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The effects of swimming frequency and intensity on selected physical fitness components

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The Effects of Swimming Frequency and Intensity on Selected Physical Fitness Components

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The Effects of Swimming Frequency and Intensity on Selected Physical Fitness Components

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Abstract

The Effects of Swimming Frequency and Intensity
on Selected Physical Fitness Components

Palmer Ray Adkins

The purpose of this dissertation was to determine the effects of swimming at two frequencies and two intensities on predicted maximal oxygen uptake, strength, flexibility, total cholesterol, high-density lipoproteins, and low-density lipoproteins. The study consisted of 60 college students enrolled in classes at Morehead State University during the fall of 1989. The subjects were randomly selected from an advanced swimming class and an intermediate swimming class. The control group was selected from a Personal Health class. The pretest-posttest design study consisted of 14 weeks of supervised training. Improvements in VO max. were determined by a bicycle ergometer test; grip strength was evaluated using the hand grip dynamometer; flexibility was scored using the sit and reach test, and total cholesterol and the lipoprotein fractions were determined using the Smith Kline Bio-Science Laboratories. The .05 level was utilized to determine significance. Means and standard deviations were calculated for all physical characteristics and dependant variables. A one-way

analysis of variance was computed to determine if there was a difference between the three groups; a Scheffé was computed to identify the group differences where a significant F ratio was obtained. Statistical treatment revealed that there were no significant differences in predicted VO max., grip strength, flexibility, total cholesterol, high-density lipoproteins or low-density lipoproteins between the three groups; Group A, 70% intensity, three days per week; Group B, 60% intensity, two days per week, or Group C, Control.

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Chapter 1

Introduction

During the past 25 years America has become increasingly health conscious. At least 50% of adult Americans are estimated to participate in some form of exercise on a regular basis (Milhorn, 1982). Much of this fitness boom can be contributed to President John F. Kennedy. President Kennedy brought vitality, youth, and fitness to Washington. He not only supported fitness in the schools and the military, but in the nation as a whole. President Kennedy spoke often of physical fitness:

> The strength of our democracy is no greater than the collective well-being of our people. The level of physical, mental, moral, and spiritual fitness of every American citizen must be our constant concern. (cited in Bucher, 1983)

President Kennedy supported fitness but, more importantly, he provided an excellent role model; his vigorous and active lifestyle was a source of pride for many Americans. Through his efforts, the role of the President's Council on Physical Education and Sports became more defined and has now taken a very active part in the fight against heart disease and for fitness.

Because we became aware of the need to get ourselves and our children physically fit, books such as Dr. Kenneth Cooper's Aerobics, Dr. George Sheehan's Running and Being, and Jim Fixx's The Complete Book of Running became popular and started our country on the running road to fitness.

In the United States the most popular and economical exercises became walking, jogging, and running. We learned that aerobic exercise is good for our physical health. A study by Blair, Goodyear, Gibbons, and Cooper (1984) stated that of 16,936 Harvard alumni who entered the university from 1916 to 1950 even modest exercise, expending 2,000 or more calories per week in walking, jogging, or playing sports, reduced substantially the risk of cardiovascular disease.

It appears that in order for a physical activity to develop proper endurance fitness, a vigorous response must be elicited by the cardiovascular system for a sufficient period of time (AAHPERD, 1980). Many individuals, because of age, weight, coordination, or chronic injuries, find some of these activities like running, bicycling, and cross-country skiing inappropriate. The negative factors of supporting the body weight with relatively small amounts of active muscle mass lead many to seek an alternative to those aerobic activities.

The President's Council on Physical Fitness and Sports (The National Spa and Pool Institute, 1980) affirmed that swimming is recognized as America's most popular active sport. It is one of the best physical activities for people of all ages and for people who are physically handicapped. Vigorous water exercise can increase a person's flexibility, strength, and cardiovascular endurance. Swimming and water exercise provide benefits independently of participants skill levels. Swimming can reduce the likelihood of injury from overuse syndromes. Water resistance exercises are suggested training for athletes, young or old, overweight, or physically unfit persons (Koszuta, 1986).

How much exercise in the form of swimming is sufficient to develop, increase, and maintain physical fitness? A great deal of research has been done quantifying running as a fitness mode (Clark & Mosser, 1980; Hartung & Squires, 1980; Hespel, Fragard, Van Hoof, Rosseneu, & Amery, 1988; and Kohrt, 1986); some work has been done dealing with world-class swimmers. But in reviewing current literature, there have been few studies to date that have been conducted dealing with recreational and fitness swimming and their ability to develop and maintain fitness.

Statement of the Problem

This investigation determined the effects of a swimming program with different intensities on predicted maximal oxygen uptake, strength, flexibility, total cholesterol, high-density lipoproteins, and low-density lipoproteins in college males and females.

Purpose

The purpose of this investigation was to enhance the knowledge in the field of physical fitness in relation to swimming intensities of 60 and 70% of maximum training heart rate.

Delimitations

The study consisted of 60 college students enrolled in classes at Morehead State University during the fall semester, 1989. They were randomly selected from advanced Swimming and Intermediate Swimming classes. The control group were students selected from a Personal Health class. The variables of the study were predicted maximal oxygen uptake, strength, flexibility, total cholesterol, high-density lipoproteins, and low-density lipoproteins.

Definitions

Aerobic

With oxygen, used to describe fitness activities such as jogging, cycling, and lap swimming that last 20 or more minutes, done at low enough intensity to allow the circulatory system to provide working muscles with oxygen.

Bicycle Ergometer

A stationary bicycle that the subject pedals, thus driving the front wheel. A friction band, or electromagnetic breaking, applies resistance against wheel, increasing or decreasing work load.

Cardiovascular Fitness

The ability of the heart, blood vessels, blood, and respiratory system to supply fuel, especially oxygen, to the muscles during sustained exercise (Corbin & Lindsey, 1985).

Dynamometer

A dynamometer is used to measure static strength and endurance.

Frequency of Treatment

Refers to the number of days of swimming per week.

Grip Strength

The weight (kgs.) exhibited by a 1-second maximal pull with a hand-held grip dynamometer.

High-Density Lipoproteins (HDL)

These lipoproteins carry the excess cholesterol from the cells to the liver where it can be excreted by the body. HDL cholesterol is sometimes referred to as the "good cholesterol" (Shell, 1982).

Intensity of Treatment

Refers to the level of work eliciting either 60 or 70% of maximum heart rate.

Low-Density Lipoproteins (LDL)

These lipoproteins carry cholesterol in the bloodstream from the digestive track. High levels over time may clog the arteries and cause heart attacks. LDL cholesterol is sometimes referred to as "bad cholesterol" (Shell, 1982).

