ABSTRACT

HUNTLEY, E. A. The effects of a ten-week step aerobic training program on the body composition of college-aged women. MS in Adult Fitness/Cardiac Rehabilitation, 1992, 51pp. (J. Porcari)

The purpose of this study was to examine the effects of a 10-week step aerobic training program on the body composition of college-aged women (mean age = 19.6 yrs). Forty-six apparently healthy females between the ages of 18 and 25 years participated in the study. Subjects in the experimental group exercised 3 times per week for 10 weeks. The average intensity maintained during exercise was 150 bpm which represented 76% of HRmax. Eighteen experimental group Ss and 23 control group Ss were hydrostatically weighed and had maximal buttocks, thigh, and calf girths measured prior to and at the end of the study. The variables analyzed included body weight, maximal buttocks girth, maximal thigh girth, maximal calf girth, residual volume, lean body mass, fat weight, body density, and percent body fat. The results showed a significant ($p < .05$) decrease for the experimental group in maximal thigh girth (1.0 cm). No significant ($p > .05$) between-group differences were observed for body weight, maximal buttocks girth, maximal calf girth, body density, LBM, fat weight, or percent body fat.

THE EFFECTS OF A TEN-WEEK STEP AEROBIC TRAINING PROGRAM ON THE BODY COMPOSITION OF COLLEGE-AGED WOMEN

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CHAPTER I

INTRODUCTION

It has been estimated that 59% of the adults in the United States exercise on a regular basis (Gordon & Gibbons, 1990). For the majority of these people, aerobic exercise such as jogging, swimming, cycling, walking, and aerobic dance are the popular modes of choice. Dr. Kenneth Cooper (1982), known as the "father" of aerobics, defines aerobic exercise as "those exercises that demand a large quantity of oxygen for prolonged periods and ultimately force the body to improve those systems responsible for the transportation of oxygen" (p. 112).

Recently, the relationship between exercise and all-cause mortality has been studied. Research has shown that a low level of fitness is highly correlated to a greater risk of death from cardiovascular and coronary heart disease as well as death from all other causes (Blair et al., 1989; Ekelund et al., 1988; Paffenbarger, Hyde, Wing, & Hsieh, 1986). Therefore, it is not surprising that more people are adopting a physically active lifestyle.

With this increased interest in exercise has come a greater demand for new and different exercise programs. Jacki Sorensen recognized this need and founded the Aerobic Dance Corporation in 1972 (Schuster, 1979). Aerobic dance incorporates calisthenics with simple dance movements which are set to music. A trained instructor leads the class in a variety of rhythmic movements beginning with a low intensity and gradually building to a higher intensity. Participants monitor their own heart rates and modify their work-out by exercising at a comfortable intensity. Thus, aerobic dance is suitable for all fitness levels. Since Sorenson first began this program more than 23 million people have enrolled in aerobic dance classes (Koszuta, 1986).

A number of studies have examined the effects of aerobic dance on maximal oxygen consumption (VO_2max) and body composition (Eickhoff, Thorland, & Ansorge, 1983; Foster, 1975; Igbanugo & Gutin, 1975; Johnson, Berg, & Latin, 1984; McCord, Nichols, & Patterson, 1989; Schuster, 1979; Vaccaro & Clinton, 1981). It is generally accepted that aerobic dance produces a level of intensity that will lead to a training effect, including significant improvements in VO_2max and body composition.

Aerobic dance, however, has changed over the years to meet the needs of varying individuals. Specialized classes are now offered including high and low impact, traditional, funk, and prenatal. The most recent development has been step aerobics.

Step aerobics has gained national attention since the formation of Step Reebok in 1988. This type of aerobic dance involves stepping on and off a step that can be adjusted to different heights. The theory behind step aerobics is that by incorporating the step into the routine, the participant will be increasing their workload, thereby working at a higher level of intensity. Another advantage of participation in step aerobics is the reduced risk of injury to bones and joints. Step aerobics began as a form of knee rehabilitation (Reebok Intl. Ltd., 1990), and Reebok International has indicated that the use of the step reduces impact stress on the bones and joints of the lower body.

Currently, thousands of aerobic dance participants regularly exercise with step aerobics (Reebok Intl. Ltd., 1990). Yet, very little research has been completed in the area. Drs. Peter and Lorna Francis (Reebok Intl. Ltd., 1990) examined oxygen consumption during a Step Reebok routine and found that step aerobics requires the same amount of oxygen as does running a 7 mile per hour pace. However, no studies have been published examining the effects of step aerobics on body composition.

Purpose of the Study

The purpose of this study was to determine the effects of a 10-week step aerobic training program on the body composition and anthropometrics of college-aged women.

