ABSTRACT

LAMBERT, C.M. A comparison of selected coronary heart disease risk factors in weight trained males. M.S. in Adult Fitness/Cardiac Rehabilitation, 1990. 37 pp. (W. Floyd)

The purpose of this study was to assess the coronary heart disease (CHD) risk factor profiles in a select group of weight trained males. Eighteen male Ss (19-26 yr.) participated in the study. All subjects engaged in rigorous weight training regimens exclusively as their form of regular physical activity. The CHD risk factors evaluated included total cholesterol (TC) levels, high density lipoprotein (HDL) levels, the TC:HDL ratio, systolic and diastolic blood pressures, and % body fat. The dietary intake levels of protein, complex and simple carbohydrates, fat, and alcohol were evaluated in 50% of the Ss. The mean values for TC (189.17 mg/dl), HDL (56.94 mg/dl), TC:HDL ratio (3.43), systolic blood pressure (120.67 mmhg), diastolic blood pressure (74.44 mmhg), % body fat (12.83%), protein intake (18.67%), and fat intake (25.84%) fell within recommended ranges. Only carbohydrate intake (49.11%) did not meet recommended levels. TC levels, while within recommended levels, were higher than those reported by other investigators in similar populations and may have been relatively high for this age group. Mean levels for HDL, TC:HDL ratio, blood pressures, and % body fat fell within ranges deemed protective against the development of CHD. It was concluded that this group did not seem to be at increased risk of developing CHD, but further longitudinal and cross-sectional research is needed to fully evaluate the effects of this type of physical activity on CHD risk factor profiles.

A Comparison of Selected Coronary Heart Disease Risk Factors in Weight Trained Males

---

A Thesis Presented

to

The Graduate Faculty

University of Wisconsin-LaCrosse

In Partial Fulfillment

of the Requirements for the

Master of Science Degree

---

by

Christopher M. Lambert

May 1991

UNIVERSITY OF WISCONSIN - LA CROSSE
College of Health, Physical Education and Recreation
La Crosse, Wisconsin 54601

Candidate: Christopher M. Lambert

We recommend acceptance of this thesis in partial fulfillment of this candidate's requirements for the degree:

M.S. - Adult Fitness/Cardiac Rehabilitation

The candidate has completed his oral report.

William Floyd — 9-6-90
Thesis Committee Chairman — Date

John E. Castek — 9/6/90
Thesis Committee Member — Date

John Curtis — 9/6/90
Thesis Committee Member — Date

This thesis is approved for the College of Health, Physical Education and Recreation.

Garth Tymeson — 1-23-91
Dean, College of Health, Physical Education and Recreation — Date

Robert Krajewski — 3-25-91
Dean of Graduate Studies — Date

TABLE OF CONTENTS

PAGE

LIST OF TABLES.......... vi

CHAPTER

I. INTRODUCTION.......... 1

Need for the Study.......... 2

Purpose.......... 3

Hypotheses.......... 3

Assumptions.......... 4

Delimitations.......... 4

Limitations.......... 4

Definition of Terms.......... 5

II. REVIEW OF RELATED LITERATURE.......... 7

Introduction.......... 7

Relationship Between Lipoproteins and CHD.......... 7

Relationship Between Obesity and CHD.......... 8

Relationship Between Hypertension and CHD.......... 9

Relationship Between Diet and CHD.......... 10

Effects of Aerobic Exercise on Risk Factors.......... 11

Effects of Weight Training on Risk Factors.......... 12

Summary.......... 15

III. METHODS.......... 16

Introduction.......... 16

Subject Selection.......... 16

Body Composition Determination.......... 17

Blood Assays.......... 19

HDL Determination.......... 20

TC Determination.......... 20

CHAPTER		PAGE
	Dietary Intake Determination	20
	Blood Pressure Determination	21
	Statistical Treatment	21
IV.	RESULTS AND DISCUSSION	22
	Introduction	22
	Physical Characteristics	22
	Serum Lipoproteins	23
	Serum TC	23
	HDL Cholesterol	24
	TC:HDL Ratio	24
	Blood Pressure	25
	Systolic Pressure	25
	Diastolic Pressure	25
	Dietary Characteristics	25
	Mean Daily Protein Consumption	26
	Mean Daily Fat Consumption	26
	Mean Daily Carbohydrate Consumption	27
	Mean Daily Alcohol Consumption	27
	Summary	28
V.	CONCLUSIONS	29
	Summary	29
	Serum Lipoprotein Levels	29
	Percent Body Fat	29
	Blood Pressures	30
	Dietary Characteristics	30
	Conclusions	30
	Recommendations	31

PAGE

REFERENCES CITED.......... 32

APPENDIX

A. Informed Consent.......... 36

LIST OF TABLES

TABLE PAGE

1. CHD Risk Relative to TC:HDL Ratio 9

2. Physical Characteristics of Subjects 23

3. Serum Lipoprotein Levels 24

4. Dietary Characteristics 26

CHAPTER I

INTRODUCTION

Investigators have been interested for many years in the role of exercise in the development or prevention of coronary heart disease (CHD). These risk factors, as outlined by the American College of Sports Medicine (ACSM) (1988) include: high blood pressure, elevated total cholesterol (TC)/high density lipoprotein cholesterol (HDL) ratio, cigarette smoking, family history of CHD, diabetes mellitus, obesity, physical inactivity, and psychosocial stress. An extensive body of research currently exists which has clearly established a link between the presence of these risk factors in individuals and the development of CHD. As a result of these studies, the medical profession currently advocates the modification of risk factors in an attempt to prevent CHD. The American Heart Association (AHA) (1987), recommends that all adults have regular screenings for these risk factors. In addition, the AHA advocates the following lifestyle changes in order to modify these risk factors: smoking cessation, maintaining a desirable body weight, a low fat diet, and engaging in regular physical activity.

The beneficial effects of exercise in the prevention of CHD may be due to its affect of controlling or eliminating other risk factors such as obesity, hypertension, and high blood lipid levels. A meta-analysis conducted by Tran, Weltman, Blass, and Mood (1983) showed that aerobic exercise produced beneficial changes in blood lipid levels. Exercise is also a recommended form of therapy for hypertension (ACSM, 1988). In addition, exercise is a well established means of preventing and reducing obesity (Hubert, 1986; Kaplan & Stamler, 1983).

An extensive base of research currently exists which has clearly established the beneficial effects of aerobic exercise on these risk factors (ACSM, 1988; Hubert, 1986; Kaplan & Stamler, 1983; Paffenbarger, Hyde, Wing, & Hsieh,1986; Tran et al. 1983). As a result of these studies, aerobic exercise is currently advocated as a means of preventing CHD for healthy individuals and as an adjunct in the therapy of patients at high risk for the disease.

The research base dealing with the effects of weight training on CHD risk factors is not nearly as extensive, and the effects of weight training on risk factors have yet to be clearly established. An early cross-sectional study by Campbell (1965) found that young men who participated in a weight training program for 10 weeks exhibited an increase in total serum cholesterol. Millard-Stafford, Rosskopf, and Sparling (1989) stated that "power athletes, unlike the typical endurance athlete, may be at increased risk for CHD." However, other studies by Goldberg, Elliot, Schutz, and Kloster (1984), Hurley et al. (1984), and Hurley et al. (1988) have suggested that weight training may affect CHD risk factors in a beneficial manner similar to the effects of aerobic training. The discrepancies between these studies may be due to the fact that differences in age, body composition, diet, and androgen administration were not carefully controlled or accounted for in all studies.