Physical Fitness

The entire human organism's ability to function efficiently and effectively. It is composed of at least 11 different components. Physical fitness also includes the individual's ability to enjoy leisure time, to be healthy, to resist hypokinetic diseases, and to meet emergency demands (Corbin & Lindsey, 1985).

Predicted Maximal Oxygen Uptake (VO_2 max.)

Refers to the highest oxygen uptake value obtained during an exercise compatible with maximal circulatory and respiratory adjustments. This measure is expressed in milliliters per kilogram of body weight per minute (ml./kg./min.) or in liters per minute (l/min.) It is synonymous with the terms maximal oxygen intake, maximal aerobic capacity, and maximal oxygen consumption.

Typical College Student

The student falling between 18 and 22 years of age.

Statistical Hypothesis

The researcher formulates that there is no difference in predicted maximal oxygen uptake, strength, flexibility, total cholesterol, high-density lipoproteins, or low-density lipoproteins for the treatment groups.

Chapter 2

Review of the Literature

The following review of literature relevant to this study, the effects of swimming frequency and intensity on maximum oxygen uptake, strength gains, flexibility, and lipoproteins fractions, is organized and presented in the following order: (1) The effects of training on maximal uptake, (2) endurance fitness and its relationship to strength and flexibility, and (3) the relationship of physical activity to cardiovascular disease and serum lipoprotein concentrations.

An excellent review by Counsilman (1988) equivocated that to make maximum cardiovascular gains, a nationally ranked swimmer must train 15,000 meters a day at the peak of training. An opposite view by Salo (1987) stated that his research indicated that averaging 15,000 meters a day has little metabolic similarity to racing 50 to 1,500 meters, and that peak cardiovascular fitness can be achieved with far less time and distance requirements.

From a student's point of view, can he or she be sure of fitness gains if he/she takes a physical education swimming class? LaPoint (1981) stated that more colleges and universities are offering physical fitness activity courses. Students need to know what exactly they can expect from those classes. Laurie (1981) reported that there have been few studies to date that evaluate the effectiveness of those courses. Pollock and Blair (1981) also suggested that the outcome of physical fitness courses should be analyzed.

The American College of Sports Medicine (1978) recommended a frequency of training from 3 to 5 days, an intensity of training of 60 to 90% heart rate, and a duration of training from 15 to 60 minutes of continuous aerobic training.

The Effects of Training on Maximal Uptake

Maximal oxygen uptake (VO_2 max.) is generally accepted as the best single measure presently available for the evaluation of the functional capacity of the respiratory and circulatory system (Montoye, Ayen, & Washburn, 1986). This study was an attempt to assess and evaluate the many techniques of measuring VO_2 from the 1920's through the present. The research indicated the need for a simple but reliable method to handle large groups such as schools or the military. Their study evaluated many such tests, from the Harvard Step Test to the Balke 15-minute run for distance. Their analysis of data from an unselected population of males illustrated that a submaximal effort on a bicycle ergometer test such as the Astrand and Rhyming (1954) is a reliable and very useful test for this purpose.

In attempting to understand cardiovascular fitness better, Hoeger (1986) stated that the best way to determine maximal oxygen uptake is through direct analysis of gas, although this technique may not be available to all researchers. There seems to be an increase in physical activity and a corresponding interest in the actual benefit of the activity; therefore, it becomes necessary to evaluate VO_2 in a simple but effective way.

Kohrt (1986) conducted three studies, using 14 triathletes to determine if triathletes experience specific or general adaptation to multiple-mode training. The first study evaluated VO_2 max. in triathletes during treadmill, bicycle ergometer, and the tethered swim. The data suggested a specific training adaptation. The same variables were studied in a longitudinal study that showed no change in swimming and running VO_2, but cycling improved 5%. The last study indicated that with reduced training, running and cycling VO_2 values decreased 4 and 10%, while swimming stayed the same.

Moffat and Sparkling (1985) investigated the influence of toe clips during bicycle ergometry on VO_2 max. The subjects consisted of eight men--four competitive cyclists and four distance runners--between the ages of 18 and 32. After each subject had undergone three randomized VO_2 max. tests, one on a treadmill, one on a bicycle with toe clips, and one without toe clips, the results showed no significant difference between toe clips and no toe clips, with the highest VO_2 max. being reached on the treadmill. As a result of this study, no favorable physiological effects may be attributed to the use of toe clips.

The American College of Sports Medicine (1980) indicated that the range of improvement for maximum VO_2 is generally from 5 to 25% depending upon the frequency of 3 to 5 days per week and for 15 to 60 minutes of continuous activity per workout. The improvement is proportional to the actual length of the training, with a plateau being reached at approximately 6 months.

Endurance Fitness and Its Relationship to Strength and Flexibility

Studies at the Human Performance Laboratory at Ball State University show that swimmers perform better when special attention is paid to strength and flexibility (Corbin & Noble, 1980). The importance of strength and flexibility is recognized by the AAHPERD's Health Related Physical Fitness Test (HRPFT) as they have a sit-and-reach test for flexibility. This test evaluates flexibility in the lower back and posterior thighs. Also included in the HRPFT are strength tests, both dynamic and static (AAHPERD, 1980).

Simpson (1987) demonstrated that there does exist a definitive negative relationship between strength and flexibility. In his study of 132 students enrolled in physical education activity courses at Tarleton State University, there was a significant relationship between strength increases and flexibility decreases. The classes evaluated were Racquetball and Aerobic Dance. Other findings indicated that all groups experienced significant changes in either flexibility, dynamic strength, body composition, or cardiorespiratory endurance due to participation in the activity programs.

In a study undertaken to determine the extent to which Ithaca College's football conditioning program improved selected components of physical fitness, Scriber (1984) evaluated 43 members of the team on muscle strength, body composition, and cardiovascular endurance. The program lasted 3 months, 5 days per week and 90 minutes per session. A circuit training approach with strength, flexibility, and aerobics was used. It was determined that significant changes occurred over time if the program was extended, with each player progressing, but at different rates.

Mulder and Allsen (1983) conducted a similar study to evaluate fitness components. Fifty-nine undergraduate college students at Brigham Young University participated in a nonsupervised physical education program, "Fitness for Life." A pretest-posttest format was used over an 8-week period. Significant cardiovascular endurance was determined for both experimental groups, but not for body composition. The author concluded that a 60 to 90% training heart rate and 3 to 5 days per week were sufficient to induce positive results in VO_2 max., but the intensity was not enough to increase strength or body composition.

