.	A	74 "	210	2.2	Light	60	120	80	14
20.	53	Library	A	71 "	152	1.88	Moderate	68	120	80	15
21.	38	Budg.Dir.	A	71.25"	182	1.9	Moderate	66	120	70	16
22.	37	HPER	A	68.5"	196	2.04	Light	72	135	85	15
23.	42	Dean-GC	A	70.5"	208	2.15	Moderate	66	140	70	16
24.	56	Dean-A&S	A	68 "	132	1.72	Moderate	66	116	65	13
25.	37	HPER	A	70.5"	179	1.95	Active	48	115	70	18
26.	46	A & S	A	72.75"	181	2.04	Light	72	130	75	11
27.	55	History	F	67 "	135	1.7	Moderate	48	115	70	17
28.	30	Education	F	70.5"	163	1.93	Active	54	130	80	16
29.	37		F	69.5"	140	1.78	Active	60	115	70	16
30.	38	HPER	F	70.5"	163	1.91	Moderate	66	100	60	11
31.	47	Ag.Econ.	F	72.25"	199	2.2	Moderate	60	124	90	10
32.	30	Geog.	F	69.75"	153	1.85	Moderate	72	130	75	12
33.	33	Geog.	F	74.5"	240	2.36	Moderate	60	136	82	14
34.	35	Chem.Engr.	F	70.25"	154	1.88	Active	60	125	70	14

SUBJECT	PREDICTED WEIGHT	WEIGHT RESIDUAL	PER CENT BODY FAT	O_2 INTAKE ML/KG	O_2 INTAKE CLASS	POST EXERCISE H.R. 5 MIN.	POST EXERCISE SYSTOLIC 5 MIN.	POST EXERCISE PULSE PRESSURE 5 MIN.
18.	179	15	18	25	2	102		
19.	196	14	13	35	3			
20..	148	4	6	38.5	4	96		
21.	178	4	5	40	4	96		
22.	189	7	14	43.5	4	84		
23.	193	15	15	38.5	4	102	135	65
24.	129	3	9	45	5	78	110	45
25.	173	6	11	47	4			
26.	171	10	8	43.5	4	102	145	74
27.	128	7	5	35	3	102		
28.	157	6	8	45	4	96	140	70
29.	138	2	7	43	4	90		
30.	158	5	8	37	3	108		
31.	190	9	14	43.5	4	102	140	60
32.	144	9	10	50	5	108	136	66
33.	220	-20	21	42	4			
34.	150	4	4	48.5	5	84	120	60

	SMOKERS	
SUBJECT	SMOKER	NON-SMOKER
18.		X
19.		X
20.		X
21.		X
22.	X	
23.		X
24.	X	
25.		X
26.		X
27.		X
28.		X
29.		X
30..		X
31.		X
32.	X	
33.		X
34.		X

SUBJECT	AGE	DEPT.	FACULTY OR ADMN.	HT.	WT.	BSA	PHYSICAL ACTIVITY PATTERN	RESTING HEART RATE	RESTING B.P. SYSTO-LIC	DIASTO-LIC	SCHNEIDER INDEX
35.	31	Soc.	F	68.5"	152	1.84	Light	72	105	65	8
36.	29	Ag.Econ.	F	70.5"	176	1.98	Moderate	78	110	75	8
37.	36	Indus.Engr.	F	68.75"	196	2.03	Moderage	51	115	70	14
38.	55	History	F	70 "	193	2.06	Light	66	108	75	16
39.	47	Civ.Engr.	F	69.5"	169	1.92	Light	51	115	75	16
40.	53	Zoology	F	67.5"	161.5	1.87	Moderate	66	115	75	15
41.	35	Vet.Med.	F	67.5"	163	1.88	Moderate	60	110	70	16
42.	44	Microbiol.	F	70 "	178	1.97	Active	54	130	80	15
43.	43	History	F	72 "	174	2.0	Moderate	78	112	65	10
44.	53	Educ.	F	64.5"	165	1.8	Light	54	115	70	18
45.	34	Geog.	F	73 "	215	2.2	Moderate	60	120	70	17
46.	48	HPER	F	67.5"	162	1.83	Active	54	122	82	17
47.	44	Ag.Econ.	F	75 "	205	2.22	Active	60	124	68	14
48.	34	Geog.	F	72.2"	191	2.1	Active	60	135	75	13
49.	28	Ani.Sci.	F	68 "	204	2.04	Light	78	135	80	11
50.	53	Agronomy	F	65 "	152	1.76	Moderate	72	130	75	12
51.	30	Math	F	67 "	155	1.82	Active	72	125	70	11