Need for the Study

Because step aerobics is gaining in popularity, it is important for participants as well as fitness specialists to be aware of the potential benefits of such training. One of the main reasons individuals participate in aerobic dance is to control or lose weight. As of yet, there has been no published research determining the effect of step aerobic training on body composition. Research completed on this topic will provide information as to whether or not step aerobics may affect one's body composition.

Hypotheses

This study tested the following null hypotheses:

1. There will be no significant difference in the changes in lean body mass exhibited by the experimental and control groups over the course of the 10-week study period.

2. There will be no significant difference in the changes in fat weight exhibited by the experimental and control groups over the course of the 10-week study period.
3. There will be no significant difference in the changes in percent body fat exhibited by the experimental and control groups over the course of the 10-week study period.
4. There will be no significant difference in the changes in maximal calf girth exhibited by the experimental and control groups over the course of the 10-week study period.
5. There will be no significant difference in the changes in maximal thigh girth exhibited by the experimental and control groups over the course of the 10-week study period.
6. There will be no significant difference in the changes in maximal buttocks girth exhibited by the experimental and control groups over the course of the 10-week study period.

Delimitations

This study had the following delimitations:

1. The subjects were college-aged volunteers who attended the University of Wisconsin-La Crosse during the Fall Semester, 1991.
2. The study was 10 weeks in duration.
3. The subjects were apparently healthy, nonsmoking women.

Limitations

The possible limitations to this study were:

1. The subjects were volunteers and thus were not randomly chosen.
2. Motivation levels of subjects could not be totally controlled.

Assumptions

In the conduct of this study it was assumed that:

1. Subjects were healthy and had no underlying coronary or metabolic disease.
2. Subjects did not modify their diet in any way during the study.
3. Subjects did not engage in any additional aerobic or weight training during the study.
4. Subjects performed the residual volume and hydrostatic weighing tests to the best of their capability.

Definition of Terms

The following terms were used in this study:

Aerobic Exercise - those exercises that demand a large quantity of oxygen for prolonged periods and ultimately force the body to improve those systems responsible for the transportation of oxygen (Cooper, 1982).

Body Composition - the components of the human body which is divided into two compartments: fat and lean tissue.

Body Density - the mass per unit volume of an individual as determined by hydrostatic weighing.

Hydrostatic Weighing - the "gold standard" for estimation of body density. The procedure involves submerging a subject underwater and obtaining their weight.

Lean Body Mass - the weight of the body that consists of muscle, bone, and viscera.

Percent Body Fat - the percentage of total body mass that consists of adipose tissue.

Residual Lung Volume - the volume of air remaining in the lungs following maximal expiration (Fox, Bowers, & Foss, 1989).

Spirometer - a device that measures the volume of air moving in and out of the lungs.

Step Reebok - a dynamic new exercise program that involves stepping up and down from a platform to the accompaniment of music. The program includes a wide variety of stepping patterns and upper body movements (Institute for Aerobics Research, 1990).

Total Lung Capacity - the volume of air in the lung at the end of a maximal inspiration (Fox et al., 1989).

Vital Capacity - the maximal volume of air forcefully expired after maximal inspiration (Fox et al., 1989).

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

This study investigated the effects of a 10-week step aerobic training program on the body composition of college-aged women. The review of literature focuses on the effects of various aerobic activities on body composition and on the measurement of body fat by hydrostatic weighing.

Body Composition

Composition of the human body can be divided into two components: lean body mass (LBM) and body fat. Lean body mass consists of bone, muscle, and viscera. Body fat consists of both adipose tissue and essential fat which surrounds the organs.

The relative mass of body fat is the most variable component and is most clearly related to nutrition. Measurement of body fat allows an estimate of the metabolically active LBM, as well as provides a direct measure of calorie nutriture and energy reserve for LBM. The balance of body fat and LBM largely determines the external appearance of the body.

Effects of Aerobic Exercise on Body Composition

Exercise training has been shown to effectively change body composition. Typical changes induced by training are decreases in body fat, slight increases in LBM, and small decreases in total body weight (Moody, Kollias, & Buskirk, 1969; Moody, Wilmore, Girandola, & Royce, 1972). The significance of these changes are dependent upon the subjects initial fitness level and the duration of the training program. It has been shown that body composition changes are more pronounced for the obese subject than for the lean individual (Fox et al., 1989). It has also been shown that female subjects who are within the optimal range of body fat (20 to 27%) may not be able to significantly modify their body composition unless they restrict their diet while training (Katch, Michael, & Jones, 1969).