The Relationship of Physical Activity to Cardiovascular Disease and Serum Cholesterol Concentration

In 1979, the landmark document "Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention" started the decade of the 1980's on a 10-year odyssey to eliminate the major killers of today, heart disease, stroke, cancer, and accidents. This document helped start a fitness revolution in America, a movement toward wellness. In view of this tremendous amount of newsprint, publicity, and money spent on fitness, why does America presently lead the world in deaths by heart attack? (Cooper, 1988).

Many factors have been attributed to this statistic. Scientists have identified several lifestyle factors that are responsible for these statistics, factors that could be controlled, but are not. John H. Knowles, former medical director of the Massachusetts General Hospital, observed that "Coronary heart disease has been called the disease of lifestyle" (cited in Dotson, 1988, p. 39). Over 99% of Americans are born healthy and suffer premature death and disability only as a result of personal misbehavior (cited in Dotson, 1988).

Lifestyle factors such as cigarette smoking, smoking that contains substances known to cause cell mutations, and low-density lipoproteins are known to infiltrate the region of the plaque formation. High blood pressure, lack of exercise, low activity, and high-stress jobs, are all contributors (Sharkey, 1984).

Our diets are high in fats, especially saturated fat, which has been linked with many of the chronic and degenerative diseases prevalent today. The link appears to be strongest between saturated fat, cholesterol, and coronary-artery disease (Bernard, 1983)

At least 50% of adult Americans are estimated to participate in some form of exercise on a regular basis (Milhorn, 1982). Is this exercise helping in the fight against heart attacks? Is it as simple as Dr. George Sheehan (1978), famed cardiologist, marathoner, and author leads us to believe when he said, "The key to enhancing your level of wellness through activity is to find your play" (p. 78). Is finding an activity that bring joy and creativity into your life, and one that you consider fun, enough?

Exercise in controlling serum cholesterol has been extensively investigated, and its importance in this problem is gaining wide acceptance. Exercise also enables the body to extract and utilize oxygen more efficiently, thereby improving the cardiorespiratory system (Williams, 1982).

Hespel et al., (1988) undertook a study to examine the effects of exercise on lipoproteins in 30 healthy sedentary men. They were divided into two groups, Group A, the training group, and Group B, the control group. Group A trained for 16 weeks, 3 times per week for 1 hour per training period. The sessions consisted of bicycle ergometer, jogging, and calisthenics divided by 5-minute rest periods. The study revealed HDLs did increase significantly at the .05 level in the training group. The data, although not significant, did indicate that endurance training did lower triglycerides and LDL concentrations.

Hartung and Squires (1980) conducted a study to determine the effects of exercise on HDL levels in 147 middle-aged men ranging in age from 35 to 65 years. They were divided into three groups: Group A, a high-mileage jogging group, Group B, a low-mileage jogging group, and the control group C, with a diet modification program only. The results of pre- and post-blood lipids tests indicated a significant improvement in HDLs in Groups A and B as compared to the control group, with Group A being significant when compared to Group B as well. The study did not show a significance with total cholesterol.

A similar study was conducted by Penny, Shaver, Carlton and Kendall (1982). Twenty-three middle-aged males were grouped by their previous training over the year. Group 1 was comprised of 6 marathoners, Group 2 had 12 regular joggers, and 11 inactive men served as the control group. The subjects were given a resting blood pressure test, predicted percent body fat and blood test to determine serum lipoprotein cholesterol counts. Training over a 1-year period was taken into consideration when cholesterol levels were correlated. As in the previous study, significantly higher values of HDL-C were found in both exercise groups and not in the control group. Unlike Hartung and Squires (1980), this study also showed a significant HDL-C/total cholesterol count for both exercise groups, but not with the control group.

In a study carried out at the Air Force Academy, Clark & Mosser (1980) observed evidence that training can reduce total serum cholesterol levels. The study was performed using the pretest-posttest format. The findings may have resulted from more strenuous conditioning--speed running with longer duration, 3 miles per day, higher frequency, 5 days per week, and a 6-month training period. As with previous studies, no attempt was made to control diet with the training group.

A later study using moderate aerobic exercise by Brownell, Bachorik, and Ayerle (1982) analyzed 61 men and women subjects from 20 to 60 years of age. The subjects were given a 10-week moderate aerobic exercise program that met 3 times per week for 30 minutes per session. The program was progressive with aerobic exercise eventually being performed at 70% of maximum heart rate. Results for the men were significant in total cholesterol, LDLs, and an increase in HDLs. The women tested as a group, though positive, were not significant at the .05 level in any components. No explanation was offered.

A similar study by Epstein and Wing (1980) indicated that people who exercise 4 or 5 times per week lose fat 3 times faster than those people who only exercise 3 times per week. For those people exercising 1 or 2 days a week, exercise was found to be completely ineffective in losing fat.

Williams (1982) reported that elevated blood cholesterol is a major risk factor for coronary artery disease. A reading of 200 mg./dl. is considered a risk; 220 mg./dl. is considered a moderate risk, and 240 mg./dl. and above is considered a severe risk. The Framingham Longitudinal study found that 180 was associated with an average risk and that, in the 35 years of the study, no one with a blood cholesterol level below 150 ever had a heart attack (Williams, 1978).

In view of the 1.5 million individuals per year that have heart attacks, most related to cholesterol components, it would seem prudent for individuals to have a cholesterol test performed and evaluate their lifestyle for possible keys to reduction in cardiovascular disease. Every 1% reduction in blood cholesterol levels is equivalent to a 2 to 3% reduction in the incidence of heart attacks and sudden deaths (Cooper, 1988).

Chapter 3

Methods

This study was conducted during the fall semester of 1989 at Morehead State University, Kentucky, over a period of 15 weeks. Sixty Morehead State University students were randomly selected to complete a pretest-posttest designed study consisting of 14 weeks of supervised training. All tests were performed in the Physical Education Physiology laboratory adjacent to the University McClure Pool, where the actual treatments were administered. The study determined the effects of two swimming intensities on predicted maximal oxygen uptake, strength, flexibility, total cholesterol, high-density lipoproteins, and low-density lipoproteins. An analysis of variance was computed to determine the differences among groups. A Scheffé was calculated on the pretest and posttest scores to determine significant differences between groups.

