A COMPARISON OF SELECTED PHYSICAL FITNESS VARIABLES AMONG STILLWATER FIREFIGHTERS IN A VOLUNTARY ASSESSMENT PROGRAM

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CHAPTER I

INTRODUCTION

For years fire departments have recognized the importance of keeping their equipment in top operating condition, but what about the human machine, the firefighter? Firefighters are exposed to "high levels of heat, dangerously low levels of oxygen, dangerous levels of carbon monoxide" (Davolos, 1975, p. 28) as well as physically demanding work, effect of the protective equipment and emotional stress, making this a very physically demanding occupation (Davis, Dotson, & Santa Maria, 1982 and Barnard, 1975).

The Los Angeles fire department (cited in Adams et al, 1986) has adequately described the basic job requirements of an active-duty fire fighter.

> Physical performance calling for above average ability, endurance, and superior condition, including occasional demand for extraordinary strenuous activities in emergencies, under adverse environmental conditions, and over extended periods of time; requires running, walking, difficult climbing, jumping, twisting, bending, and lifting over 25 pounds; pace of work is typically set by the emergency situation.

Studies conducted by Lemon and Hermiston (1977) revealed that the level of fitness of some firefighters were on an equal basis with sedentary males. Barnard (1975) reported similar findings. He compared the physical fitness level of some firefighters to that of the average American and indicated that this is detrimental to job performance since most Americans are overweight, underactive, and in poor physical condition.

Physical fitness programs could help decrease firefighter injury and illness and improve performance levels. One way to gradually and continually increase departmental fitness levels is by requiring a rigorous entry level physical fitness evaluation.

Such assessment should be highly valid, reliable, and objective as well as safe, inexpensive and practical to administer (Bahrke, Etheridge, & Mc Swain, 1981).

Statement of the Problem

The purpose of this study was to compare selected physical fitness variables among Stillwater firefighters in a voluntary assessment program during 1986 and 1987.

Hypotheses

The null hypothesis was employed in examining the following questions:

1. There will be no significant difference in percent predicted maximal breathing capacity scores for the total group from 1986 to 1987.

2. There will be no significant difference in percent predicted vital capacity scores for the total group from 1986 to 1987.

3. There will be no significant difference in timed vital capacity scores for the total group from 1986 to 1987.

4. There will be no significant difference in resting heart rate scores for the total group from 1986 to 1987.

5. There will be no significant difference in resting systolic blood pressure scores for the total group from 1986 to 1987.

6. There will be no significant difference in resting diastolic blood pressure scores for the total group from 1986 to 1987.

7. There will be no significant difference in body weight scores for the total group from 1986 to 1987.

8. There will be no significant difference in grip strength scores for the total group from 1986 to 1987.

9. There will be no significant difference in push strength scores for the total group from 1986 to 1987.

10. There will be no significant difference in pull strength scores for the total group from 1986 to 1987.

11. There will be no significant difference in leg extension strength scores for the total group from 1986 to 1987.

12. There will be no significant difference in flexibility scores for the total group from 1986 to 1987.

13. There will be no significant difference in oxygen intake scores for the total group from 1986 to 1987.

14. There will be no significant difference in oxygen intake scores for the 20 to 29 year age group from 1986 to 1987.

15. There will be no significant difference in oxygen intake scores for the 30 to 39 year age group from 1986 to 1987.

16. There will be no significant difference in percent body fat scores for the total group from 1986 to 1987.

17. There will be no significant difference in percent body fat scores for the 20 to 29 year age group from 1986 to 1987.

18. There will be no significant difference in percent body fat scores for the 30 to 39 year age group for 1986 to 1987.

19. There will be no significant difference in total cholesterol scores for the total group from 1986 to 1987.

20. There will be no significant difference in total cholesterol scores for the 20 to 29 year age group from 1986 to 1987.

21. There will be no significant difference in total cholesterol scores for the 30 to 39 year age group from 1986 to 1987.

22. There will be no significant difference in percent high density lipoproteins scores for the total group from 1986 to 1987.

23. There will be no significant difference in percent high density lipoproteins scores for the 20 to 29 year age group from 1986 to 1987.

24. There will be no significant difference in percent high density lipoproteins scores for the total group for the 30 to 39 year age group from 1986 to 1987.

Limitations

1. The study was limited to data collected on Stillwater Firefighters that volunteered to participate in an assessment program in each of the years 1986 and 1987.

2. There was no attempt to control diet and exercise.

Delimitations

1. Analysis included data from 19 male Stillwater firefighters between the ages of 20 and 41.

2. Analysis included data from the following sixteen physical fitness variables: percent predicted maximal breathing capacity, percent predicted vital capacity, timed vital capacity, resting heart rate, systolic and diastolic blood pressure, body weight, grip strength, push strength, pull strength, leg extension strength, flexibility, maximal oxygen intake, body composition, total cholesterol, percent high density lipoproteins cholesterol (HDL-C).

3. All variables were delimited to the group as a whole (ages 20 to 41). Maximal oxygen intake, body composition, total cholesterol, and percent HDL-C measures were also delimited to the age groups 20-29 years and 30-39 years.

Assumptions

1. It was assumed that the physiological test data selected are considered to be valid criteria of physical fitness.

2. It was assumed that data was collected correctly and accurately.

3. It was assumed that data was collected by equipment that was reliable and correctly calibrated.

4. It was assumed that modest differences in protocols did not alter physiological measurements from year to year.

Significance of the Study

This study compared selected physical fitness variables among Stillwater firefighters in a voluntary assessment program. The significance of this study was to determine if the physical fitness level of the firefighters had improved, remained the same, or declined in each of the variables studied over a one year period. The results of this study should enable the Stillwater Fire Department to establish a better fitness program and monitor the physical condition of its firefighters.

Definition of Terms

Physical Fitness: The ability to perform daily tasks vigorously and alertly, with energy left over for enjoying leisure time activities and meeting emergency demands.

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

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

Timed Vital Capacity: The maximum volume of air that can be exhaled per unit of time.

FEV1.Ø/FVC: The maximum volume of air that can be exhaled in one second.

Maximum Oxygen Uptake (Aerobic Capacity): The largest amount of oxygen that one can utilize under the most strenuous exercise.