An epidemiologic study by Goldberg et al. (1984) concluded that the periodic intense muscular activity associated with heavy work occupations may reduce the incidence of CHD. The fact that this type of work resembles weight training, along with the promising results of the studies mentioned in the previous paragraph suggests that more study into the effects of weight training on CHD risk factors is warranted.

Need for the Study

Investigations into the effects of weight training on CHD risk factors have resulted in contrasting reports. Most studies have dealt with competitive athletes or have been conducted in a pre- and posttreatment fashion on a small study sample. This researcher is unaware of any cross-sectional studies on the risk factor profiles of populations of noncompetitive weight lifters. A significant population of "recreational" weight lifters exists, and is evident in any college or health club weight room. Many individuals in this population lift weights exclusively as their only form of exercise. Therefore, research into the risk factor profiles of this population would seem warranted to determine if this lifestyle affords any protection or predisposition to the development of CHD.

Purpose

In light of the facts presented above, the purpose of this study was to compare the risk factor profiles of a group of young adult male weight lifters to published standards of acceptable levels of blood pressure, percent body fat, serum cholesterol levels, and dietary intakes.

Hypotheses

For the purpose of this study, the following hypotheses were examined:

1. The levels of HDL, TC, and the TC/HDL ratio for young adult male lifters will be consistent with published standards for these variables.

2. The percent body fat of young adult male lifters will be consistent with published standards.

3. The systolic blood pressure values obtained for young adult male lifters will be within an acceptable range according to published standards.

4. The diastolic blood pressure values obtained for young adult male lifters will be within an acceptable range according to published standards.

5. Dietary intakes of protein, fat, complex carbohydrates, simple carbohydrates, and alcohol for young adult male lifters will be within recommended ranges.

Assumptions

The following were assumptions of this study:

1. All testing procedures (blood analysis, percent body fat, blood pressure measurement, and dietary recall) and instructions given to the subjects were appropriate and consistent for the entire study population.
2. All subjects adhered to the procedures and directions to the best of their abilities.
3. All equipment used was properly maintained and calibrated to ensure maximal accuracy of the tests conducted.

Delimitations

The following were delimitations of this study:

1. All subjects were young adult males between the ages of 19 and 26 years.
2. The subjects were volunteers who consented to participate in this study.
3. All subjects were considered to be in good health.
4. All subjects were lifetime abstainers of tobacco use.
5. All subjects taking medications which may alter lipid metabolism or blood pressure were eliminated.

Limitations

The following limitations were recognized in this study:

1. The subjects were not selected randomly.
2. The training regimens of subjects in the experimental group varied, but were consistently high volume, high intensity training programs using primarily moderate-resistance, high-repetition exercises with short rest

intervals between exercise bouts, typical of the training programs used by bodybuilders.

Definition of Terms

1. Aerobic Exercise - Exercise involving dynamic, rhythmic muscular contractions characterized by periods of relaxation between contractions, and moderate increases in heart rate and systolic blood pressure. Aerobic training leads to increased concentrations of aerobic enzymes from the citric acid, electron transport, and beta-oxidation pathways (ACSM, 1988).

2. Blood Pressure - The pressure exerted by the blood against the walls of blood vessels (ACSM, 1988).

3. Cardiovascular Risk Factors - A number of personal traits associated with an increased risk of atherosclerotic disease. These traits include cigarette smoking, elevated blood pressure, elevated blood lipid levels, the presence of diabetes, a diet excessive in calories, saturated fats, cholesterol, and salt, a marked imbalance of caloric intake and expenditure with subsequent obesity, and a consistently sedentary lifestyle (AHA, 1980).

4. Coronary Heart Disease - A condition caused by the narrowing of the coronary arteries characterized by a decreased blood supply to the heart (AHA, 1989).

5. Diastolic Blood Pressure - Defined as the point when Korotkoff sounds become inaudible while properly using a sphygmomanometer and stethoscope to measure a subjects blood pressure (AHA, 1980).

6. High Density Lipoprotein - A carrier of cholesterol believed to transport cholesterol away from the tissues to the liver where it can be excreted (AHA, 1989).

7. Hypertension - Higher than normal blood pressure defined as a resting blood pressure greater than 140/90 mmhg. (ACSM, 1988).

8. Lipoprotein - The combination of a lipid and a protein, the protein making the insoluble lipid soluble in the blood (AHA, 1989).

9. Low Density Lipoprotein - The primary carrier of the cholesterol which results in fatty build up in blood vessels (AHA, 1989).

10. Obesity - An excess accumulation of fat on the body resulting in increased strain on the heart and an increased chance of developing hypertension. Generally defined as greater than 25% body fat in men (AHA, 1989).

11. Systolic Blood Pressure - Arterial pressure during the systolic phase of the heart's cycle (ACSM, 1988).

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The strong statistical relationship between CHD risk factors and the development of CHD has been an established fact for many years. Preventing the development of CHD through the modification of risk factors is a primary strategy for combating the disease and is a major concern of health professionals such as physicians, exercise physiologists, and dietitians. Research on the impact of risk factors and lifestyle modifications which may alter a persons risk factor profile is ongoing. Researchers continue to search for the best interventions and strategies in an attempt to reduce the incidence of CHD. In this chapter, research dealing with the effects of lipoprotein levels, blood pressure, obesity, diet, and forms of aerobic exercise and weight training on the development of CHD will be reviewed.

Relationship Between Lipoproteins and CHD

Several of studies have established the link between blood lipid and lipoprotein levels and CHD. In 1979, Kannel, Castelli, and Gordon reported data drawn from the Framingham Study and others. They stated that data from these epidemiologic studies show conclusively that the risk of CHD in people younger than 50 years was highly and directly related to total serum cholesterol levels. The partitioning of TC into various lipoprotein fractions was also found to affect the degree of risk. A relatively large amount of cholesterol in the LDL fraction was found to contribute to the development of CHD, while a relatively large amount of cholesterol in the HDL fraction was found to have a preventative effect.

Castelli et al. (1977) also studied the relationship between blood cholesterol and lipoprotein levels and CHD. They found statistically significant lower mean levels of HDL in persons with CHD than in those without the disease. They also reported a direct relationship between LDL and the incidence of CHD. These researchers stated that their research clearly demonstrated the advantage of partitioning TC into lipoprotein fractions. They reported that a lipoprotein profile based on HDL and LDL levels was a preferable method of accessing the CHD risks associated with blood lipids.

In 1989, the United States Department of Health and Human Services published a report on the detection, evaluation, and treatment of high blood cholesterol in adults. In this report, it was concluded that "increased blood cholesterol levels, more specifically increased levels of LDL-cholesterol, are causally related to an increased risk of CHD. Coronary risk rises progressively with cholesterol levels, particularly when cholesterol levels rise above 200 mg/dl. There is also substantial evidence that lowering total and LDL-cholesterol levels will reduce the incidence of CHD" (p. 7). This report also suggested that all adults 20 years of age and older should have their TC level tested at least once every 5 years.