Subjects

The subjects used in this study were randomly selected from three Morehead State University classes taught by the investigator. Sixty students in all were utilized. Twenty students were selected from an Advanced swimming class and designated as Group A, swimming 3 days per week, for 14 weeks, at 70% intensity. Group B consisted of 20 students selected from an intermediate swimming class. Group B swam two days per week, for 14 weeks, at 60% intensity. Group C, 20 students selected from a Personal Health class, served as controls. There were 32 males in the study and 28 females. The mean age (years), height (centimeters), and weight (kilograms) for Group A was 19.70 yr., 185.00 cm., and 70.39 kg. respectively. The mean age, height, and weight for Group B was 19.75 yr., 155.82 cm., and 67.99 kg., while the mean age of Group C was 24.45 yr., 156.21 cm., and 68.96 kg.

The study was approved by the Middle Tennessee State University Research Ethics Committee (see Appendix A). The students were asked to sign an Informed Consent letter (see Appendix B). Effort was made to ensure the subjects' right to confidentiality. The basic elements of informed consent as specified by the Research Quarterly for Exercise and Sports Advisory Committee (1983) were followed.

Testing Procedures

The testing procedures section is divided into four basic areas: (1) the bicycle ergometer test used to determine predicted VO_2 max, (2) the hand-grip dynamometer used to determine dynamic grip strength, (3) the sit-and-reach test used to determine flexibility, and (4) the blood test to determine cholesterol and lipoprotein fractions. Two research assistants were trained and assisted by the investigator in the administration of all tests and data collection for the study. All subjects were measured during the second day of class and the last day of class. Group A met 3 days per week for 60 minutes; Group B met 2 days per week for 60 minutes, and Group C met 2 days per week for 60 minutes of class lecture. The actual study covered 15 weeks. The investigator taught all classes used in this study, performed all treatments and tests to ensure as much consistency throughout the study as possible.

Predicted Maximal Oxygen
Uptake

Astrand and Rhyming (1954) developed a nomogram for predicting maximal oxygen uptake (VO_2 max.) from exercise heart rate on a bicycle ergometer. In situations where the oxygen uptake cannot be determined, the maximum oxygen uptake can be estimated from the nomogram by using the body weight scale and heart rate. Generally during the first 2 to 3 minutes of work, respiration and circulation increase. After 4 to 5 minutes of work, the pulse rate has generally reached a steady state, which forms the basis for predicting maximum oxygen consumption.

Prior to the initiation of the test, the saddle and handle bars of the bicycle ergometer were appropriately adjusted to the subject, and noted for the posttest. The subjects were allowed a short familiarization on the bicycle before the actual resistance stage. A metronome was used to maintain a rate of 50 revolutions per minute throughout the test. Since weight is related to maximum oxygen consumption, the subjects were weighed before the test. The fifth- and sixth-minute heart rate average from the bicycle ergometer test was utilized with the nonogram to predict VO_2 for each subject.

Grip Strength

Grip strength was determined by using a dynamometer. Dynamometers are used to measure static strength, force exerted against an immovable resistance, or dynamic strength, force exerted by a muscle group as a body part moves through space. This study used the hand grip dynamometer to test static strength.

The test started with an assistant measuring the student's hand. The subject then stood in front of the investigator, held the dynamometer parallel to his or her side with the dial facing away from his/her body. To measure grip strength, the dynamometer was squeezed as hard as possible without moving the arm. Three trials were performed with a 1-minute rest between trials. The average of three trials was recorded (Safrit, 1986).

Sit-and-Reach Test for
Flexibility

One of the items in the AAHPERD Health Related Physical Fitness Test is the sit-and-reach test for flexibility. This test evaluates flexibility in the lower back and posterior thighs (AAHPERD, 1980).

The students were instructed to wear clothing that was not restrictive to their movement, and to wear the same thing for the pretest and the posttest. The test was administered as follows. The subjects were told to remove their shoes and assume the starting position with their knees fully extended and their feet shoulder-width apart. Their feet should be flat against the end boards. They were instructed to extend their arms forward with the hands placed on top of each other to perform the test. The subjects were instructed to reach directly forward, palms down, along the measuring scale, four times, and to hold the position of maximum reach on the fourth trial. The position of maximum reach must be held for one second (AAHPERD, 1980). All subjects were instructed to look down at their knees throughout the test.

Total Cholesterol and
Lipoprotein Fractions

The electrophoresis method was used for determining the serum lipoprotein cholesterol counts. Blood samples were drawn from all subjects in the evening from 6:00 p.m.

to 9:00 p.m. after a 12- to 16-hour fast. After separation, the lipoproteins were incubated at 37 degrees centigrade with a high-density lipoprotein cholesterol reagent which quantitatively visualizes cholesterol and cholesterol esters. The relative percent of cholesterol in each fraction was obtained by scanning with a densitometer equipped with a 500 mm. filter. Total cholesterol was determined by the formula as suggested by Allain, Poon, Chan, Richmond, and Fu (1974). A control blood sample provided by Helena Laboratories was used prior to determining the subject's total cholesterol, HDL, and LDL cholesterol. Quick scans of high-density lipoproteins and low-density lipoproteins were developed for each subject. All subjects were requested not to exercise during the fasting period. The lipoprotein fractions were determined by SmithKline Bio-Science Laboratories in Lexington, Kentucky. The blood samples were analyzed utilizing the Chem-Scan SMAC 25 blood test.

Training Programs

The following training programs were used in this study.

Group A

The 20 subjects in Group A were selected from a 2-credit hour Lifeguarding activity/lecture class. They participated in the class for 15 weeks. The subjects swam 3 times per week for 60 minutes per class period. Thirty of these minutes were swum at 70% of maximum training heart rate. The remainder of the class period was broken down as: 5 minutes to dress, 5 minutes of flexibility and warm up, 5 minutes of demonstration and stroke correction, 5 minutes of stroke drills and skill development, 30 minutes of treatment, 5 minutes for review and assignment, and 5 minutes for cool down and stretch.

Group B

The 20 subjects in Group B were selected from a 1-credit hour Intermediate Swimming activity class. They participated in class for 15 weeks. The subjects swam 2 times per week, for 60 minutes per class. Thirty of those minutes per class were swum at a 60% of maximum training heart rate. The remainder of the class period was broken down as: 5 minutes to dress, 5 minutes of flexibility and warm up, 5 minutes of demonstration and stroke correction, 5 minutes of stroke drills and skill development, 30 minutes of treatment, 5 minutes for review and assignment, and 5 minutes for cool down and stretch.

Group C

The 20 subjects in Group C were selected from a 2-credit hour Health 150 lecture class. Group C served as the control group for the study. They had no treatment responsibilities and were encouraged not to participate in any aerobic exercise programs.