MET: One met equals 3.5 ml. of oxygen/kg./min.

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 filling with blood.

Flexibility: The range of possible movement about a joint or a sequence of joints.

Strength: The maximum force that one can generate in an isolated movement of a single muscle or a group of muscles.

CHAPTER II

REVIEW OF LITERATURE

Introduction

While much effort has been expended in designing industrial jobs to match the physiological limitations of the work force, the work environment of the firefighter has remained fairly constant during the last century (Davis, Biersner, Barnard, & Schamadan, 1982).

Firefighting is unquestionably a very hazardous occupation. Ample evidence exists supporting the notion that structural firefighting is a physically demanding occupation (Davis, Dotson, & Santa Maria, 1982). Despite many chemical and physical stresses of firefighting, very little scientific inquiry has been directed to this large occupational group.

The literature appears to be limited in the area of firefighters. More information needs to be collected in the area of medical evaluation of firefighters, their environmental stressors (i.e. temperature, noise, and a dangerous breathing atmosphere), and their physical stressors (i.e. cardiovascular system, pulmonary function, sensory function, orthopedic status, body weight) (Davis, Biersner, Barnard, & Schamadan, 1982).

Medical Evaluation of Firefighters

Aside from the obvious dangers associated with the job, firefighting subjects the body to environmental and physical stressors that can adversely affect various systems. In fact, the effects of these stressors on the cardiovascular system have made coronary heart disease a greater killer among firefighters than among other occupational groups (Davis, Biersner, Barnard & Schamadan, 1982).

To property evaluate firefighters medically, physicians need to appreciate the environmental and physical stressors to which firefighters are exposed. According to Davis, Biersner, Barnard and Schamadan, effective adaptation to these stressors requires optimum respiratory and cardiovascular health, which should be thoroughly examined to determine the level of fitness for the firefighting duty (1982).

A distinct difference exists between firefighters and other occupational groups. Unlike other occupational groups, firefighters do not control the physical (i.e. cardiovascular, pulmonary, etc.) requirements of the work environment, but rather must respond to drastic emergency conditions.

Environmental Stressors

In their job, firefighters are typically exposed to the environmental stressors of temperature and breathing a dangerous atmosphere.

Temperature. Heat, always present at the fire scene, poses a very serious problem. In a burning structure, ambient temperature can rise above 449.6 degrees Fahrenheit (Abeles, Delvecchio, & Himel, 1973). Most protective equipment cannot withstand such temperatures for prolonged periods and firefighters have been severely burned. It also limits dissipation of body heat generated during physical work, creating a secondary heat environment resulting in lowering of plasma volume; therefore, if proper hydration is not provided, accelerated fatigue, heat exhaustion, or heat stroke could occur (Dunkin, Gardner, & Barnard, 1979).

Noise. Research conducted by Reischl, Bair, & Reischl has shown that noise levels during firefighting continuously exceed the safe limits recommended by the Occupational Health and Safety Administration (1979).

Noise is a somewhat complex subject in that some high levels can be tolerated for a short period of time while continued exposure to middle levels of sound can have some damaging effects. For example, mechanical equipment, ruptured steam lines, or process product lines, particularly in chemical plants, can produce unusually high noise levels (between 110 and 150 decibels). other high noise levels frequently encountered on the fire scene are in areas where gasoline power tools, such as chain saws and high speed rotary saws, are in use. Such conditions indicate a serious need for noise abatement and hearing protection (Laughlin, Carlson, & Osterhout, 1979).

According to Sanden & Axelsson, the exposure to high noise levels can lead to substantial hearing loss, but can also result in fatigue and adverse cardiovascular effects (1981).

Breathing A Dangerous Atmosphere. A number of deadly gases are routinely present at fires, particularly during the portion of interior firefighting. At this point levels of carbon monoxide increase very rapidly causing a very hazardous atmosphere. According to epidemiologic research done on firefighters around the United States, pulmonary effects resulting from exposure to the products of combustion include lowered dynamic pulmonary function. This effect was potentiated by cigarette smoking (David, Biersner, Barnard, & Schamadan, 1982).

Physical Requirements

Cardiovascular Fitness. A high level of aerobic fitness coupled with low level of risk factors for cardiovascular disease is an ideal combination for firefighters required to work in a hostile environment. The seven cardiovascular risk factors are: age, sex, heredity, smoking, hypertension, obesity, and sedentary lifestyle (David & Curtis).

Medical history of a firefighter should show no presence of ischemic heart disease. Episodes of fainting resulting from hypotension, seizure, or any other factor should be recorded. The above mentioned factors are reason for disqualification from employment.

In addition to a medical history evaluating the presence of cardiovascular disease, an extensive cardiovascular assessment, including a resting electrocardiogram (EKG) and a multi-lead exercise test should be done. Even though a graded exercise test is preferred, field methods such as the step test or a mile-and-a-half run can be used to assess aerobic fitness. It is essential that the firefighter demonstrate an above-average level of aerobic fitness due to the rigorous physical demands of his job (Davis, Biersner, Barnard, & Schamadan, 1982 and Davis, & Curtis). According to Davis, Biersner, Barnard, & Schamadan

(1982), a minimum fitness level should be 12 METS, however a level of 14 METS is recommended. It is also recommended that the treadmill test should be a maximum symptom-limited test with no notation of malignant EKG abnormalities. Even though corrections in cardiovascular performance for age are made for the general population, it is not recommended that these corrections be made for firefighters.

Pulmonary Function. Information is lacking on the possible chronic effects of smoke inhalation, however Peters, Theriault, Fine, & Wegman (1974) conducted a study of pulmonary function on 1,430 Boston firefighters during 1970 to 1972. Forced vital capacity and forced expiratory volume in one second were measured at two different times. The rate of loss in pulmonary function observed for all subjects was more than double the expected rate. These changes were significantly related to the frequency of fire exposure, and could not be attributed to difference in age, smoking habits, or ethnic background. Therefore, this research suggests that occupational exposures are contributing to chronic impairment of pulmonary functioning of firefighters.

Sensory Functions. Sensory functions should be carefully evaluation because normal sensory function minimizes the hazards associated with driving heavy equipment rapidly through crowded intersections.