SUBMECT	VITAL CAPACITY ACTUAL	VITAL CAPACITY RESIDUAL	TIMED VITAL CAPACITY ACTUAL	TIMED VITAL CAPACITY RESIDUAL	MBC ACTUAL	MBC RESIDUAL	EKG AMP. R	EKG AMP.T	REST/ WORK
35.	4.53	-.31	3.75	-.25	141.64	-30.36	10.5	4.0	2.0
36.	5.5	.36	4.95	.75	153.19	-27.81	15.5	2.5	1.69
37.	3.62	-1.07	3.6	.04	210.99	46.99	13.5	2.0	1.70
38.	3.99	-.51	2.6	-.8	104.05	-40.95	8.5	1.5	1.71
39.	4.29	-.33	4.05	.45	164.76	8.24	7.0	5.0	2.27
40.	4.20	.10	3.87	.67	121.4	-18.6	12.5	2.0	1.83
41.	4.45	-.17	4.27	.47	183.26	19.26	11.5	1.5	2.0
42.	4.01	-.71	3.45	-.25	173.4	15.4	14.5	3.5	2.68
43.	5.56	.52	5.4	1.4	156.09	-11.91	13.5	1.0	1.83
44.	3.26	-.56	2.92	-.08	153.19	21.19	7.0	2.0	2.25
45.	6.29	.91	6.2	1.6	225.45	42.45	9.5	3.0	2.40
46.	4.66	.34	3.95	.55	199.44	53.44	4.5	3.0	2.25
47.	5.85	.45	4.75	-.65	190.76	15.76	8	4.5	1.75
48.	5.75	.45	4.67	.37	141.64	-38.36	7.0	3.5	2.46
49.	5.29	.45	4.6	.6	174.59	.59	10.5	2.0	1.85
50.	3.58	-.32	3.1	.1	91.34	-40.66	17.5	1.5	1.85
51.	4.23	-.43	3.75	-.05	205.21	37.21	16.0	4.5	1.56

SUBJECT	PREDICTED WEIGHT	WEIGHT RESIDUAL	PER CENT BODY FAT	O_2 INTAKE ML/KG	O_2 INTAKE CLASS	POST EXERCISE H.R. 5 MIN.	POST EXERCISE Systolic 5 MIN.	POST EXERCISE Pulse Pressure 5 MIN.
35.	146	6	9	38.5	3	102		
36.	168	8	12	42	3	102	132	50
37.	181	15	16	38.5	3	84	132	57
38.	178	15	16	35	4	78	118	56
39.	164	5	12	40	4	120	126	56
40.	155	6.5	11	38.5	4	96		
41.	155	8	13	38.5	3	90	119	48
42.	170	8	14	42	4	96	140	58
43.	164	10	7	37	3			
44.	147	18	18	30	2	90		
45.	202	13	14	40	4	102	120	70
46.	160	-2	10	50	5	96	140	68
47.	199	6	10	45	4	96	128	60
48.	179	12	16	45	4	96		
49.	187	17	17	28	2	108		
50.	139	13	8	35	4	102		
51.	144	11	13	45	4	102	138	72

SUBJECT	SMOKERS	
	SMOKER	NON-SMOKER
35.	X	
36.	X	
37.		X
38.		X
39.	X	
40.	X	
41.		X
42.	X	
43.	X	
44.	X	
45.		X
46.		X
47.		X
48.		X
49.		X
50.		X
51.		X