Another indicator of CHD risk related to cholesterol levels is the ratio of total cholesterol to HDL-cholesterol. It is important for this ratio to be below certain levels. Cooper (1988) stated that it is important for men to keep this ratio below 4.6. He further defined the relationship of these ratios to the development of CHD by classifying the relative risk in 20-29 year old males as shown in Table 1.

Relationship Between Obesity and CHD

Obesity has been associated with the development of CHD as both an independent risk factor and in association with other risk factors. Noppa (1980) studied the relationship of body weight change to CHD and changes in other risk

Table 1. CHD Risk Relative to TC:HDL Ratio.

	Excellent Protection	Moderate Risk	High Risk
TC:HDL Ratio	< 3.7	3.7 - 5.1	> 5.1

Note. (Cooper, 1988, p. 59).

factors. Significant correlations were found between weight gain and the incidence of angina, hypertension, and increased TC. Noffa concluded that obesity generally appears in association with other risk factors and that weight loss brings about concomitant reductions in these other risk factors. Because of this, reduction of obesity has a large impact on reducing one's risk of developing CHD.

In a similar study (Hubert, Feinleib, McNamara, & Castelli, 1983) based on data from the Framingham Study, it was found that, while obesity is associated with high blood pressure and blood lipids, it is also an independent risk factor. The authors suggested that intervention in obesity, as well as other established risk factors, is an advisable goal in the prevention of CHD. These results agreed with those found later by Hubert (1986), who stated that "obesity is such a precursor to disease development and that prevention of CHD can be greatly promoted by the control of this attribute" (p.493).

Exercise is an accepted therapeutic strategy for the prevention of obesity (Kaplan & Stamler, 1983). This approach involves increased energy expenditure through physical activity in order to enhance weight loss. In addition, the ACSM (1988) states, "increased levels of physical activity have the advantage of not only enhancing caloric expenditure but also drawing on the beneficial effects of exercise in influencing blood lipids, blood pressure, mood, and attitude" (p.118).

Relationship Between Hypertension and CHD

In 1980, the American Heart Association issued a statement for physicians concerning risk factors and CHD. They stated that elevated blood pressure, either systolic or diastolic, is associated with an increased risk of CHD. Clear evidence of this association is presented in epidemiologic studies such as that conducted by Kannel et al. (1986). This study, drawing on data gathered on 325,384 subjects from the Multiple Risk Factor Intervention Trial confirmed hypertension as a risk factor for CHD. They also noted that risk of CHD increased significantly when hypertension was combined with other risk factors.

Regular physical activity can aid in the prevention and treatment of hypertension (ACSM, 1988; Kaplan & Stamler, 1983). Epidemiologic research conducted by Paffenbarger, Wing, Hyde, and Jung (1983) has correlated physical activity with a decreased incidence of hypertension. Also, pre- and posttraining studies (Fleck & Kraemer, 1988; Hurley et al., 1988) have shown the beneficial effect of physical activity on lowering blood pressure.

Relationship Between Diet and CHD

In 1982, Grundy et al. issued a report entitled "Rationale of the Diet-Heart Statement of the American Heart Association". This report drew conclusions on the relationship of diet and CHD based upon the extensive literature which has accumulated on the subject. Epidemiologic research, studies on diet and CHD in experimental animals, and dietary intervention trials were thoroughly reviewed. The AHA concluded from this research that diet can affect risk for CHD. This conclusion was based on two well-established facts which were presented in the research. These facts are that saturated fats and cholesterol in the diet directly raise TC and LDL, and that high TC and LDL contribute directly to CHD.

In response to the conclusions drawn from the available research, Grundy et al. (1982) make the following dietary recommendations in order to decrease the risk of CHD: (a) Caloric intakes from fat should be 30% at maximum, with saturated fats accounting for only 10% or less; (b) Cholesterol intake should not exceed 300 mg. per day; (c) 55% of caloric intake should be from carbohydrates, with most of this coming in the form of complex carbohydrates such as those found in vegetables, beans, cereals, and fruits; and (d) 15% of caloric intake should come from protein.

Effects of Aerobic Exercise on Risk Factors

Evidence of the beneficial effects of aerobic exercise is wide spread throughout the literature. The results of studies on athletes, as well as trained and untrained subjects, have indicated that aerobic exercise improves plasma cholesterol profiles by increasing HDL levels and/or decreasing LDL levels. In 1983, Heath, Ehgani, Hagberg, Hinderliter, and Goldberg (1983) conducted a study on the effect of endurance training on lipoprotein profiles in 10 male CHD patients between the ages of 46 and 62 years. These patients maintained body weight, health-related behaviors, and dietary habits throughout a training program at 50-85% of maximal oxygen consumption for 40-60 minutes, 3-5 days per week for an average of 29 weeks. It was found that plasma cholesterol, LDL, and triglyceride levels all decreased significantly, while HDL and the ratio of HDL to LDL increased significantly. It was concluded that the potentially antiatherogenic benefits of exercise seemed to be due to a training effect, since they correlated best with changes in maximal oxygen uptake and were maximal in patients with initially low maximal oxygen uptake, high LDL, and low HDL levels.

In 1983, Tran et al. conducted a meta-analysis on 66 training studies which evaluated the effects of exercise on blood lipids and lipoproteins. They found that the average exercising subject had significant decreases in TC levels, total triglycerides, and LDL. The ratio of TC to HDL levels showed an increase. However, the increase was not statistically significant. The researchers noted that there was a strong correlation between initial lipid and lipoprotein levels and their respective changes as a result of exercise. Initially high levels of TC, triglycerides, and TC to HDL ratio resulted in greater decreases after training. It was concluded that researchers must consider initial levels of lipoproteins, as well as age, length of training, intensity, maximal oxygen consumption, and body weight and composition when analyzing the effects of exercise on blood lipids and lipoproteins.

Paffenburger et al. (1986) studied the effects of physical activity on mortality and longevity in 16,936 Harvard University alumni. They found that physical activity among the subjects, such as walking, stair climbing, and sports play, was inversely related to total mortality, primarily to death caused by cardiovascular and respiratory diseases. In this study, death rates were one quarter to one third lower among subjects who expended 2,000 or more kilocalories/week during exercise than among less active subjects.

Effects of Weight Training on Risk Factors

An early study which examined the effects of weight training on blood lipid profiles was conducted by Campbell in 1965. He studied the effects of cross-country running, golf, tennis, gymnastics, wrestling, and weight training on serum cholesterol levels. It was determined that running, golf, and tennis significantly decreased cholesterol levels, while gymnastics, wrestling, and weight training did not. Furthermore the gymnastic, wrestling, and weight training groups exhibited increases in cholesterol levels. The author concluded that "dynamic activities" (i.e., running, golf, and tennis) produced a significant decrease in serum cholesterol levels, while "static activities" (i.e., gymnastics, wrestling, and weight training) had an opposite effect. This study did not control or discuss related variables such as diet, age, body composition, or androgen use.