The absence of vertigo, unimpaired binocular vision, and adequate bilateral auditory perception in the speech range are essential for proper balance, vision and communication, therefore, these areas ought to be taken into consideration in the evaluation of firefighters for duty (Davis, Biersner, Barnard, & Schamadan, 1982).

Orthopedic Status. Cady, Bischoff, O'Connell, et al report that back injuries are a leading cause of disability among firefighters. Therefore, a careful orthopedic examination is essential. High levels of strength in the upper and lower torso can reduce the frequency of back injuries (1979). "The orthopedic examination should show complete joint stability and mobility, including that of the intervertebral articulations" (Davis, Biersner, Barnard, & Schamadan, 1982, p. 245). Any loss of limb or its function is grounds for 100% disability for firefighters or for disqualification of prospective firefighters.

Body Weight. Excess body fat has no advantage. it has the same debilitating effect on performance as does the carrying of unnecessarily heavy equipment. For years, there has been concern about the weight of protective equipment. Yet, the aspect of performance that can be readily controlled--body fat levels--has not received the same amount of attention.

Since the storing of body fat is a reversible condition, the debilitating effects of obesity can be reversed. The maintenance of a firefighting force is every bit as important as apparatus maintenance (Davis & Starck, 1980).

Summary

Since firefighting is one of the most hazardous civilian occupations, high rates of injury occur despite rigorous medical screening to select recruits in peak physical condition. The problem, it seems, is maintaining these initial levels of health and physical fitness (Miller, 1987).

CHAPTER III

METHODS AND PROCEDURES

Preliminary Procedures

Data analyzed in this study was collected by the Oklahoma State University Fitness Center personnel through a contract with the City of Stillwater. Permission for data access was granted to the author by the City of Stillwater.

Selection of Subjects

Data for nineteen male firefighters, between the ages of 20 and 41, who voluntarily participated in an assessment program was used for this study. Data for all nineteen subjects was compared for all sixteen variables used in the study. In addition, data for ten fire fighters between the ages of 20 and 29 and data for eight fire fighters between the ages of 30 and 39 was used for the percent body fat and oxygen intake measurements. Data for eight fire fighters between the ages of 20 and 29 and data for seven fire fighters between the ages of 30 and 39 were used for the total cholesterol and percent HDL-C measurements.

Selection of Measurements

Data for this study utilized the following measurements: percent predicted maximal breathing capacity, percent predicted vital capacity, timed vital capacity, resting heart rate, blood pressure, body weight, grip strength, push strength, pull strength, leg extension strength, flexibility, maximum oxygen intake, body composition, total cholesterol, and percent HDL-C. Entire group data for each measurement was compared during the year 1986 and 1987. Data was also analyzed using four age dependent variables using the age groups 20-29 and 30-39. The four variables used were maximum oxygen intake, body composition, total cholesterol, and percent HDL-C.

Maximal Ventilatory Volume

According to Lester (1984), the maximal breathing capacity test has been used for many years to test for such conditions as emphysema and bronchitis. The most common use of this test is to identify those subjects who may have clinical pulmonary insufficiency from those with normal pulmonary conditions.

The Vitalograph S-model Spirometer and the Vitalograph Function Analyzer model "A" were utilized for measuring maximal ventilatory volume.

According to Miller (1987), normal values for MVV for adult men can be calculated by the following formula: 109 - (age/2) M BSA. MVV can be estimated by multiplying FEV0.5 by 53 or by multiplying FEV1 by 41.

Vital Capacity

Vital capacity is the amount of air that a person can expel from the lungs after first filling the lungs to their maximum extent and then expiring to the maximum extent (Lester, 1984). Vital capacity is a commonly performed test. When correlated with body surface area it "is often taken as an index of physical fitness" (Guyton, 1981).

The Vitalograph S-model Spirometer and the Vitalograph Function Analyzer model "A" were utilized for measuring maximal ventilatory volume.

Sarkon, et al (1979) divide norms for vital capacity (liters) of males into the three following age groups: 3.35-5.90 (Age 20-29), 2.72-5.30 (Age 40-59), and 2.42-4.70 (Age 60+).

Timed Vital Capacity

Timed vital capacity (FEV1/FVC) is the percentage of forced vital capacity that is expired in the first second and can be used to show whether a person has an airway obstruction such as one that might occur with acute asthma (Guyton, 1981). The forced vital capacities (FVC) of two persons, one with normal lungs and one with an airway obstruction, might be almost equal, indicating only moderate differences in lung volumes. However, there would be a major difference in the flow rate at which the persons could expire. The most important difference in flow rate occurs in the first second. It is customary to record forced expiratory volume during the first second (FEV1) and to use this for comparison between the normal and the abnormal (Guyton, 1981).

According to Sarkon, et al (1979) normal values for timed vital capacity (FEV% or FEV1/VC%) for men are 77 (ages 20-39), 70 (ages 40-59), and 60 (ages 60+).

The Vitalograph S-model Spirometer and the Vitalograph Function Analyzer model A were utilized for measuring maximal ventilatory volume.

Resting Heart Rate

Saltin (1969) indicates that the average for resting heart rate is approximately 72 beats per minute.

Goss states that "the easiest method for comparison, longitudinally in an individual or between groups of subjects, is the heart rate" (1978, p. 56). Heart rate is the number of ventricular beats per minute as counted from records of the electrocardiogram or blood pressure curves. The heart rate can also easily be determined by auscultation with a stethoscope or by palpation over the heart, both during rest and exercise (Astrand & Rodahl, 1977).

According to Saltin, Essen, & Pedersen, heart rate is closely and positively related to the oxygen uptake in intermittent and continuous exercise (1976). Heart rate is also related to cardiovascular fitness--"the lower the heart rate, the higher the level of fitness" (Lester, 1984, p. 3). Whether an elite athlete or a regular exerciser is considered, the resting heart rate will be low when compared to the general population (Goss, 1978).

The heart rate was monitored by a 12-lead resting electrocardiogram using a Birtcher Electrocardiograph Machine Model 344.

Blood Pressure

Generally, investigations concerning blood pressure readings recorded during the resting state indicate a range of 110 to 135 mmHg for systolic pressure and 60 to 90 mmHg for diastolic pressure. A person's blood pressure may be considered to be normal if its comes within the minimum-maximum range (Rushmer, 1976).