SUBJECT	AGE	DEPT.	FACULTY OR ADMN.	HT.	WT.	BSA	PHYSICAL ACTIVITY PATTERN	RESTING HEART RATE	RESTING B.P. SYSTO-LIC	DIASTO-LIC	SCHNEIDER INDEX
52.	33	Educ.	F	71"	150	1.88	Light	72	130	80	14
53.	35	Driv.Ed.	F	71"	190	2.05	Light	69	110	58	10
54.	56	Geog.	F	67"	150	1.8	Moderate	76	137	80	10
55.	32	Soc.	F	68.5"	165	1.89	Light	62	115	75	14
56.	39	Hum.Studies	F	74.25"	196	2.14	Light	78	125	75	15
57.	42	Physics	F	73"	233	2.2	Active	50	110	75	17
58.	37	Mech.Engr.	F	73.5"	184	2.08	Light	72	120	75	9
59.	36	Comp.Oper.	F	67.75"	195	2.0	Light	96	165	105	5
60.	54	Geog.	F	69.5"	183	2.02	Moderate	66	120	65	16
61.	37	Biochem.	F	67.5"	155	1.84	Moderate	78	130	75	12
62.	33	Ag.Econ.	F	73"	218	2.2	Light	114	140	80	0
63.	29	Educ.	F	67.5"	169	1.89	Moderate	60	110	75	17
64.	40	Soc.	F	73.5"	200	2.16	Light	72	135	85	11
65.	37	Ag.Econ.	F	70"	152	1.85	Moderate	66	120	70	15
66.	35	SafetyEd.	F	71.5"	169	1.96	Moderate	66	135	90	14
67.	33	Geog.	F	70.5"	166	1.92	Active	66	120	80	17
68.	49	Vet.Med.	F	73.5"	194	2.13	Light	78	120	70	10

SUBJECT	VITAL CAPACITY ACTUAL	VITAL CAPACITY RESIDUAL	TIMED VITAL CAPACITY ACTUAL	TIMED VITAL CAPACITY RESIDUAL	MBC ACTUAL	MBC RESIDUAL	EKG AMP. R.	EKG AMP.T	REST/ WORK
52.	4.65	-.38	4.05	.02	196.16	12.16	9.5	2.5	1.87
53.	4.9	-.2	3.85	-.18	161.86	-15.14	10.5	2.5	2.33
54.	4.61	.56	3.02	-.08	125.4	-8.6	6.0	1.5	1.71
55.	4.23	-.59	3.7	-.2	182.1	12.1	6.0	2.7	2.14
56.	5.39	-.03	4.9	.6	182.09	2.09	14.0	4.0	1.92
57.	4.39	-.79	3.55	-.55	184.98	12.98	6.5	3.5	2.1
58.	4.67	-.69	4.0	-.6	164.76	-16.24	13	3.0	1.75
59.	4.0	-.62	3.5	-.2	164.7	2.7	16	1.5	1.29
60.	4.9	.44	3.82	.42	154.5	8.5	5.5	2.5	2.27
61.	5.6	1.03	5.1	1.5	164.75	3.75	9.0	1.5	1.53
62.	6.24	.84	5.5	1.1	190.76	6.76	18.0	2.0	1.85
63.	4.64	-.16	4.12	.12	161.8	-12.2	9.5	5.0	2.13
64.	5.5	.2	4.72	.52	153.19	-22.81	13.0	3.0	2.0
65.	4.42	-.48	3.92	.02	179.21	11.21	11.5	4.0	2.29
66.	5.4	.26	4.35	.20	199.4	23.4	15.5	3.0	2.0
67.	5.32	.30	3.77	-.33	132.96	-41.04			
68.	5.45	.35	4.82	.82	193.6	29.6			

SUBJECT	PREDICTED WEIGHT	WEIGHT RESIDUAL	PER CENT BODY FAT	O_2 INTAKE ML/KG	O_2 INTAKE CLASS	POST EXERCISE H.R. 5 MIN.	POST EXERCISE Systolic 5 MIN.	POST EXERCISE Pulse Pressure 5 MIN.
52.	144	6	8	40	4	84	140	80
53.	182	8	11	37	3	102	135	65
54.	148	2	12	38.5	4	96	130	55
55.	145	20	14	43.5	4	102		
56.	188	8	17	35	3	108	130	56
57.	220	13	17	38.5	4	84		
58.	172	12	18	37	3	93	130	60
59.	178	17	22	23.5	1	108		
60.	166	17	12	42	4	96	135	55
61.	149	6	16	37	3	108	140	74
62.	205	13	21	35	3	102	156	88
63.	157	12	8	43.5	4	90	120	48
64.	192	8	9	35	3	102	128	48
65.	150	2	10	48.5	5	108	140	80
66.	166	3	7	45	4	96	148	64
67.	154	12	6	42	4	78	120	40
68.	182	12	14	31.5	3	114	140	60