Similar results were reported by Clarkson, Hintermister, Fillyaw, and Stylos (1981). This study compared the lipoprotein profiles of weight lifters to those of runners and sedentary controls. It was reported that the TC and TC/HDL ratio for weight lifters did not differ from the controls', while these variables in the runners were significantly lower. It was concluded that anaerobic exercise does not produce beneficial changes in lipoprotein profiles as does aerobic exercise.

More favorable results have been reported by other researchers. Goldberg et al. (1984) studied lipoprotein levels in previously sedentary men and women who underwent a 16 week weight training program. The weight training program consisted of progressive weight training 3 times per week. Three sets of 3 to 8 repetitions were performed on 7 or 8 exercises with a maximum of 2 minutes of rest between sets. They found that the weight training produced favorable changes in lipid and lipoprotein levels in all subjects. The TC, LDL, and triglycerides decreased significantly in all subjects. In addition, TC to HDL ratios showed significant reductions in all subjects. Mean HDL levels increased, but the increase was statistically insignificant.

More favorable results were reported by Hurley et al. (1984) who studied the relationship between lipid profiles and types of weight training. The types of weight training studied were power lifting, consisting of high resistance, low repetition (1-5) exercises, and bodybuilding, which involved moderate resistance, high repetition (10-20) exercises. The weight training subjects were competitive power lifters and bodybuilders. A group of runners were also compared to an untrained control group. Both the bodybuilders and runners had significantly lower LDL levels than the controls. Furthermore, the LDL to HDL ratios in these two groups were significantly lower than the control group's. In powerlifters, LDL levels were comparable to the controls', however HDL levels were lower and LDL to HDL ratios were higher. The study also examined the effect of consequent androgen use by the weight lifting groups. Results indicated that androgen use caused significant increases in LDL levels and decreases in HDL levels. The LDL to HDL ratios also decreased significantly following androgen administration. The steroid effects on lipoprotein profiles reported in this study were similar to those reported by Alen, Rahkila, and Marniemi (1985). It should be noted that the bodybuilders' initial lipoprotein profiles appeared to be more favorable than the runners', even though a dietary analysis revealed they consumed a more atherogenic diet than did the runners.

In another study which compared the effects of low vs. high repetition weight training, Kokkinos et al. (1988) found very different results. This study which compared lipoprotein profiles in untrained males after 10 weeks of training, grouped the subjects into a low repetition training group, a high repetition training group, and an inactive control group. The authors reported no significant changes in the plasma concentrations of TC or HDL in any of the groups. It was suggested that the failure to find significant changes in these variables may have been due to the initially low values present in the subjects.

A study by Faber, Benade, and vanEck (1986) investigated the relationship between diet and blood lipid profiles in weight training bodybuilders. Dietary analysis indicated that the subjects consumed a high fat, high cholesterol diet which was considered atherogenic. A wide range of cholesterol and fat intake was indicated throughout the subject population and this was attributed to a highly varied egg intake (0 to 81 per week). The subjects were grouped according to egg intake with one group consuming less than 1.5 eggs per day, and another group consuming more than 6 per day. Comparison of TC, LDL, and HDL levels and HDL to TC ratios between the two groups did not reveal a significant difference. The subjects plasma TC level was significantly lower, and the HDL to TC ratio significantly higher than the national average.

Hurley et al. (1988) conducted a study to examine the effects of a weight training program on coronary risk factors. Eleven untrained males were examined before and after a 16 week training program. The authors found significant decreases in LDL, TC/HDL, and diastolic blood pressure. A significant increase was also found in HDL levels. Other variables measured included VO_2 max, body weight, and body composition. No significant differences were found among these variables. The authors concluded that resistive training can lower risk for CHD.

A review of physiologic responses to weight training by Fleck and Kraemer (1988) drew similar conclusions to those of the previous study. The authors stated that although evidence is limited, resistance training can produce beneficial changes in lipoprotein profiles. They also stated that weight training leads to no change, or a decrease in resting blood pressure. No conclusion was drawn concerning body composition due to the fact that many of the subjects were competitive lifters and bodybuilders and were thus subject to weight class restrictions and strict dietary habits. Overall, the authors concluded that weight training, especially high-volume, low-load training such as used in circuit training and bodybuilding, reduces cardiovascular risk.

Summary

The literature reviewed in this chapter has established the relationship of the risk factors of hyperlipidemea, hypertension, and obesity to the development of CHD. There is a general consensus among researchers that aerobic exercise produces beneficial effects on these risk factors. However, the research presented demonstrates the lack of a general consensus regarding the effects of weight training on these risk factors. This lack of a consensus illustrates the need for further studies which carefully control the influence of factors such as androgen usage, smoking, and diet which can affect the measured variables.

CHAPTER III

METHODS

Introduction

The purpose of this study was to compare the cardiovascular risk factors of obesity, serum cholesterol profiles, and blood pressure in a population of weight lifters to published standards. This chapter will describe the methods used in: a) the selection of subjects; b) body composition determination; c) blood assays determination; d) dietary intake determination; e) blood pressure determination; and f) statistical treatment.

Subject Selection

A total of 18 males, ages 19 to 26 years, volunteered to participate in this study. The experimental group consisted of subjects who engaged in a regular weight training program. Each subject's qualifications for participation in this study were determined during a personal interview. The interview was used to assess each subject's physical status, training habits, smoking status, and drug or androgen use. Any subjects who had ever smoked or used androgens were eliminated as well as those who were currently taking any medications which could alter their blood lipid profile or blood pressure.

The experimental group consisted of weightlifters who completed 3 or more bouts of exercise per week. Each bout of exercise consisted of one hour or more of intense weight training. Although the training regimens varied somewhat among subjects, they typically involved 3 or more sets of 8 to 15 repetitions for every exercise

The subjects generally concentrated on certain body parts each exercise session. For example, a subject would do exercises for arms and shoulders on one day, exercises for chest and back muscles on another day, and leg muscles on yet another day. The number of exercises done on any day would range from five to ten.

Body Composition Determination

Body composition was determined from hydrostatic weighing with correction for residual volume (RV) and gastrointestinal gas using the technique developed by Wilmore (1969). Residual lung volumes were determined using an electronic nitrogen analyzer (Med-Science Model 505 Nitrolyzer) (Med-Science, 1985). Two to three trials were performed to determine the RV with the subjects sitting in a position similar to that assumed during hydrostatic weighing, and the lowest RV value obtained was used in the calculation of body density (BD).

To determine RV, a 6 liter spirometer was filled with approximately 5 liters of pure oxygen by an electronic dispensing valve. The spirometer and rebreathing bag were filled and emptied two to three times to flush out all remaining gases from previous tests. The spirometer was then filled with 5 to 6 liters of oxygen, with this volume recorded for the subject's trial. This volume was then transferred into the 6 liter rebreathing bag. With a nose clip on and with lips tightly sealed around a disposable mouthpiece, the subject was instructed to exhale maximally and to signal the researcher when RV was reached. At this point, the subject was connected to the oxygen-filled rebreathing bag and instructed to breath in and out rapidly and deeply until nitrogen equilibrium was reached between the subjects lungs and the rebreathing bag. Equilibrium was represented as the point when differences in readings of inspiratory and expiratory phases reached a minimum on the graphical printout. The values obtained were placed in the formula developed by Wilmore (1969).

$$RV = 1.1X\left[\frac{BV(EN-IN)}{AN-FN} - DS\right]$$

where: RV = Residual Volume

BV = Volume of Oxygen in Rebreathing Bag

AN = % of Alveolar Nitrogen

IN = % of Impurity Nitrogen in Rebreathing Bag

EN = % of Nitrogen in Rebreathing Bag at Equilibrium

FN = % of Nitrogen in Expired Air at Equilibrium

DS = Dead Space of Tubes and Analyzer Head (80 mls.)