Blood pressure, a risk factor for cardiovascular disease, can be controlled (Davis & Curtis). A clear relationship between elevated blood pressure and increased susceptibility to heart disease has been discovered. The heart is similar to a hydraulic pump. if the pump has to work continuously against resistance, it is going to deteriorate faster than if it is working against normal pressure. The same is true for the heart.

Factors that influence blood pressure are cigarette smoking, obesity, stress, heredity, and the excessive intake of salt and fat (Davis & Curtis).

Blood pressure was measured using an adult-size occluding cuff and a PhMoh Trimline Sphygmomanometer.

Body Weight

Body weight standards are usually specified for height, assuming a standard ratio of fat and nonfat tissue (lean tissue). This may not be true, since the football player, for instance, may exceed his body weight for height and not be fat. How does one discriminate? The answer lies in the technique of measuring skinfold thickness at selected anatomical sites (Allen, 1975). Therefore, the combination of body weight and body composition can indicate whether the change in body composition was due to loss or gain of fat or muscle.

According to Tannenhaus (1986), consultation of various weight tables will indicate weights which are all relatively close to one another, regardless of the method used to determine them. One method that can be used is to measure one's height in inches and divide that figure by 66. Then multiply the answer by itself. Next, multiply that answer by one's age plus 100. The result is the midpoint of a safe range for you. One can weigh up to 15 pounds more or less than that without health risk.

For example, a 35-year-old male who is six feet tall could safely weigh 146 to 176 pounds, with 161 pounds being the midpoint.

Subjects were weighed on a Detecto-Medic balance beam scale.

Strength

According to Pollock, Willmore, & Fox (1978), "Muscular strength refers to the maximum amount of force that one can generate in an isolated movement of a single muscle or a group of muscles" (p. 56).

Strength can be measured by any one, or a combination of three different types of maximal muscular contractions--isotonic, isometric, and isokinetic--using either eccentric (lengthening) or concentric (shortening) contractions (Lester, 1984 and Pollock, Willmore, & Fox, 1978).

Davis & Associates (cited in David, Biersner, Barnard, & Schamadan, 1982) found a significant relationship between physiological fitness variables, such as strength, and effectiveness on fire fighting jobs.

The grip strength was measured using a narangasett Hand Dynamometer. The leg extension strength was measured using a cable tensiometer. The push-pull strength was measured using a Narangasett Hand Dynamometer and a push-pull attachment.

The Oklahoma State University Health and Fitness Center Strength Scale, as developed by Aix B. Harrison, indicates norms for the strength tests administered to the subjects (Appendix C).

Flexibility

Patton, Corry, Gettman, & Graf (1986) state that the most effective method in assessing flexibility is done with a gravity goniometer, "an instrument that determines the range of movement of each body part" (p. 101). However, this method is not widely used due to its high cost and large amount of time expenditure involved. Therefore, the most highly used measure is the sit-and-reach test.

The sit-and-reach test was used to determine flexibility at the hip joint.

According to Manitoba Department of Education (1977), the percentile norms for young adult males performing the sit-and-reach test range from 1.0 inches at the 0 percentile to 15.5 inches at the 100 percentile with 9.0 inches at the 50th percentile. This data is based on a test procedure where nine inches is at the level of the soles of the feet.

Maximum Oxygen Intake

Cooper's age adjusted scale indicates fitness levels as measured by maximum oxygen intake (Appendix B).

"Maximum aerobic capacity (VO2max), the ability to use oxygen, has been identified as an important factor in the work performed by firefighters" (Davis, Bierner, Barnard, & Schamadan, 1982, p. 242). Maximum oxygen intake is also one of the best methods available for measuring physical fitness level.

A modified Balke protocol was used with a motorized treadmill in order to predict maximum oxygen intake. The predicted maximum oxygen intake in ml/kg/min. was determined from calculations (according to the American college of Sports medicine Guidelines) using the corresponding treadmill angle.

According to Oldham (1976), the Balke Treadmill Test is: (1) A standardized test which can be used for men representing a wide range in age and physical fitness. (2) The test is one of gradually increasing work load and requires only walking skill, warm-up and, therefore, training factors are minimal. (3) It has been used in other studies dealing with the assessment of aerobic work capacity in adult males. (4) Ease of administration and interpretation together with norms ascribed to the test render it a desirable one (Oldham, 1976).

Maximum oxygen intake is one of the age dependent variables selected for analysis since a progressive decline in maximum oxygen intake occurs with age. The decline in aerobic capacity with aging is mostly due to age-related decrements in physiologic functions related to oxygen transport (McArdle, Katch, & Katch, 1986). It has been estimated from cross-sectional data that approximately a 0.4 ml/kg/min decrease in maximum oxygen intake occurs each year after age 25 (Dehn, et al, 1972). This estimate is probably high because when longitudinal data is obtained on the same men who remain healthy and active for many years, the rate of decline is about half as fast (Bruce, et al, 1978).

Body Composition

Another important element in any test battery is the determination of the participants' body composition. The fat and lean components of an individual are best assessed by underwater weighing techniques, but these require expensive equipment and a lot of time. One field method that is widely used today and correlates very well with the underwater weighing technique is the measurement of skinfold thicknesses with the use of calipers (Patton, Corry, Gettman, & Graf, 1986 and Lester, 1984). "Because approximately 50% of the total fat of a young adult is deposited subcutaneously, skinfold thickness at specific sites allow you to estimate overall fat percentage (Patton, Corry, Gettman, & Graf, 1986, p. 114). Generally accepted methods have not been agreed upon, but this method can be used to highlight the different body compositions of two persons of the same body weight and height.

The Lange skinfold caliper was utilized to obtain skinfold thicknesses at seven different sites. Those sites were the following: the chest, mid-axilla, triceps, subscapula, abdominal, suprailliac, and thigh.

Body composition is one of the age dependent variables selected for analysis since body fat tends to increase with age. In the Western world, the average

35-year-old male will gain 0.2 to 0.8 kg of fat each year until the fifth or sixth decade of life (Parizkova, 1974). When the fat content of 27 adult men was studied over a 12-year span from age 32 to 44 years, the deposition of body fat increased with age (Chien, et al, 1975). Even though most "normal" people commonly grow fatter with age, those persons who engage in heavy resistance training increase their lean body mass component and decrease body fat.