SUBJECT	SMOKERS	
	SMOKER	NON-SMOKER
52.	X	
53.		X
54.	X	
55.		X
56.		X
57.		X
58.		X
59.		X
60.	X	
61.		X
62.		X
63.		X
64.		X
65.	X	
66.		X
67.		X
68.		X

SUBJECT	AGE	DEPT.	FACULTY OR ADMN.	HT.	WT.	BSA	PHYSICAL ACTIVITY PATTERN	RESTING HEART RATE	RESTING B.P. SYSTOLIC	RESTING B.P. DIASTOLIC	SCHNEIDER INDEX
69.	47	Agron.	F	72.5"	179	2.05	Active	54	135	80	14
70.	50	For.Lang.	F	67"	145	1.76	Active	72	120	75	15
71.	37	Educ.	F	68"	160	1.87	Active	45	115	70	17
72.	47	Geog.	F	76"	185	2.05	Light	84	130	75	7
73.	44	Agron.	F	70"	182	2.0	Moderate	72	120	70	13
74.	39	Ag.Econ.	F	75"	246	2.4	Moderate	58	110	75	15
75.	34	Geol.	F	72"	166	1.97	Active	54	120	75	18
76.	45	Botany	F	70.25"	156	1.89	Active	72	120	75	11
77.	35	Geog.	F	68.5"	162	1.87	Active	66	118	60	17
78.	41	Acctg.	F	75.5"	196	2.02	Active	60	115	75	15
79.	30	PolySci.	F	66"	156	1.8	Light	88	125	65	4
80.	32	Leg.Couns.	F	71"	162	1.94	Active	66	135	85	15
81.	30	Math	F	75"	176	2.28	Light	78	116	65	14
82.	30	Geog.	F	71"	170	1.96	Moderate	84	118	65	6
83.	37	For.Lang.	F	70"	159	1.88	Light	72	120	80	9
84.	38	For.Lang.	F	70"	182	2.0	Moderate	68	130	80	14
85.	32	Math	F	74"	174	2.06	Active	69	125	70	11

SUBJECT	VITAL CAPACITY ACTUAL	VITAL CAPACITY RESIDUAL	TIMED VITAL CAPACITY ACTUAL	TIMED VITAL CAPACITY RESIDUAL	MBC ACTUAL	MBC RESIDUAL	EKG AMP.R.	EKG AMP.T	REST/ WORK
69.	4.89	-.11	3.97	.07	185	23	12.0	3.5	2.53
70.	3.9	-.3	3.55	.25	150.31	8.31	14.0	3.0	1.86
71.	4.9	.26	4.35	.55	150.31	-11.69	5.0	2.5	2.59
72.	2.6	-2.8	2.25	-2.15	72.3	-101.7	8.0	2.5	1.64
73.	5.64	.9	3.85	.15	179.21	21.21	9.0	3.0	2.14
74.	5.75	.23	5.3	.9	152.04	-29.96	6.5	2.0	2.80
75.	5.97	.73	5.05	.65	141.60	-37.40	11.0	3.0	2.12
76.	5.2	.46	4.65	.95	196.5	37.5	7.5	2.0	1.71
77.	5.26	.50	4.74	.84	165.91	-1.09			
78.	5.72	.16	3.82	-.78	156.09	-25.91	6.0	4.0	2.57
79.	3.91	-.57	3.75	-.05	143.36	-20.64	16.0	2.0	1.67
80.	4.27	-.87	3.8	-.4	156.09	-21.91	16.0	3.0	2.28
81.	5.48	-.22	5.25	.65	158.95	-33.05	10.0	7.0	1.67
82.	5.1	-.1	4.4	.2	146.26	-33.74	8.0	1.5	1.43
83.	4.1	-.8	3.3	-.6	158.9	-11.1			
84.	4.59	-.27	4.1	.2	164.76	-1.24	8.5	2.5	2.0
85.	4.99	-.59	4.65	.15	210.99	20.99	17.5	2.5	1.72