1.1 = Body Temperature Pressure Saturated Correction Factor

Two to three minutes were allowed between trials to permit the elimination of excess oxygen remaining in the lungs following this procedure.

The subjects were then instructed to shower thoroughly, and enter the immersion tank (4X4X4 ft. S.S. Hydrotesting Tank, Model #09771), making sure to free air trapped in swim suits. A submersible seat suspended from three Omega load-cells (Model LCJ-200) which were accurate to 0.01 kg. was used for the hydrostatic weighing. The load-cells were interfaced with a computer system to provide an average of 100 underwater weighing measures within a 2 second time period. This system eliminated the difficulty of interpreting an oscillating autopsy scale.

With the subjects seated, they were instructed to exhale maximally and submerge. The weight was obtained and recorded when subjects were completely submerged. The investigator signaled the subjects when they could bring their heads out of the water. The average of the highest 3 of 6-10 trials was used to represent underwater weight. Dry weight was obtained prior to entering the immersion tank using a Continental Health-O-Meter scale (Model #200 DLK) and recorded to the nearest 0.5 lb. Water temperature was maintained between 33-35 degrees celsius.

Body density was determined using the following equation developed by Goldman and Buskirk (1961):

$$DB = \frac{\dfrac{MA}{MA - MW}}{DW} - RV$$

where: DB = Body Density

MA = Mass of Body in Air

MW = Mass of Body in Water

DW = Density of Water

RV = Residual Volume

Body density was converted to percent body fat using the equation developed by Brozek, Grande, Anderson, and Keys (1963). This formula is presented below:

$$FAT\% = \frac{457}{DB} - 414.2$$

Blood Assays

Blood samples of 1 ml were taken from each subject via a finger prick at the Human Performance Laboratory of the University of Wisconsin-La Crosse. The subjects were instructed to fast for at least 12 hours prior to the blood drawing, and to avoid heavy exercise for 48 hours prior. The blood was coagulated, the serum extracted by centrifugation, and immediately frozen. After draws were taken from all subjects, the serum was thawed, analyzed, and validated against samples from certified lipid evaluation centers. Serum samples were analyzed using a Kodak Ektachem Model #DT 60 Analyzer, according to procedures set forth for TC and HDL (Eastman Kodak Company, Clinical Products Division, 1986).

HDL Determination

To determine HDL concentrations, a 50 ul of each serum sample was placed in its respective prelabeled Ektachem Micro HDL tube. This tube contained a precipitating reagent and the mixture vortexed. The tubes were then centrifuged for 95 seconds, leaving a supernatant which contained the HDL fraction. A pipette was then used to transfer 10 ul of supernatant directly to a Kodak Ektachem DT slide for analysis on the DT 60 analyzer.

TC Determination

For TC determination, 10 ul of thawed serum was transfered to a Kodak Ektachem DT slide for analysis on the DT 60 analyzer.

Dietary Intake Determination

A dietary intake analysis was completed for each subject. It consisted of a 3 day dietary recall. Each subject completed a daily intake diary for 2 week days and 1 weekend day. The subjects were given forms designed by the Cooper Clinic (Kostas, 1988) and instructed to record all food and beverage intake for that 3 day period.

The analysis of each subject's dietary intake was completed using the Cooper Clinic Nutrition and Exercise Evaluation System computer program (Kostas, 1989). The food items and corresponding amounts were entered for each subject along with the appropriate exercise activities. A complete report including the following information was provided for each subject: (a) present and recommended daily intake of calories; (b) gram amounts and caloric percentages of protein, carbohydrates and fat; and (c) intake levels of fiber and 16 vitamins and minerals.

Blood Pressure Determination

Blood pressures were determined for each subject according to the guidelines set forth by the American Heart Association (Kirkendall, Feinleib, Freis, & Mark, 1980). Blood pressures were determined with the subjects in a seated position using their left arm. The subjects had been seated for at least 5 minutes. The forearm was supported at heart level. A mercury gravity sphygmomanometer with a standard adult sized cuff (13X24 cm) was used on all blood pressure determinations. The deflated cuff was applied to the subjects arm with the lower margin about 2.5 cm above the antecubital space with the bladder directly over the medial surface of the arm.

A standard stethoscope was applied over the brachial artery in the antecubital space. At this point, the pressure was raised to approximately 30 mmhg above the point at which the radial pulse disappeared in a preliminary palpatory determination of systolic pressure. The pressure was then released at a rate of 2 to 3 mmhg/ sec. Systolic pressure was recorded as the point marked by the appearance of the first faint, clear tapping sounds. Diastolic pressure was recorded as the point at which sound disappeared. Blood pressures were determined on two different occasions for each subject, with the average of these readings used to represent resting blood pressure.

Statistical Treatment

Standard descriptive statistics were used to describe the subjects. Means and standard deviations were computed for the following variables: (a) serum TC; (b) HDL cholesterol; (c) TC:HDL ratio; (d) percent body fat; (e) select dietary information (caloric percentages of fat, protein, simple and complex carbohydrates, and alcohol); and (f) systolic and diastolic blood pressures.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

The purpose of this study was to compare the cardiovascular risk factors of TC, HDL cholesterol, TC:HDL ratio, blood pressure, body adiposity, and dietary intake in a select group of male weight lifters to established standards for these variables. This chapter includes a presentation and discussion of the data collected.

Physical Characteristics

Eighteen male subjects, ages 19 to 26 years, volunteered to participate in this study. All participants were students at the University of Wisconsin-La Crosse who adhered to a weight training regimen as described in Chapter II. Means, standard deviations, and ranges of their physical characteristics are presented in Table 2.

The average percent body fat of 12.83% for this population fell below the ideal level of body fat of 14% as presented by the ACSM (1988). All of the subjects were within one standard deviation of the mean body fat levels of men relative to their age category. Therefore, none of the subjects were considered obese or at high risk of CHD due to obesity. Further breakdown of the results showed that 67% of the subjects fell below the average body fat level for this age group, while 28% fell within the average range of 14-20%, and only one subject was above average.

Table 2. Physical Characteristics of Subjects.

Variable	Mean	Standard *Deviation*	Range
Age (yrs)	22.17	1.80	19 - 26
Height (in)	71.07	4.08	64 - 78
Weight (lb)	187.64	18.20	150 - 215
% Body Fat	12.83	4.51	5 - 22.8

The characteristics of subjects in this study were very similar to published reports of weight trained populations. Hurley et al. (1984) reported mean percent body fat levels of 12% for bodybuilders and 14% for powerlifters. In another study of college students by Wilmore et al. (1978), a mean percent body fat of 16% was reported. Faber et al. (1986) reported a percent body fat of 15.4% for bodybuilders with a mean age of 27.4 years.