Although not specifically documented, the ideally "healthy fat percentage" is generally agreed to be less than 20% for males (Brooks & Fahey, 1984).

Blood Cholesterol

Blood serum measures are used for the determination of high- and low-density lipoproteins by which it reveals a more accurate assessment of blood fats (Brooks & Fahey, 1984).

The amount of cholesterol present in the blood rises as one gets older. A normal adult male will have approximately 200 mg/dl. A plasma level of over 300 mg/dl is considered potentially dangerous. The norm, then, is considered to be anything between 180 & 250 mg/dl (International Family Health Encyclopedia, 1971). Pertinent literature regarding wellness norms for cholesterol indicates that cholesterol should be 200 mg/dl or less. Literature regarding HDL-C indicates that a normal HDL-C level would be about 20% of total cholesterol of a 5:1 ratio (Raphael et al, 1985).

"Cholesterol is one of many lipids or fats found in the blood. This substance has been continuously linked to the accumulation of plaque in the coronary arteries that supply the heart" (Davis & Curtis, p. 9).

A number of sub-components are found in cholesterol. The high density component (HDL) is a desirable or beneficial type of cholesterol because it prevents the low density component (LDL) from forming plaque on the walls of the coronary arteries. The ratio of these two types of cholesterol components to each other can be as important to health as the total amount of cholesterol in the blood (Davis & Curtis). Average risk of coronary heart disease is associated with a 5.0 ratio of total cholesterol to HDL-C. Levels of HDL-C of 70 mg/dl or more are associated with the longevity syndrome (Raphael et al, 1985).

Total cholesterol is one of the age dependent variables selected for analysis. According to Rifkind and Segal, plasma cholesterol concentration increases gradually from a mean of 150 mg/dl to a mean of 200 md/dl between ages 20 and 50 and remains stable until age 70. A slight decline in plasma cholesterol occurs thereafter (1983).

Statistical Treatment

The following data from 1986 and 1987 was utilized: body weight, percent body fat, resting systolic and diastolic blood pressure, resting heart rate, percent vital capacity, timed vital capacity, percent maximal ventilatory volume, push-pull strength, grip strength, leg extension strength, flexibility, maximum oxygen intake, cholesterol and HDL-C. Data was also analyzed for four age dependent variables using the age groups 20-29 and 30-39. The four age dependent variables used were maximum oxygen intake, body composition, total cholesterol, and percent HDL-C. Means and standard deviations were calculated for each variable for total group and for age groups as previously discussed.

A correlated group t test was utilized to determine differences, if any at the .05 level of significance between 1986 and 1987 data for total group and for age groups as previously discussed.

All computations were done at the Oklahoma State University Department of Education Microcomputer Lab using the SYSTAT statistical analysis program (Wilkinson, L. (1986). SYSTAT: The System for Statistics. Evanston, IL: SYSTAT.)

CHAPTER IV

RESULTS AND DISCUSSION

Data for nineteen male fire fighters who participated in a voluntary assessment program in 1986 and 1987 was used in this study. Data for a total of sixteen physical assessment variables were compared in the year 1986 and the year 1987. Subject were divided into two age groups, 20 to 29 years and 30 to 39 years, and compared on four age dependent variables.

Correlated group t tests were calculated on all variables. Results are displayed in Table I.

Significant Differences

Analysis of the t tests for all variables revealed no significant difference on the following scores: percent maximal ventilatory volume, resting systolic blood pressure, leg extension strength, maximum oxygen intake (total group 20-29 year age group and 30-39 year age group), percent body fat (20-29 year age group), cholesterol (total group, 20-29 year age group and 30-39 year age group), and percent HDL-C (30-39 year age group).

TABLE I

MEANS AND t TEST DIFFERENCES FOR 1986 AND 1987 VARIABLES

Test Item	N	1986 Mean (S.D.)	1987 Mean (S.D.)	t
Percent Maximal Ventilatory Volume	19	102.90 (+/-10.19)	102.32 (+/-19.10)	0.23
Percent Vital Capacity	19	119.05 (+/-11.04)	111.79 (+/-15.54)	4.18*
Timed Vital Capacity (FEV1/FVC)	19	81.03 (+/-4.61)	84.83 (+/-5.97)	7.14*
Resting Heart Rate (Beats per Minute)	19	82.26 (+/-12.81)	78.21 (+/-9.29)	4.07*
Resting Systolic Blood Pressure (mmHg)	19	125.74 (+/-8.74)	127.00 (+/-14.02)	0.66
Resting Diastolic Blood Pressure (mmHg)	19	77.47 (+/-4.54)	81.84 (+/-8.77)	3.71*
Body Weight (lbs.)	19	172.00 (+/-13.61)	168.52 (+/-14.22)	4.61*
Grip Strength (Pounds)	19	143.53 (+/-19.39)	132.47 (+/-20.87)	3.28*
Push (Chest) Strength (Pounds)	19	138.16 (+/-28.70)	128.63 (+/-29.47)	5.37*

TABLE I (Continued)

Test Item	N	1986 Mean (S.D.)	1987 Mean (S.D.)	t
Pull (Back) Strength (Pounds)	19	103.71 (+/-15.47)	95.00 (+/-20.00)	4.73*
Leg Extension Strength (Pounds)	19	119.71 (+/-30.25)	123.26 (+/-23.62)	0.48
Flexibility	19	-5.21 (+/-2.62)	-3.47 (+/-2.24)	7.64*
Maximum Oxygen Intake (Ml./Kg./Min.)				
Total Group	19	43.13 (+/-5.39)	44.72 (+/-3.88)	1.81
Age Group 20-29 Yrs.	10	44.34 (+/-7.66)	45.48 (+/-3.97)	0.63
Age Group 30-39 Yrs.	8	41.81 (+/-3.60)	42.42 (+/-3.38)	0.35
Percent Body Fat				
Total Group	19	16.17 (+/-2.42)	15.12 (+/-2.93)	4.60*
Age Group 20-29 Yrs.	10	15.76 (+/-3.01)	14.72 (+/-3.48)	0.69
Age Group 30-39 Yrs.	8	16.57 (+/-1.81)	15.14 (+/-2.35)	2.83*

TABLE I (Continued)

Test Item	N	1986 Mean (S.D.)	1987 Mean (S.D.)	t
Cholesterol (Mg./Dl.)				
Total Group	15	179.81 (+/-22.41)	186.76 (+/-30.59)	1.12
Age Group 20-29 Yrs.	8	180.68 (+/-15.12)	192.15 (+/-33.20)	0.95
Age Group 30-39 Yrs.	7	175.94 (+/-30.03)	173.41 (+/-19.64)	0.36
Percent HDL-C				
Total Group	15	24.71 (+/-4.50)	20.96 (+/-4.72)	3.66*
Age Group 20-29 Yrs.	8	26.19 (+/-5.87)	20.80 (+/-4.56)	2.45*
Age Group 30-39 Yrs.	7	23.56 (+/-1.92)	22.04 (+/-4.83)	0.76

*Significant at the .05 level.