Statistical Analysis

Utilizing the Honeywell CP-6, SPSS-X system at Middle Tennessee State University, means and standard deviations were calculated for all physical characteristics and dependent variables. An analysis of variance was computed to determine if a difference existed between the three groups. If a significant F ratio was obtained, the Scheffé test was computed to identify the group differences. The .05 level of significance was used.

Chapter 4

Analysis of Data

The physical characteristics for Group A (N = 20), Group B (N = 20), and Group C (N = 20) are presented in Table 1. There were 32 males and 28 females in the study. The mean age (years), height (centimeters), and weight (kilograms) for Group A was 19.70 yrs., 185.00 cm. and 70.93 kg., while the mean age, height, and weight for Group B was 19.75 yrs., 155.82 cm., and 67.99 kg. Group C had a mean age of 24.45 yrs., 156.21 cm., and 68.96 kg.

Predicted VO_2 Analysis

The mean and standard deviation for pretest and posttest predicted maximal VO_2 for each of the three groups are presented in Table 2. The pretest mean and standard deviation for predicted VO_2 for Group A was 40.80 ml./kg./min. and 6.35 respectively. The mean score for the posttest was 42.77 ml./kg./min., and the standard deviation was 8.46 with a pretest-posttest difference of 1.97.

Group B's pretest mean score was 37.30 ml./kg./min., and the standard deviation was 7.15. The mean for the posttest score was 40.00 ml./kg./min., and the standard deviation was 8.26 with a pretest-posttest difference of 2.70.

Table 1

Physical Characteristics: Mean Values for Age, Weight, and Height

Group	N	Age (yrs.)	Height (cm.)	Weight (kg.)
A	20	19.70	185.00	70.93
B	20	19.75	155.82	67.99
C	20	24.45	156.21	68.96

Table 2

Pretest and Posttest Means for Predicted VO_2 Max.

Group	N	$\overline{X}$	SD	$\overline{X}$	SD	X Diff.
A	20	40.80	6.35	42.77	8.46	1.97
B	20	37.30	7.15	40.00	8.26	2.70
C	20	37.52	9.47	37.10	10.42	-0.42

The pretest mean and standard deviation for Group C, the control group, was 37.52 ml./kg./min. and 9.47 respectively. The mean score for the posttest was 37.10 ml./kg./min., and the standard deviation was 10.42 with a pretest-posttest difference of -0.42.

The results of a one-way ANOVA for the posttest revealed an F ratio of 1.939 which was not significant at the .05 level (see Table 3), indicating that there was no significant difference for predicted VO_2 among the three groups.

Table 3

One-Way ANOVA for Posttest Predicted VO_2 by Groups

Source	df	MS	F	Sig. of F
Between Groups	2	160.768	1.939	.153
Within Groups	57	88.888		
Total	59			

Grip Strength

Pretest and posttest means and standard deviations for Group A, B, and C grip strength are presented in Table 4. Group A had a pretest mean of 42.70 kgs. with a standard deviation of 12.53. The mean score for the posttest was 45.75 kgs., with a 11.71 standard deviation and a pretest-posttest difference of 3.05.

Table 4

Pretest and Posttest Means for Grip Strength

Group	N	$\overline{X}$	SD	$\overline{X}$	SD	X Diff.
A	20	42.70	12.53	45.75	11.71	3.05
B	20	41.30	13.21	44.80	13.60	3.50
C	20	43.65	12.62	43.20	12.63	-0.45

Data from Group B revealed a pretest mean of 41.30 kgs. and a standard deviation of 13.21. The mean score for the posttest was 44.80 kgs., and the standard deviation was 13.60 with a pretest-posttest difference of 3.50.

Group C's pretest mean score was 43.65 kgs., and the standard deviation was 12.62. A posttest mean of 43.20 kgs. with a standard deviation of 12.63 left a pretest-posttest difference of -0.45.

The one-way ANOVA disclosed an F ratio of 0.206 which was not significant at the .05 level (see Table 5), indicating that there was no significant difference for grip strength among the three groups.

Table 5

One-Way ANOVA for Posttest Grip Strength by Groups

Source	df	MS	F	Sig. of F
Between Groups	2	33.2167	0.206	.814
Within Group	57	160.722		
Total	59			

Flexibility

The mean and standard deviation for pretest and posttest flexibility for each of the three groups are presented in Table 6. The pretest mean and standard deviation for flexibility for Group A was 3.22 and 3.24, respectively. The mean score for the posttest was 4.67, and the standard deviation was 2.75 with a pretest-posttest difference of 1.45.

Group B's pretest mean score was 2.75, and the standard deviation was 3.66. The mean for posttest score was 3.80, and the standard deviation was 3.87 with a pretest-posttest difference of 1.05.

The pretest mean and standard deviation for Group C, the control group, was 3.50 and 2.82, respectively. The mean score for the posttest was 2.25, and the standard deviation was 2.53 with a pretest-posttest difference of -0.25.

Table 6

Pretest and Posttest Means for Flexibility

Group	N	$\overline{X}$	SD	$\overline{X}$	SD	X Diff.
A	20	3.22	3.24	4.67	2.75	1.45
B	20	2.75	3.66	3.80	3.87	1.05
C	20	2.50	2.82	2.25	2.53	-0.25

The results of a one-way ANOVA revealed an F ratio of 3.116 which was not significant at the .05 level (see Table 7). Although there were differences in the group's posttest mean, the difference was not significant.

Total Cholesterol

Pretest and posttest means and standard deviations for Group A, B, and C total cholesterol are presented in Table 8. Group A had a pretest mean of 174.10, and a standard deviation of 27.44. The mean score for the posttest was 168.35 with a 27.92 standard deviation and a pretest-posttest difference of -5.75.

Table 7

One-Way ANOVA for Posttest Flexibility by Groups

Source	df	MS	F	Sig. of F
Between Groups	2	30.162	3.116	.0519
Within Groups	57	9.677		
Total	59			

Table 8

Pretest and Posttest Means for Total Cholesterol

Group	N	$\overline{X}$	SD	$\overline{X}$	SD	X Diff.
A	20	174.10	27.44	168.35	27.92	-5.75
B	20	178.90	36.88	168.40	30.26	-10.50
C	20	186.75	40.30	188.65	46.01	1.90

Descriptive data from Group B revealed a pretest mean of 178.90 and a standard deviation of 36.88. The mean score for the posttest was 168.40, and the standard deviation was 30.26 with a pretest-posttest difference of -10.50.

Group C's pretest mean score was 186.75 and the standard deviation was 40.30. A posttest mean of 188.65 with a standard deviation of 46.01 left a pretest-posttest difference of 1.90.