Serum Lipoproteins

The means, standard deviations, and ranges for serum TC, HDL cholesterol, and TC:HDL ratios are presented in Table 3.

Serum TC

The average TC level of 189.17 mg/dl fell below the limit of 200 mg/dl for a normal risk level relative to this age group as set forth by the ACSM (1988). However, 44.4% of the subjects had higher than recommended levels with 27.8% falling within the moderate risk range of 200-219 mg/dl and 16.6% of the subjects were at high risk with TC levels greater than 220 mg/dl.

Table 3. Serum Lipoprotein Levels.

Variable	Mean	Standard Deviation	Range
TC (mg/dl)	189.17	50.82	98 - 305
HDL (mg/dl)	56.94	16.40	32 - 90
TC:HDL	3.43	0.82	1.85 - 4.95

The TC values obtained in this study also proved to be somewhat higher than those obtained in other similar studies. These values include 179.47 mg/dl (Clarkson et al., 1981), 168.4 mg/dl (Campbell, 1965), and 182.9 mg/dl (Faber et al., 1986).

HDL Cholesterol

The average HDL cholesterol level of 56.94 placed this group in a range which would give them excellent protection against CHD according to standards set forth by Cooper (1988). Of the 18 subjects, 50% were in the excellent range with HDL cholesterol levels greater than 51 mg/dl. Of the rest, 44.4% were at moderate risk with HDL cholesterol levels within the range of 37-51 mg/dl. Only one subject was considered to be at high risk with a HDL cholesterol level below 37 mg/dl.

The mean HDL cholesterol level was higher than those reported in most of the similar studies reviewed with only the 58.6 mg/dl reported by Goldberg et al. (1984) being higher. Other results reviewed include 44 mg/dl (Hurley et al., 1988), 52.58 mg/dl (Clarkson et al., 1981), 52.0 mg/dl (Faber et al., 1986), 55 mg/dl (Hurley et al., 1984), and 40 mg/dl (Kokkinos et al., 1988).

TC:HDL Ratio

The mean TC:HDL ratio of 3.43 for this group also places them in the category of excellent protection according to Cooper (1988). Of the 18 subjects, 55.6% fell within this range with TC:HDL cholesterol ratios below 3.6. The remaining subjects all fell within the range of 3.7-5.1 which was classified as being at moderate risk. This ratio was lower than that of 4.7 reported by Hurley et al. (1984), and similar to the 3.44 reported by Clarkson et al. (1981).

Blood Pressure

Systolic Pressure

The mean systolic blood pressure for this group was 120.67 mmhg with a standard deviation of 12.91 mmhg. Systolic blood pressures ranged from 94-152 mmhg. These values fell well below the 140 mmhg limit set forth by the ACSM (1988). Only one subject exceeded this limit with a systolic blood pressure of 152 mmhg. It is possible that this did not represent a true resting blood pressure in this individual and may have been elevated due to anxiety associated with the testing procedures (Kirkendall et al., 1980).

Diastolic Pressure

The mean diastolic blood pressure for this group was 74.44 mmhg with a standard deviation of 5.72 mmhg. Diastolic blood pressures ranged from 62-84 mmhg. These values also fell well below the 90 mmhg limit set forth by the ACSM (1988). All subjects in the study fell below this level.

Dietary Characteristics

Dietary intake patterns were interpolated from a 3 day dietary recall which 9 of the subjects completed on their own for 2 weekdays and 1 day on the weekend. The Cooper Clinic Nutrition and Exercise Evaluation System (Kostas, 1988) computer program was used to analyze the dietary recalls. The program provided the average daily percentage of consumed amounts of protein, complex carbohydrates, simple carbohydrates, fat, and alcohol, as well as other dietary information which was not relevant to this study. Means, standard deviation, and ranges of select dietary components are presented in Table 4.

Table 4. Dietary Characteristics.*

Variable	Protein	Fat	Carbohydrates Complex	Carbohydrates Simple	Alcohol
Mean	18.67	25.89	43.67	5.44	6.33
Standard Deviation	4.69	10.74	11.04	4.35	4.34
Range	12-27	5-37	26-97	1-13	0-16

Note.* All values presented are average percent of total caloric intake.

Mean Daily Protein Consumption

The mean daily protein consumption for this group of 18.67% of caloric intake was above the 15% level recommended by the AHA and falls within the range for protein of 12 to 20% which is the recommended daily allowance (RDA), (National Research Council [NRC], 1980). All subjects who completed the dietary recall fell within the RDA and only one was below the 15% level recommended by the AHA (Grundy et al, 1982).

In light of recent research (Lemon, 1987; Tarnopolsky, MacDougall, & Atkinson, 1988) it may be prudent for individuals involved in intensive weight training to consume slightly more protein than is often recommended. However, many weight lifters, under the impression that ingesting large amounts of protein will enhance the development of lean body mass, ingest protein well above the levels recommended. Often their protein sources are also sources of fat. In such cases, it may be prudent to decrease these dietary components in order to decrease protein and fat intake. Replacing this intake with complex carbohydrates would present a more advisable dietary regimen in order to decrease their risk of CHD without sacrificing their potential for gaining lean body mass.

Mean Daily Fat Consumption

The mean daily fat consumption for this group of 25.89% of caloric intake was below the 30% level recommended by the AHA (Grundy et al, 1982), and within the 20 to 30% RDA range (NRC, 1980). Two of the subjects had extremely low levels of fat consumption (5 and 9%), while four subjects consumed more than the recommended 30% of daily caloric intake in the form of fat. These results may be biased by the fact that only 50% of the participants completed the dietary recall, and that some of these participants practiced strict dietary regimens of restricted fat intake as evidenced by the two subjects with extremely low fat intakes. This may have been due to the fact that many bodybuilders believe that a low-fat diet helps reduce body fat and leads to a more defined muscular appearance.

Mean Daily Carbohydrate Consumption

The mean daily carbohydrate consumption for this group was 49.11% of total caloric intake, with 43.67% coming from complex carbohydrates and 5.44% derived from simple carbohydrates. This level falls just below the RDA range of 50 to 70% (NRC, 1980), and the 55% recommended by the AHA (Grundy et al, 1982). Only three of the subjects had adequate carbohydrate intakes. Only one subject exceeded the 10% of daily caloric intake of simple carbohydrates listed by the RDA (NRC, 1980). In light of this, it would be prudent for this population to increase their intake of carbohydrates, especially complex carbohydrates in order to reduce their risk of CHD as well as certain cancers (Grundy et al, 1982).

Mean Daily Alcohol Consumption

Five of the nine subjects who completed the dietary recall reported alcohol intakes ranging from 8 to 13% of total caloric intake. The mean alcohol intake for the group, including those who abstained, was 6.33% of total caloric intake. It is recommended that all individuals keep alcohol comsumption to a minimum (Grundy et al, 1982; NRC, 1980). It would therefore be prudent for those individuals who consumed alcohol to reduce their intake as much as possible.

Summary

The purpose of this study was to compare the CHD risk factors of blood pressure, obesity, serum lipoprotein levels, and diet in a select group of male college-age weight lifters to established values for these variables. This was done in order to assess this group's risk for the development of CHD.