Percent vital capacity was reduced from a mean of 119.05% to 111.79%, with standard deviations of 11.04 and 15.54, respectively, The t value was 4.18; significant at the .05 level.

Occupational exposure to fires may have contributed to a loss in pulmonary function as observed in percent vital capacity. A study by Peters, et al (1974) revealed that frequency of fire exposure contributes to chronic impairment of pulmonary function in firefighters. The rate of loss in pulmonary function observed in Boston firefighters was more than twice the expected rate for vital capacity.

Timed vital capacity showed a rise from a mean of 81.03 for 1986 to a mean of 84.83 for 1987, with standard deviations of 4.61 and 5.97, respectively. The computed t score of 7.14 was significant at the .05 level. According to the author, the rise in timed vital capacity was expected since a decrement in vital capacity was noted, assuming FEV1 remained about the same.

Resting heart rate scores showed a mean of 82.26 beats per minute for 1986 (s.d. = 12.81) and a mean of 78.21 beats per minute for 1987 (s.d. = 9.29). The computed t score of 4.07 was significant at the .05 level.

A decrease in heart rate occurs with improvement in cardiovascular fitness (Scheuer, 1977). Since there was no significant increase in maximum aerobic capacity in this study, it is the author's opinion that the significant difference was due to fluctuations in heart rate arising from test anxiety.

Resting diastolic blood pressure rose from a mean of 77.47 mmHg (s.d. = 4.54) to 81.84 mmHg (s.d. = 8.77). The t value was 3.71 which was significant at the .05 level.

One factor that can affect blood pressure is stress or anxiety. The researcher believes that the firefighters may have been apprehensive about the test battery causing blood pressure to fluctuate from one year to the next. Although, there was a significant difference between 1986 and 1987 scores, the mean values for diastolic blood pressure were well within normal ranges.

The mean body weight score for 1986 was 172.00 pounds, with a standard deviation of 13.61. The mean body weight score for 1987 was 168.52 pounds. with a standard deviation of 14.22. The t value was calculated to be 4.61, significant at the .05 level.

It is the author's opinion that the decrease in body weight could be the result of expending more calories than consumed or loss of muscle due to inactivity. Since body composition improved, it is most likely that the decrease in body weight was due mostly to loss of fat.

There was a decrease in grip strength from a mean of 143.53 pounds for 1986 (s.d. = 19.39) and a mean of 132.47 pounds for 1987 (s.d. = 20.87). The t of 3.28 was significant at the .05 level.

Push strength was reduced from a mean of 138.16 pounds to 128.63 pounds, with standard deviations of 28.70 and 29.47, respectively. The t value was 5.37; significant at the .05 level.

Pull strength was reduced from a mean of 103.71 pounds to 95.00 pounds, with standard deviations of 15.47 and 20.00, respectively. The t value was 4.73; significant at the .05 level.

It is the opinion of the author that the significant decrease in grip, push, and pull strengths was due to the lack of upper body muscle stimulation.

The flexibility measures revealed a significant decrement ($p<.05$). The 1986 and 1987 mean scores were -5.21 and -3.47, respectively. The t value was 7.64, significant at the .05 level. It should be noted that a decrement in flexibility was indicated as an increase in the score.

The researcher believes that the decrease in flexibility was due to inactivity.

The percent body fat measure for the total group revealed significant improvement. The mean 1986 and 1987 scores were 16.17% and 15.12%, respectively. The t value was 4.60, significant at the .05 level. It should be noted that an improvement in body fat was indicated by a decrease in the score.

The percent body fat measure for the 30-39 year age group also revealed a significant improvement. The mean 1986 and 1987 scores were 16.57% and 15.14%, respectively. The t value was 2.83, significant at the .05 level.

The significant decrease in body fat may have been mostly due to the loss of fat since body weight also significantly decreased.

A decrease was noted in percent HDL-C for the total group. Mean scores were 24.71% for 1986 and 20.96% for 1987, with standard deviations of 4.50 and 4.72, respectively. The t value was 3.66; significant at the .05 level.

A decrease was noted also in percent HDL-C for the 20-29 year age group. The mean scores were 26.19% for 1986 and 20.80% for 1987, with standard deviations of 5.87 and 4.56, respectively. The t value was 2.45; significant at the .05 level.

According to the author, the decrease in HDL-C levels may be due to inactivity since an increase in activity has been known to increase the level of HDL-C in the blood (Raphael et al, 1985).

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to compare selected physical fitness variables among Stillwater firefighters in a voluntary assessment program.

The results of this study found the following generally stated findings:

1. There will be no significant difference in percent predicted maximal breathing capacity scores for the total group from 1986 to 1987. This hypothesis was accepted.

2. There will be no significant difference in percent predicted vital capacity scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant decrement in percent vital capacity was found at the .05 level of significance.

3. There will be no significant difference in timed vital capacity scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant improvement in timed vital capacity scores at the .05 level of significance was found.

4. There will be no significant difference in resting heart rate scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant improvement at the .Ø5 level of significance was found in resting heart rate.

5. There will be no significant difference in resting systolic blood pressure scores for the total group from 1986 to 1987. This hypothesis was accepted.

6. There will be no significant difference in resting diastolic blood pressure scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant increase at the .Ø5 level of significance was found in resting diastolic blood pressure.

7. There will be no significant difference in body weight scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant improvement at the .Ø5 level of significance was found in body weight.