The one-way ANOVA for total cholesterol among groups revealed an F ratio of 2.156 which was not significant at the .05 level (see Table 9), indicating no significant difference among groups.

Table 9

One-Way ANOVA for Posttest Total Cholesterol by Groups

Source	df	MS	F	Sig. of F
Between Groups	2	2740.52	2.156	.125
Within Groups	57	1271.08		
Total	59			

High-Density Lipoproteins

The mean and standard deviation for pretest and posttest high-density lipoproteins for each of the three groups are presented in Table 10. The pretest mean and standard deviation for high-density lipoproteins for

Group A was 58.60 and 14.95, respectively. The mean score for the posttest was 58.85 and the standard deviation was 14.30 with a pretest-posttest difference of 0.25.

Table 10

Pretest and Posttest Means for High-Density Lipoproteins

Group	N	$\overline{X}$	SD	$\overline{X}$	SD	X Diff.
A	20	58.60	14.95	58.85	14.30	0.25
B	20	54.95	11.65	56.50	12.59	1.55
C	20	55.60	14.23	53.90	13.85	-1.70

Group B's pretest mean score was 54.95, and the standard deviation was 11.65. The mean for posttest scores was 56.50, and the standard deviation was 12.59 with a pretest-posttest difference of 1.55.

The pretest mean and standard deviation for Group C, the control group, was 55.66 and 14.23 respectively. The mean score for the posttest was 53.90, and the standard deviation was 13.85 with a pretest-posttest difference of -1.70.

The results of the one-way ANOVA disclosed an F ratio of 0.662 which was not significant at the .05 level (see

Table 11), indicating that there was no significant difference among the groups for high-density lipoproteins.

Table 11

One-Way ANOVA for Posttest High-Density Lipoproteins

Source	df	MS	F	Sig. of F
Between Groups	2	122.616	.6625	0.519
Within Groups	57	185.076		
Total	59			

Low-Density Lipoproteins

Pretest and posttest means and standard deviations for Group A, B, and C low-density lipoproteins are presented in Table 12. Group A had a pretest mean of 90.30 with a standard deviation of 24.73. The mean score for the posttest was 88.05 with a 25.68 standard deviation and a pretest and posttest difference of -2.25.

Descriptive data from Group B revealed a pretest mean of 96.25 and a standard deviation of 36.13. The mean score for the posttest was 94.25 with a standard deviation of 29.00 with a pretest-posttest difference of -2.00.

Group C's pretest mean score was 100.10, and the standard deviation was 35.67. A posttest mean of 101.35

with a standard deviation of 33.22 left a pretest-posttest difference of 1.25.

Table 12

Pretest and Posttest Means for Low-Density Lipoproteins

Group	N	$\bar{X}$	SD	$\bar{X}$	SD	X Diff.
A	20	90.30	24.73	88.05	25.68	-2.25
B	20	96.25	36.13	94.25	29.00	-2.00
C	20	100.10	35.67	101.35	33.22	1.25

The one-way ANOVA for low-density lipoproteins revealed an F ratio of 0.367 which was significant at the .05 level (see Table 13), indicating no significant difference among groups.

Table 13

One-Way ANOVA for Posttest Low-Density Lipoproteins

Source	df	MS	F	Sig. of F
Between Groups	2	885.80	1.020	0.367
Within Groups	57	868.267		
Total	59			

Chapter 5

Summary, Conclusions, Recommendations

Summary

The primary purpose of this investigation was to determine the effects of swimming at two frequencies and two intensities on predicted maximal oxygen uptake, strength, flexibility, total cholesterol, high-density lipoproteins, and low-density lipoproteins. Specifically, the study consisted of 60 college students enrolled in classes at Morehead State University during the fall semester of 1989. They were randomly selected from an Advanced swimming class and an Intermediate swimming class. The control group was students selected from a Personal Health class. The pretest-posttest designed study consisted of 14 weeks of supervised training. Changes in predicted VO_2 max. were determined by a bicycle ergometer test, in grip strength by the hand grip dynamometer, the sit-and-reach test for flexibility, and a blood test to determine total cholesterol and lipoprotein fractions. The .05 level was utilized to determine significance.

Means and standard deviations were calculated for all physical characteristics and dependant variables. A one-way analysis of variance was computed to determine if there was a difference between the three groups.

The results revealed no significant difference among the groups for predicted VO_2 max., grip strength, flexibility, total cholesterol, high-density lipoproteins, or low-density lipoproteins.

<u>Conclusions</u>

Based on the findings reported in the analysis of the data, the following conclusions were made concerning the statistical hypothesis. The investigator must accept the null hypothesis that there was no significant difference among the three groups in predicted maximal oxygen uptake, grip strength, flexibility, total cholesterol, high-density lipoproteins, or low-density lipoproteins.

The American College of Sports medicine (1980) indicated that the range of improvement for maximum VO_2 is generally from 5 to 25%, depending upon the frequency of 3 to 5 days per week and for 15 to 60 minutes of continuous activity. The investigator's findings in this study were not consistent with the improvements in the aforementioned report or studies by Cooper (1988) and Kohrt (1986).

In examining the theoretical contributions of the study, the nonsignificant gains in any of the variables was surprising to the investigator. Mulder and Allsen (1983) conducted a similar study with significant gains in VO_2 max., but not in strength. In Simpson (1987), a study with 132 college students, it appears that a great deal of weight training and resistance work is necessary to develop a significant gain in strength. Swimming has not been considered a leader in strength development in the past.

The nonsignificance in flexibility was not consistent with the research that indicates significant gains from a minimum of 3 days per week and 90 minutes per day (Simpson, 1987).

The lack of significance in cholesterol components, though disconcerting, were not entirely unexpected. Past research (Hespel, et al., 1988) with 30 subjects, 3 days per week, 60 minutes per day at 75% intensity had similar positive results that were not significant. Brownell, Bachorik, and Ayerle (1982), Epstein and Wing (1980), and Hartung and Squires (1980) had varying degrees of success, with only Hartung and Squires (1980) showing significance with high-density lipoproteins, while employing similar training regiment. Clark and Mosser's (1980) study conducted at the Air Force Academy proved significant with total cholesterol and high-density lipoproteins. These significant results may have resulted from a more strenuous conditioning, speed running, 3 miles per day, higher frequency, 5 days per week, and a 6-month training period. And lastly Cooper (1988) states that 5 to 6 days of aerobic activity are necessary to make a significant gain in cholesterol components.

Within the limitations of this study, the following conclusions are derived:

1. Swimming at 60 to 70% training heart rate, 30 minutes per day, 2 to 3 days per week, for 14 weeks, will not significantly change predicted VO max., strength, or flexibility.