The TC levels for this group of 189.17 mg/dl fell below recommended levels. However, these levels were higher than those reported for similar populations. The AHA (1987) suggests that though a TC level above 181 mg/dl in a young adult may not be associated with an increased risk of CHD, the individual may be prone to a higher risk later in life. However, weight training studies by Goldberg et al. (1984) and Hurley et al. (1988) have been done on populations with mean ages of 33 and 44 years, respectively. The results suggest that maintaining TC levels below 200 mg/dl and similar to those reported in this study may be possible in older individuals through a weight training regimen.

The HDL levels reported for this group proved to be higher than those reported in other similar studies. As a group, the mean HDL level was within a range deemed to be protective against the development of CHD according to published standards. Likewise, the mean TC:HDL ratio for this group was lower than those reported in the literature for similar populations. The ratio, 3.43, was deemed protective against the development of CHD.

None of the subjects in this study were obese. With a mean body fat percentage of 12.83%, the group was just below the 14% body fat level considered to be ideal for this age group. There was no indication that this group was at risk due to hypertension. With mean blood pressures of 120.67 mmhg systolic and 74.44 mmhg diastolic, the group fell well below the established limits for borderline hypertension.

Dietary recalls on 50% of the study group revealed that they consumed recommended levels of protein and fat. However, the group failed to ingest adequate amounts of carbohydrates. The evidence also suggests that it would be prudent for some of the subjects to reduce alcohol consumption.

CHAPTER V

CONCLUSIONS

Summary

This study analyzed the CHD risk factors of serum lipoproteins, adiposity, blood pressure, and dietary habits in a select group of male, college-age weight lifters. The purpose was to determine if this unique exercise regimen, characterized by noncompetitive, intense resistive weight training, afforded any protection against the development of CHD through the management of the aforementioned risk factors.

Serum Lipoprotein Levels

The mean serum lipoprotein levels for this group was within acceptable ranges. The group would not be at increased risk of developing CHD due to hypercholestrolemia. In fact, the mean HDL level was higher, and the TC:HDL ratio was lower, then those reported for similar populations. These values placed the group within ranges deemed protective against CHD for these respective variables. However, the mean TC level was higher than other reported values for similar populations and a substantial number of subjects (44.4%) had higher than recommended TC levels.

Percent Body Fat

The mean percent body fat of this group fell just below the value considered to be ideal for this age group. The majority of the subjects were below average for adiposity. No subjects were found to be obese.

Blood Pressures

Subjects exhibited no signs of a propensity for hypertension. Group means of systolic and diastolic blood pressures were well below standard limits for hypertension. Only one subject may have been considered hypertensive due to an elevated systolic blood pressure.

Dietary Characteristics

Dietary intakes, as interpolated from 3 day dietary recalls completed by 50% of the subjects, revealed that the group consumed the recommended levels of protein and fat. As a group, the subjects failed to ingest adequate amounts of carbohydrates.

Conclusions

The results of this study indicate that the mean values for TC, HDL cholesterol, TC:HDL ratios, systolic and diastolic blood pressures, percent body fat, and the dietary intakes of protein and fat were normal. Only the mean intake of carbohydrates was outside of recommended levels. In light of this, the group would not appear to be at increased risk for the development of CHD.

As a group, risk factor means for HDL, TC:HDL ratios, blood pressures, and percent body fat were within ranges which would seem protective against the development of CHD. However, TC levels for this group were higher than those reported by other investigators, and may actually be relatively high for this age group. The fact that HDL levels were high and the TC:HDL level was lower than average may counteract any atherogenic tendencies due to high TC levels in this group.

Dietary recalls indicated that it may be prudent for this group to increase their intake of complex carbohydrates. This would probably be best accomplished through increased ingestion of fruits, vegetables, and whole grain breads. It would also be beneficial to compensate for this increased carbohydrate intake by reducing the intake of fats and alcohol.

There was some evidence that certain subjects were very diet conscience, being careful to ingest adequate amounts of protein while limiting their fat intake. This may be due to the fact that many popular publications which cater to weight lifting proponents stress diet as an important adjunct to proper training. Improved diet may represent a positive trend in lifestyle modification. However, it may be prudent to caution some individuals not to sacrifice their intakes of other nutrients, especially complex carbohydrates, in an attempt to ingest increased amounts of protein, as all subjects seemed to be ingesting adequate amounts of this nutrient.

Recommendations

Based on the conclusions, the following recommendations are made:

1. Similar populations should be studied longitudinally to further evaluate the long-term effects of this kind of exercise regimen on risk factor profiles.

2. Comparable cross-sectional studies on similar populations of different age groups would also help determine if this type of exercise is beneficial in preventing CHD.

3. Similar cross-sectional and longitudinal studies are needed with persons who combine this type of weight training with various forms of aerobic exercise to evaluate risk factor profiles. By studying various combinations of durations and intensities expended on weight training and aerobic exercise, it may be possible to define an exercise regimen which elicits optimal risk factor profiles in individuals.

References Cited

Alen, M., Rahkila, P., & Marniemi, J. (1985). Serum lipids in power athletes self-administering testosterone and anabolic steroids. International Journal of Sports Medicine, 6, 139-144.

American College of Sports Medicine. (1988). Resource manual for guidelines for exercise testing and prescription (3rd ed.). Philadelphia: Lea & Febiger.

American Heart Association. (1980). Risk factors and coronary disease: A statement for physicians. Circulation, 62(2), 449A-455A.

American Heart Association. (1987). Cardiovascular and risk factor evaluation of healthy American adults: A statement for physicians. Dallas, TX: Author.

American Heart Association. (1987). Coronary risk factor statement for the American public. Dallas, TX: Author.

American Heart Association. (1989). 1989 heart facts. Dallas, TX: Author.

Brozek, J., Grande, F., Anderson, J.T., & Keys, A. (1963). Densiometric analysis of body composition: Revision of some quantitative assumptions. Annals New York Academy of Sciences, 110, 113-140.

Campbell, D. E. (1965). Influence of several physical activities on serum cholesterol concentrations in young men. Journal of Lipid Research, 6, 478-480.

Castelli, W. P., Doyle, J.T., Gordon, T., Hames, C.G., Hjortland, M.C., Hulley, S.B., Kagen, A., & Zukel, W.J. (1977). HDL cholesterol and other lipids in coronary heart disease. Circulation, 55(5), 767-772.

Clarkson, P.M., Hintermister, R., Fillyaw, M., & Stylos, L. (1981). High density lipoprotein cholesterol in young adult weight lifters, runners, and untrained subjects. Human Biology, 53(2), 254-257.

Cooper, K.H. (1988). Controlling cholesterol. New York: Bantam.

Eastman Kodak Company, Clinical Products Division. (1986). Kodak ektachem DT60 analyzer operator's manual. Rochester, NY: Author.

Faber, M., Benade, A.J.S., & vanEck, M. (1986). Dietary intake, anthropometric measurements, and blood lipid values in weight training athletes. International Journal of Sports Medicine, 7, 342-346.

Fleck, S.J., & Kraemer, W.J. (1988). Resistance training: Physiological responses and adaptations. The Physician and Sportsmedicine, 16(5), 63-75.