8. There will be no significant difference in grip strength scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant decrement in grip strength scores was found at the .Ø5 level of significance.

9. There will be no significant difference in push strength scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant decrement

in push strength scores was found at the .05 level of significance.

10. There will be no significant difference in pull strength scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant decrement in pull strength was found at the .05 level of significance.

11. There will be no significant difference in leg extension strength scores for the total group from 1986 to 1987. This hypothesis was accepted.

12. There will be no significant difference in flexibility scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant decrement at the .05 level of significance was found in flexibility scores.

13. There will be no significant difference in oxygen intake scores for the total group from 1986 to 1987. This hypothesis was accepted.

14. There will be no significant difference in oxygen intake scores for the 20 to 29 year age group from 1986 to 1987. This hypothesis was accepted.

15. There will be no significant difference in oxygen intake scores for the 30 to 39 year age group from 1986 to 1987. This hypothesis was accepted.

16. There will be no significant difference in percent body fat scores for the total group from 1986 to

1987. This hypothesis was rejected. A significant improvement in percent body fat at the .05 level of significance was found.

17. There will be no significant difference in percent body fat scores from the 20 to 29 year age group from 1986 to 1987. This hypothesis was accepted.

18. There will be no significant difference in percent body fat scores for the 30 to 39 year age group for 1986 to 1987. This hypothesis was rejected. A significant improvement in percent body fat at the .05 level of significance was found.

19. There will be no significant difference in total cholesterol scores for the total group from 1986 to 1987. This hypothesis was accepted.

20. There will be no significant difference in total cholesterol scores for the 20 to 29 year age group from 1986 to 1987. This hypothesis was accepted.

21. There will be no significant difference in total cholesterol scores for the 30 to 39 year age group from 1986 to 1987. This hypothesis was accepted.

22. There will be no significant difference in percent high density lipoproteins scores for the total group from 1986 to 1987. This hypothesis was rejected. A significant decrement at the .05 level of significance was found in percent HDL-C scores.

23. There will be no significant difference in percent high density lipoproteins scores for the 20 to 29 year age group from 1986 to 1987. This hypothesis was rejected. A significant decrement at the .05 level of significance was found in percent HDL-C scores.

24. There will be no significant difference in percent high density lipoproteins scores for the total group for the 30 to 39 year age group from 1986 to 1987. This hypothesis was accepted.

Conclusions

The purpose of this study was to compare selected physical fitness variables among Stillwater fir fighters in a voluntary assessment program during 1986 and 1987.

No significant difference was found on the following scores: percent body fat (20-29 year age group), resting systolic blood pressure, percent maximal ventilatory volume, leg extension strength, maximum oxygen intake (total group, 20-29 and 30-39 year age groups), cholesterol (total group, 20-29 and 30-39 year age groups), and percent HDL-C (30-39 year age group).

The participants improved significantly ($p<.05$) in decreasing percent body fat (total group and 30-39 year age group), resting heart rate, and timed vital capacity.

There was a significant decrement ($p<.05$) in percent vital capacity, push strength, pull strength, grip strength, flexibility, and percent HDL-C (total group and 20-29 year age group) scores.

There was a significant increase ($p<.05$) in resting diastolic blood pressure.

There was a significant decrease ($p<.05$) in body weight.

Recommendations

1. It is recommended that a study be conducted to determine if any significant differences in the physical fitness levels of the City of Stillwater firefighters have occurred since 1987.

2. It is recommended that Stillwater firefighters participating in a voluntary assessment program be compared with a similar program in other municipalities.

3. It is recommended that a study be conducted to compare the physical fitness levels of City of Stillwater firefighters with other firefighters around the nation.

BIBLIOGRAPHY

Abeles, F. J., Delvecchio, R. J., & Himel, V. H. (1973). A firefighter's integrated life protection system: Phase I design and performance requirements. New York: Grumman Aerospace.

Allen, M. C. L. (1975). Physical fitness and stress. Third Symposium of Occupational Health and Hazard of the Fire Service (pp. 49-51). Washington D.C.: International Association of Firefighters.

Astrand, P.O. & Rodahl, K. (1977). Textbook of work physiology. New York: McGraw Hill.

Barnard, R. J. (1975). Preventive maintenance for firefighters. Third Symposium on Occupational Health and Hazards of the Fire Service (pp. 33-35). Washington D.C.: International Association of Firefighters.

Brooks, G. A. & Fahey, T. D. (1984). Exercise physiology: Human bioenergetics and its applications. New York: John Wiley & Sons.

Bruce, R. A., et al (1978). Longitudinal comparisons of responses to maximal exercise. In L. A. Folinsbee, et al (Eds.), Environmental Stress: Individual Adaptations. New York: Academic Press.

Cady, L. D., Bischoff, D. P., O'Connell, E. R., et al (1979). Strength and fitness and subsequent injuries in firefighters. Journal of Occupational Medicine, 21, 269-72.

Chien, S., et al (1975). Longitudinal measurements of blood volume and essential body mass in human subjects. Journal of Applied Physiology, 39, 818.

Davis, P. O., Biersner, R. J., Barnard, R. J., & Schamadan, J. (1982). Medical evaluation of firefighters. Post Graduate medicine, 72, 24-248.

Davis, P. O. & Curtis, A. V. The firefighter's survival manual: A guide to physical fitness. Quincy, MA: National Fire Protection Association.

Davis, P.O. & Dotson, C. O., & Santa Maria, D. L. (1982). Relationships between simulated fir fighting tasks and physical performance measures. Medicine and Science in Sports and Exercise, 14(1), 65-71.

Davis, P.O. & Starck, A. R. (1980). Excess body fat--not age--viewed as greater culprit in fitness decline. Fire Engineering, June 1983, 33-37.

Davolos, D. D. (1975). heart disease and the fir service. Third Symposium on Occupational Health and Hazards of the Fire Service (pp. 28-29). Washington D.C.: International Association of Firefighters.

Dehn, M. M., et al (1972). Longitudinal variations in maximal oxygen intake with age and activity. Journal of Applied Physiology, 33, 805.

Duncan, H. W., Gardner, G. W., & Barnard, R. J. (1979). Physiological responses of men working in fire-fighting equipment in the heat. Ergonomics, 22, 521-7.