SUBJECT	PREDICTED WEIGHT	WEIGHT RESIDUAL	PER CENT BODY FAT	O_2 Intake ML/KG	O_2 Intake CLASS	POST EXERCISE H.R. 5 MIN.	POST EXERCISE Systolic 5 MIN.	POST EXERCISE Pulse Pressure 5 MIN.
69.	171	8	14	43.5	4	84	144	84
70.	142	3	6	48.5	5	102	136	68
71.	151	9	11	45	4	104	135	70
72.	176	9	16	30	3	90	130	52
73.	170	12	14	37	4	84		
74.	225	21	17	42	4	90	122	58
75.	163	3	7	45	4			
76.	152	4	4	38	4	102		
77.	150	12	10	50	5	102	125	65
78.	188	8	10	45	4	90		
79.	140	16	11	32	3	88		
80.	155	7	6	55	5	84		
81.	170	6	6	42	4	102	128	60
82.	161	9	8	35	3	84	120	50
83.	148	11	9	38.5	3	102	135	75
84.	179	3	14	45	4	96	144	76
85.	170	4	7	48.5	5	102	128	68

	SMOKERS	
SUBJECT	SMOKER	NON-SMOKER
69.		X
70.	X	
71.	X	
72.	X	
73.		X
74.		X
75.		X
76.		X
77.		X
78.		X
79.	X	
80.		X
81.		X
82.		X
83.	X	
84.		X
85.		X

SIXTEEN SUBJECTS PREVIOUSLY TESTED

SUBJECT	RESTING HEART RATE	RESTING B.P.. SYSTOLIC	DIASTOLIC	SCHNEIDER INDEX	VITAL CAPACITY	TIMED VITAL CAPACITY	MAXIMAL BREATHING CAPACITY
6.	66	100	60	14	3.88	3.76	72.7
9.	52	130	85	17	6.02	5.2	135.85
13.	60	150	110	18	5.09	3.15	161.86
14.	60	112	65	14	5.53	4.95	173.43
15.	60	110	60	17	4.01	3.6	108.5
16.	48	145	80	17	3.54	3.25	64.43
23.	64	145	90	17	5.15	4.6	187.88
39.	44	115	80	19	4.94	4.2	164.76
42.	60	140	95	19	4.01	3.42	168.8
51.	88	120	80	8	4.39	3.67	202.33
57.	60	120	75	16	4.15	3.42	141.19
68.	80	125	75	8	5.69	4.9	208.1
69.	60	135	82	17	5.1	4.1	167.6
70.	76	130	80	9	4.5	3.75	106.9
80.	72	155	90	16	4.29	3.7	118.68
83.	80	125	70	8	3.7	3.3	132.2

SIXTEEN SUBJECTS PREVIOUSLY TESTED

SUBJECT	R WAVE AMPLITUDE	T WAVE AMPLITUDE	REST/WORK RATIO	% BODY FAT	AGE ADJUSTED O_2 INTAKE	POST EXERCISE HEART RATE 5 MIN.	O_2 INTAKE ML/KG/MIN.
6.	9.0	3.5	2.5	9	5	96	48
9.	5.5	3.0	2.37	5	2	96	33
13.	10.0	2.0	2.25	12	3	102	37
14.	11.0	3.0	2.43	14	4	102	37
15.	13.0	3.5	2.0	12	4	96	38
16.	17.0	4.5	2.28	14	4	72	43
23.	14.0	1.5	2.06	18	4	108	40
39.	7.0	5.0	2.5	7	4	124	38
42.	13.0	4.5	2.53	12	4	96	37
51.	7.5	2.0	1.33	12	3	108	42
57.	6.5	4.0	2.0	16	4	90	43.5
68.	8.0	3.0	1.85	12	4	96	37
69.	10.0	3.0	2.18	11	3	84	33.5
70.	16.0	3.0	1.97	9	5	106	50
80.	10.5	4.0	2.31	10	5	96	55
83.	11.0	1.5	1.79	7	3	108	38.5

VITA

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Candidate for the Degree of

Doctor of Education

Thesis: THE APPRAISAL OF THE CURRENT PHYSICAL FITNESS STATUS OF EIGHTY-FIVE VOLUNTEER MALES OF THE OKLAHOMA STATE UNIVERSITY FACULTY AND ADMINISTRATION

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