Goldberg, L., Elliot, D.L., Schutz, R.W., & Kloster, F.E. (1984). Changes in lipid and lipoprotein levels after weight training. The Journal of the American Medical Association, 252(4), 504-506.

Goldman, R., & Buskirk, E. (1961). Body volume measurement by underwater weighing: Description of a method. In J. Brozek and A. Henschel (Eds.), Techniques for measuring body composition (pp. 78-89). Washington, DC: National Academy of Sciences - National Research Council.

Grundy, S.M., Bilheimer, D., Blackburn, H., Brown, W.V., Kwiterovich, P.O., Mattson, F., Schonfeld, G., & Weidman, W.H. (1982). Rationale of the diet-heart statement of the American Heart Association. Circulation, 65(4), 839A-854A.

Heath, G.W., Ehgani, A.A., Hagberg, J.M., Hinderliter, J.M., & Goldberg, A.P. (1983). Exercise training improves lipoprotein lipid profiles in patients with coronary artery disease. American Heart Journal, 105(6), 889-893.

Hubert, H.B. (1986). The importance of obesity in the development of coronary risk factors and disease: The epidemiologic evidence. Annual Review of Public Health, 7, 493-502.

Hubert, H.B., Feinleib, M., McNamara, P.M., & Castelli, W.P. (1983). Obesity as an independent risk factor for cardiovascular disease: A 26-year follow-up of participants in the Framingham heart study. Circulation, 67(5), 968-977.

Hurley, B.F., Hagberg, J.M., Goldberg, A.P., Seals, D.R., Ehsani, A.A., Brennan, R.E., & Holloszy, J.O. (1988). Resistive training can reduce coronary risk factors without altering VO2max or percent body fat. Medicine and Science in Sports and Exercise, 20(2), 150-154.

Hurley, B.F., Seals, D.R., Hagberg, J.M., Goldberg, A.C., Ostrove, S.M., Holloszy, J.O., Wiest, W.G., & Goldberg, A.P. (1984). High-density lipoprotein in bodybuilders vs. powerlifters. The Journal of the American Medical Association, 252(4), 507-513.

Kannel, W.B., Castelli, W.P., & Gordon, T. (1979). Cholesterol in the prediction of atherosclerotic disease. Annals of Internal Medicine, 90(1), 85-91.

Kannel, W.B., Newton, J.D., Wentworth, D., Thomas, H.E., Stamler, J., Hulley, S.B., & Kjelsberg, M.O. (1986). Overall and coronary heart disease mortality rates in relation to major risk factors in 325,348 men screened for the MRFIT. American Heart Journal, 112(4), 825-836.

Kaplan, N.M., & Stamler, J. (1983). Prevention of coronary heart disease: Practical management of the risk factors. Philadelphia: Saunders.

Kirkendall, W.M., Feinleib, M., Freis, E.D., and Mark, A.L. (1980). Recommendations for human blood pressure determination by sphygmomanometers: American Heart Association committee report. Circulation, 62(5), 1145A-1155A.

Kokkinos, P.F., Hurley, B.F., Vaccaro, P., Patterson, J.C., Gardner, L.B., Ostrove, S.M., & Goldberg, A.P. (1988). Effects of low and high-repetition resistive training on lipoprotein-lipid profiles. Medicine and Science in Sports and Exercise, 20(1), 50-55.

Kostas, G. (1988). Cooper clinic nutrition and exercise evaluation system (computer program). Dallas, TX: The Cooper Clinic Nutrition Department.

Lemon, P.W. (1987). Protein and exercise: Update. Medicine and Science in Sports and Exercise, 19(5), 179-190.

Med Science. (1985). Instruction manual for Model 505 Nitralyzer. St. Louis, Mo: Author.

Millard-Stafford, M., Rosskopf, L.B., & Sparling, P.B. (1989). Coronary heart disease: Risk profiles of college football players. The Physician and Sports Medicine, 17(9), 150-163.

National Research Council. (1980). Recommended dietary allowances (9th ed.). Washington, DC: National Academy of Sciences.

Noppa, H. (1980). Body weight change in relation to incidence of ischemic heart disease and change in risk factors for ischemic heart disease. American Journal of Epidemiology, 111(6), 693-704.

Paffenburger, R.S., Hyde, R.T., Wing, A.L., & Hsieh, C. (1986). Physical activity, all-cause mortality, and longevity of college alumni. The New England Journal of Medicine, 314(10), 605-613.

Paffenburger, R.S., Wing, A.L., Hyde, R.T., & Jung, D.L. (1983). Physical activity and incidence of hypertension in college alumni. American Journal of Epidemiology, 117(3), 245-257.

Tarnopolsky, M.A., MacDougall, J.D., & Atkinson, S.A. (1988). Influence of protein intake and training status on nitrogen balance and lean body mass. Journal of Applied Physiology, 64(1), 187-193.

Tran, Z.W., Weltman, A., Glass, G.V., & Mood, D.P. (1983). The effects of exercise on blood lipids and lipoprotein: A meta-analysis of studies. Medicine and Science in Sports and Exercise, 15(5), 393-402.

United States Department of Health and Human Services. (1989). Report of the expert panel of detection, evaluation, and treatment of high blood cholesterol in adults (NIH Publication No. 89-2925). Washington, DC: U.S. Government Printing Office.

Wilmore, J.H. (1969). A simplified method for determination of residual lung volumes. Journal of Applied Physiology, 27(1), 96-100.

Wilmore, J.H., Parr, R.B., Girandola, R.N., Ward, P., Vodak, P.A., Barstow, T.J., Pipes, T.V., Romero, G.T., & Leslie, P. (1978). Physiologic alterations consequent to circuit weight training. Medicine and Science in Sports, 10(2), 79-84.

APPENDIX A

INFORMED CONSENT

Informed Consent

A Comparison of Selected Coronary Heart Disease Risk Factors
in Sedentary and Weight Trained Males.

I, ________________, volunteer to participate in the underwater weighing, blood tests, blood pressure determination, and dietary recall to study the effects of weight training in young adult males.

I understand the body composition test will consist of a residual lung volume test, as well as having my body weight determined while submerged in water. The risks involved in underwater weighing include infection, as well as accident and possible drowning. However, there has never been an accident or infection reported as a result of underwater weighing at the Human Performance Laboratory at the University of Wisconsin-La Crosse.

I also understand that the blood test will involve having approximately 1 ml of blood taken from my finger via a finger prick. The blood will be drawn by a trained technician. There is a potential risk of infection and other complications with this procedure. Again, however, no such complications have been reported at this laboratory in the past.

The procedures used to determine blood pressure and dietary intake are both non-invasive and involve no associated risks.

To my knowledge, I have no medical or physical conditions or limitations which would affect my participation in this study.

I have read the foregoing and have been fully advised of the nature and risks involved in the procedures and tests included in this study. Any questions which may have occurred have been answered to my satisfaction. I hereby acknowledge that no representations, warranties, guaranties, or assurances of any kind pertaining to the procedures have been made to me by the University of Wisconsin-La Crosse, the officers, administrators, employees, or by anyone acting on behalf of any of them.

Signed:________________Date:_______________

Witness:________________Date:_______________