Goss, J. E. (1978). Cardiovascular adaptations to endurance training. In Jokl, E. & Hebbelinck, M., Appenzeller, O., et al (Eds.), Medicine and Sport: Vol 12. Health Aspects of Endurance Training (pp. 56-71). Basel Switzerland: S. Karger.

Guyton, A. C. (1981). Textbook of medical physiology. Philadelphia: W. B. Saunders..

Laughlin, J. W., Carlson, G. P., & Osterhout, C. E. (Eds.) (1979). Fire fighter occupational safety. Oklahoma State University: Fire Protection Publications.

Lemon, P. W. & Hermiston, R. T. (1977). The human energy cost of firefighting. Journal of Occupational Medicine, 19, 558-562.

Lester, M. (1984). Exercise physiology laboratory manual. Minneapolis, Minnesota: Alpha Editions.

McArdle, W. D., Katch, F. I., & Katch, V. L. (1986). Exercise Physiology: Energy, Nutrition, and Human Performance (2nd ed.). Philadelphia: Lea & Febiger.

Manitoba Department of Education (1977). Manitoba Physical Fitness Performance Test Manual and Fitness Objectives. Winnipeg: Manitoba Department of Education.

Miller, A. (1987). A fireman's heart. Personal Management, July, 24-26.

Miller, W. F. (1987). Laboratory Evaluation of Pulmonary Function. Philadelphia: J. B. Lippincott.

Oldham, M. D. (1976). The appraisal of the current physical fitness status of eighty-five volunteer males of the Oklahoma State University faculty and administration. Unpublished doctoral dissertation, Oklahoma State University.

Palton, R. W., Corry, J. M., Gettman, L. R., & Graf, J. S. (1986). Implementing health and fitness programs. Champaign, IL: Human Kinetics.

Parizkova, J. (1974). Body composition and exercise during growth and development. In G. L. Rarick (Ed.), Physical Activity: Human Growth and Development. New York: Academic Press.

Pollock, M. S., Wilmore, J. H., & Fox, S. M. (1978). Health and fitness through physical activity. New York: John Wiley & Sons.

Raphael, S. S., et al (1985). Lynch's Medical Laboratory Technology (4th ed.). Philadelphia: W. B. Saunders.

Reischl, U., Bair, H. S., Jr., & Reischl, P. (1979). Fire fighter noise exposure. Journal of the American Industrial Hygiene Association, 40, 482-489.

Rifkind, B. & Segal P. (1983). Lipid research clinics program reference values for hyperlipidemia and hypolipidemia. Journal of the American Medical Association, 250, 1869-1872.

Rushmer, R. F. (1976). Cardiovascular Dynamics. Philadelphia: W. B. Saunders.

Saltin, B. (1969). Physiological effects of physical conditioning. Medicine and Science in Sports, 1, 5Ø.

Saltin, B., Essen, B., & Pedersen, P. K. (1976). Intermittent exercise: its physiology and some practical applications. In Jokl, E. Hebbelinck, M., & Anand, R. L., et al (Eds.), Medicine and sport: Vol. 9. Advances in Exercise Physiology (pp. 23-51). Switzerland: S. Karger.

Sanden, A. & Axelsson, A. (1981). Comparison of cardiovascular responses in noise-resistant and noise-sensitive workers. Acta Otolaryngal, 377, 75-1ØØ.

Sarkon, M. et al (1979). Clinical Implications of Laboratory Tests (2nd ed.). St. Louis: C. V. Mosby.

Scheuer, J. & Tipton, C. M. (1977). Cardiovascular adaptation to physical training. Annual Review of Physiology, 39, 221.

Tannenhaus, N. (1986). Weight Problems. Springhouse PA: Springhouse Corp.

APPENDIXES

APPENDIX A

INFORMED CONSENT

OKLAHOMA STATE UNIVERSITY

HEALTH AND FITNESS CENTER

INFORMED CONSENT FORM

Subject's Name____________________________ Date________________________

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

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

on __________________________________.

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

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

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

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

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

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

Subject's signature_______________________________

Witness____

APPENDIX B

COOPER'S FITNESS CLASSIFICATION

Cooper's Fitness Classification: Men

		Age					
Category	Measure 0^{2}ml/kg/min	13-19	20-29	30-39	40-49	50-59	60+
I. Very Poor		< 35.0	< 33.0	< 31.5	< 30.2	< 26.1	< 20.5
II. Poor		35.0-38.3	33.0-36.4	31.5-35.4	30.2-33.5	26.1-30.9	20.5-26.0
III. Fair		38.4-45.1	36.5-42.4	35.5-40.9	33.6-38.9	31.0-35.7	26.1-32.2
IV. Good		45.2-50.9	42.5-46.4	41.0-44.9	39.0-43.7	35.8-40.9	32.2-36.4
V. Excellent		51.0-55.9	46.5-52.4	45.0-49.4	43.8-48.0	41.0-45.3	36.5-44.2
VI. Superior		> 56.0	> 52.5	> 49.5	> 48.1	> 45.4	> 44.3

APPENDIX C

OSU HEALTH AND FITNESS CENTER STRENGTH SCALE

MALE	Grip strong lbs	Grip weak lbs	push lbs	pull lbs	Leg strong lbs	Leg weak lbs
Your Values						
	180	170			250	230
SUPERIOR			200	180		
	170	160				
	160	150			210	200
EXCELLENT						
	150	140	170	150	170	160
ABOVE AVERAGE	140	130	145	125	145	135
	130	120				
AVERAGE	120	110	120	100	120	110
	110	100				
BELOW AVERAGE	100	90	95	80	95	85
POOR	90	80	70	60	70	65
	80	70				
VERY POOR	70	60	45	30	20	20

OKLAHOMA STATE UNIVERSITY

HEALTH AND FITNESS CENTER

INFORMED CONSENT FORM

Subject's Name_____________________________ Date__________________________

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on ____________________________________.

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

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

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

Subject's signature__________________________________

Witness____

VITA

Leonardo Rafael Riera

Candidate for the Degree of

Master of Science

Thesis: A COMPARISON OF SELECTED PHYSICAL FITNESS VARIABLES AMONG STILLWATER FIREFIGHTERS IN A VOLUNTARY ASSESSMENT PROGRAM

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