2. Swimming at 60 to 70% training heart rate, 30 minutes per day, 2 to 3 days per week, for 14 weeks, will not significantly improve total cholesterol, high-density lipoproteins, or low-density lipoproteins.

3. The reduction in total cholesterol with training at 60% and 70% training heart rate was observed. This demonstrates a possibility that swimming at higher intensity or longer duration and frequency may significantly improve total cholesterol.

4. The results obtained in this study also showed that a small amount of swimming, 30 minutes a day, 2 days per week, at 60% intensity, could not only check the deconditioning of the traditional college student, but could actually increase many physical fitness components.

Recommendations

Based on the observations found in this study, it is recommended that:

1. A study should be conducted with increased intensity, frequency, and duration of training.

2. A study should be conducted at a military academy, military school, preparation school, or private school.

3. A study should be conducted using only physical fitness components.

4. A study should be conducted using blood components, including iron and triglycerides.

5. A study needs to be repeated with a group of subjects who are less physically fit.

Appendix A

Research Ethics Approval

on-campus memo: MTSU

To: Palmer Adkins

From: Michael Principe, Chair
MTSU Research Ethics Committee

Subject: I.R.B. Review

Date: September 24, 1990

I have reviewed the materials for the proposed investigation "The Effects of Swimming Frequency and Intensity on Selected Physical Fitness Components." While I understand that the research has already been completed, the investigation is unproblematic enough to warrant retroactive approval. I give this approval through the expedited review procedures authorized in 46.110 of 45 CRF Part 46.

I have kept a copy of your proposal and permission memorandum for our files. If this is a problem contact me.

Appendix B

Informed Consent Letter

Student Informed Consent Letter

I, the undersigned, agree to participate in a doctoral dissertation study for Palmer Adkins, doctoral candidate at Middle Tennessee State University. The procedures and purpose of this study have been fully explained to me. I understand what is required of me and know how to terminate the testing session should I feel the need to do so.

The testing session will require that I have a blood test to determine lipoproteins; a small amount of blood will be drawn by a certified professional. This test, valued at approximately $50, will be free to me. A 6-minute bicycle ergometer test to determine predicted maximal oxygen uptake, a sit-and-reach test to determine flexibility, and a grip test to determine strength all will be conducted before and after the course.

I, the undersigned, recognize that the testing contains moderate exercise, and the training regimen, though progressive, will be strenuous at times. I state that I am in good health, and that I will not hold the University, Hospital, or Clinic staff or agents responsible or liable for any accident or personal injury sustained during this study. This participation is voluntary and will not affect the letter grade that is earned for the course. Names will be confidential.

PRINT FULL NAME ______________________ DATE ______________

SIGNATURE ______________________ WITNESS ______________

Appendix C

Raw Data: Sex, Age, Height, Weight, Pre and Post

Table 14

Raw Data: Sex, Age, Height, and Weight of Subjects

Subject	Sex	Age	Height (cms.)	Weight (kgs.) Pre	Post
Group A					
1	M	18	172.7	70.3	70.3
2	M	19	190.5	75.7	73
3	M	20	182.8	73.4	76.2
4	F	19	170.2	59.4	60
5	M	18	182.9	86.1	82.2
6	M	22	162.6	64.4	65.3
7	F	19	167.6	75.2	77.1
8	F	22	177.8	70.3	67.1
9	M	20	190.5	86.9	81.6
10	F	18	172.7	70.3	68.4
11	M	20	172.7	72.5	63.5
12	F	21	175.3	56.6	58.9
13	F	19	167.0	68.9	67.1
14	M	19	177.8	77.1	76.2
15	M	18	185.4	83.0	82.1
16	M	18	175.3	58.8	65.3
17	F	18	167.6	60.7	61.2
18	F	27	175.3	51.2	50.8

Table 14 (continued)

Subject	Sex	Age	Height (cms.)	Weight (kgs.) Pre	Post
19	M	21	180.3	94.8	96.1
20	M	18	187.9	80.2	75.2
Group B					
1	F	42	167.6	54.4	53.5
2	F	18	165.1	63.5	63.9
3	M	19	175.2	83.0	81.6
4	F	19	174.6	50.8	52.1
5	M	19	177.8	80.7	73.4
6	F	18	162.6	73.0	74.3
7	F	23	157.5	65.3	63.9
8	F	18	172.2	63.5	59.8
9	M	18	177.8	76.6	71.6
10	F	25	180.3	93.8	86.1
11	F	18	177.8	72.5	70.3
12	M	19	172.8	75.7	76.2
13	F	17	170.2	48.0	49.8
14	M	18	177.8	81.6	81.6
15	F	18	170.2	63.9	63.0
16	M	19	167.6	60.7	61.2
17	F	19	175.3	74.8	73.5
18	M	29	175.3	81.6	78.9

Table 14 (continued)

Subject	Sex	Age	Height (cms.)	Weight (kgs.) Pre	Post
19	M	18	185.4	83.9	84.8
20	M	20	185.4	77.5	77.1
Group C: Control					
1	M	20	177.8	72.5	71.2
2	M	19	183.3	74.8	74.3
3	F	18	170.2	74.8	74.3
4	M	48	185.4	95.2	96.1
5	M	20	182.9	78.4	77.5
6	F	18	154.4	44.4	47.6
7	F	18	165.1	55.3	57.1
8	M	54	172.7	89.8	94.3
9	F	21	165.1	56.6	56.6
10	M	20	172.7	70.3	69.8
11	M	21	177.8	61.2	60.3
12	M	20	182.9	86.1	81.6
13	F	21	165.1	54.4	56.2
14	F	17	157.9	63.8	67.1
15	M	21	180.3	68.0	68.4
16	F	31	167.5	59.8	59.4
17	F	18	160.2	49.4	48.0
18	M	18	185.4	102.0	97.5

Table 14 (continued)

			Height	Weight (kgs.)	
Subject	Sex	Age	(cms.)	Pre	Post
19	F	36	180.3	62.1	63.9
20	M	20	177.8	68.9	69.8

Appendix D

Raw Data: Predicted VO_2, Pre and Post; Grip Strength, Pre and Post; and Flexibility, Pre and Post

Table 15

Raw Data: Predicted VO_2, Pre and Post; Grip Strength, Pre and Post; and Flexibility, Pre and Post

	(ml./min.kg.) VO_2		(kg.) Strength		(in.) Flexibility	
Subject	Pre	Post	Pre	Post	Pre	Post
1	44.5	43.5	36	37	2.5	4.5
2	34	42	60	59	5.0	6.0
3	43	46.5	52	56.5	-3.0	.5
4	37	36	35	38	2.0	2.0
5	39	40	45	50	1.0	4.0
6	37.5	36	55	56	5.0	6.0
7	32	29	31	31.5	6.0	4.5
8	55	60.5	34.5	44	5.0	9.0
9	34.5	33	55	61.5	-1.0	-1.0
10	36	38.5	25	34	8.0	9.5
11	51	54	40.5	40	7.0	6.5
12	38	38	29	28	9.0	7.5
13	34	38.5	28	32	1.5	4.5
14	43	52	45	46	2.0	4.5
15	48.5	52	70	68	-.5	2.5
16	33	29	46	51	3.0	3.0
17	44	49	25	26	5.0	6.0
18	46	50	41	51	6.0	8.0

Table 15 (continued)

Subject	(ml./min.kg.) VO_2 Pre	Post	(kg.) Strength Pre	Post	(in.) Flexibility Pre	Post
19	42	42	56	55	2.0	4.5
20	44	46	45	46.5	-1.0	1.5
<u>Group B</u>						
1	46	52	34	38	-2.5	-1.0
2	31	30	36	38	1.5	2.0
3	32.5	34	40	43	-4.0	-2.0
4	33	52	32	49	5.0	9.0
5	37.5	46	68.5	73	3.5	4.0
6	27	25.5	31	33	2.0	3.0
7	35	36	35	39	5.0	5.0
8	23	35.5	19	21	5.0	9.0
9	41	51	41	45	-3.0	-2.0
10	39	40	58	55	8.0	9.5
11	46	48	37	35.5	6.0	5.0
12	35	35	51	60	1.0	1.0
13	32.5	31	29.5	32	6.0	7.5
14	44	44	46	53.5	2.0	4.5
15	39	41	34	34.5	7.0	7.0
16	52.5	50	35	35	3.0	5.5
17	38	39	30	31	9.0	8.5
18	45	54	56	59	1.0	1.0

Table 15 (continued)

	(ml./min.kg.)		(kg.)		(in.)	
	VO_2		Strength		Flexibility	
Subject	Pre	Post	Pre	Post	Pre	Post
19	31	29	44	49.5	.5	1.0
20	38	38	69	70	-1.0	-1.5
Group C: Control						
1	45	43	53	57	6.0	5.0
2	52.5	53	51	52	2.0	2.0
3	40	38	37	36	2.0	2.5
4	33	35	45	47	3.0	1.5
5	31	31	50	50	.5	1.0
6	26	24	32	30	4.0	5.0
7	32.5	33	37.5	38	5.0	4.0
8	28	25.5	55	58	-3.0	-2.0
9	35.5	31.5	29	30	2.0	3.0
10	44	44.5	51	50	6.5	3.5
11	55	56.5	45	45	2.5	2.0
12	32	33.5	65.5	66	6.5	5.0
13	32	34	27	25	2.0	2.0
14	22	19	30	31	-.5	-1.0
15	47.5	44.5	48	45	3.0	3.0
16	41	42	37.5	36	1.0	1.5
17	35	36	24	24	7.0	7.5
18	28	28.5	68	65	-3.0	-3.5

Table 15 (continued)

	(ml./min.kg.) VO$_2$		(kg.) Strength		(in.) Flexibility	
Subject	Pre	Post	Pre	Post	Pre	Post
19	34	32	32.5	33	2.0	1.0
20	53.5	57.6	55	46	1.5	2.0

Appendix E

Raw Data: Total Cholesterol, Pre and Posttest;

High-Density Lipoproteins, Pre and Post;

Low-Density Lipoproteins, Pre and Post

Table 16

Raw Data: Total Cholesterol, Pre and Posttest;

High-Density Lipoproteins, Pre and Post;

Low-Density Lipoproteins, Pre and Post

	(mg/dl)					
	Total		HDL		LDL	
Subject	Pre	Post	Pre	Post	Pre	Post
Group A						
1	229	229	52	46	130	135
2	170	181	59	51	85	108
3	150	160	55	59	77	87
4	199	198	71	74	107	107
5	177	178	59	59	91	110
6	172	152	37	46	59	91
7	153	153	46	68	68	66
8	125	138	52	53	56	74
9	147	147	102	102	81	31
10	184	181	85	80	90	93
11	166	139	62	51	88	51
12	175	154	52	57	93	72
13	156	170	70	61	66	92
14	176	150	52	50	113	91
15	159	162	48	53	86	89
16	185	185	71	71	73	73
17	204	183	57	61	133	108

Table 16 (continued)

	(mg/dl)					
	Total		HDL		LDL	
Subject	Pre	Post	Pre	Post	Pre	Post
18	160	136	48	43	100	81
19	239	232	52	55	144	136
20	156	139	52	47	66	66
Group B						
1	165	137	61	57	72	59
2	182	164	67	62	100	91
3	206	209	62	62	114	120
4	152	153	65	64	75	82
5	142	118	57	43	67	57
6	290	214	38	86	196	154
7	174	174	77	74	65	62
8	140	144	56	49	68	80
9	174	166	47	54	104	99
10	223	191	40	44	159	134
11	192	176	57	51	91	107
12	165	177	49	47	87	93
13	143	143	52	55	78	81
14	184	187	68	71	100	103
15	164	150	47	42	88	87
16	181	163	61	49	102	102
17	198	195	56	53	99	93

Table 16 (continued)

	(mg/dl)					
	Total		HDL		LDL	
Subject	Pre	Post	Pre	Post	Pre	Post
18	220	228	36	51	150	158
19	152	167	67	74	55	71
20	131	112	36	42	55	52
<u>Group C: Control</u>						
1	174	164	38	36	107	101
2	163	160	45	48	88	83
3	132	132	84	80	81	77
4	239	218	50	63	151	136
5	177	171	27	30	54	54
6	177	166	78	66	75	75
7	200	187	58	54	122	116
8	276	268	43	56	173	183
9	154	158	64	64	73	75
10	227	209	59	56	147	125
11	241	222	53	51	139	140
12	134	204	56	38	58	111
13	207	180	61	49	111	93
14	172	189	63	69	91	96
15	165	147	51	46	76	76
16	149	145	78	76	56	54
17	175	187	54	51	91	112

Table 16 (continued)

	(mg/dl)					
	Total		HDL		LDL	
Subject	Pre	Post	Pre	Post	Pre	Post
18	238	329	51	54	134	148
19	196	187	62	61	119	107
20	139	151	37	36	55	65

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