When using exercise as a means of weight reduction the total energy cost of the training program is of critical importance. Studies have shown that significant changes in body composition can result from exercise even when diet remains unchanged (Pollock, Wilmore, & Fox, 1984). However, body weight has been found to change very little if at all during the first 6 to 8 weeks of an exercise program (Behnke & Wilmore, 1974). Therefore, the duration of a training program is critical to the amount of body composition change produced.

Many studies have investigated the effects of various aerobic exercise modalities on body composition. Regardless of the mode of activity, most studies indicate that with aerobic exercise moderate to large changes in body composition can be achieved (Wilmore, 1983). Changes are similar in males and females if the training program is of similar duration, frequency, and relative intensity (Massicotte, Avon, & Corriveau, 1979; Smith & Stransky, 1976).

Two studies that examined the effects of running and/or walking on the body composition of normal and obese subjects found significant decreases in body fat for obese groups only (Moody et al., 1972; Wallace, 1975). Moody et al. (1972) studied 28 obese and 12 normal weight high school girls before and after 4-day per week, 15 and 29-week walking/jogging programs. The subjects' body fat was determined by skinfold measurements, and girth measurements were taken on the chest, bust, waist, hips, thigh, calf, and upper arm. The training program began with the girls walking or jogging 1 mile each session, and gradually progressed until the distance covered was 3 to 3.5 miles per session. Subjects were required to jog at least 75% of this distance. Subjects of normal weight exhibited no significant changes in body composition or sum of girth measurements. Obese subjects in the 15-week group significantly decreased their body fat by 2.53% and increased LBM by 1.13 kg; no change was observed for the sum of girth measurements. The 29-week obese group significantly decreased body fat by 3.14% and increased LBM by 1.51 kg. In addition, a significant decrease of 9.5 cm was observed in this group for sum of girth measurements.

Wallace (1975) studied 31 college women before and after a 4-month, 3-day per week training program consisting of running and walking. Subjects were divided into groups according to age and initial fitness level. The group with the greatest initial body fat evidenced significant decreases in body fat from 30.27 to 24.80% (-5.47%), while the initially leaner groups evidenced nonsignificant decreases in body fat of only 1.36%. The failure of the leaner groups to decrease body fat was attributed to their mean initial body fat (21.41%).

Moody et al. (1969) investigated the effects of a 6-day per week, 8-week walk/jog program on 11 overweight college women. The average subject covered between 4.5 and 5.5 miles each day, expending an average of 340 kilocalories per session. Subjects agreed not to modify their diet while training. Significant decreases in body fat and total body weight occurred. The average fat loss was 10.1% (5.27 kg) with a total body weight decrease of 2.4 kg. However, the investigators felt that the skinfold method by itself was inaccurate for determining the body fat reduction of the subjects, as the calculated loss of body fat greatly exceeded the caloric deficit of the training program.

In a 3-day per week, 10-week jogging program, Wilmore, Royce, Girandola, Katch, and Katch (1970) studied the body composition changes of 55 men aged 17 to 59 years. Small, yet significant alterations in body composition were manifested. Body weight decreased by 1.01 kg, while body fat decreased by 1.11%. Lean body mass however, had a nonsignificant increase of 0.14 kg. The investigators found the magnitude of these changes were not exceptionally large, but substantial considering the short duration of the program.

Lieber, Lieber, and Adams (1989) studied 12 sedentary males, ages 28 to 35 years, during an 11.5-week running program. Subjects ran for 60 minutes, 3 days per week at 75% of their treadmill VO_2max. Subjects evidenced a significant increase in LBM (59.78 to 61.09 kg), and nonsignificant decreases in body fat (20.02 to 18.4%) and total body weight (75.19 to 75.16 kg).

Milesis et al. (1976) examined the effects of a 3-day per week, 20-week run/walk program on percent body fat and girth measurements of lean men whose initial mean body fat was 13%. Ninety-nine subjects were randomly divided into a control, and three training groups where exercise was 15, 30, or 45 minutes in duration. In results not anticipated, a significant decrease in body fat was found for all three training groups. In addition, the 45 minute group was found to have reduced body fat significantly more than the 15 minute group (1.2 versus 0.5%), and was the only group to significantly reduce waist girth (83.6 to 81.8 cm). None of the groups changed significantly in chest expansion, gluteal girth, or thigh girth.

In the first study to provide evidence of the physiological benefits of a swimming program, Stransky, Mickelson, Van Fleet, and Davis (1979) found that young female swimmers significantly increased LBM from 46.0 to 46.7 kg after a 7-week, 4-day per week training program. The training also produced a nonsignificant decrease in body fat of 2.1%, and a nonsignificant decrease in total body weight of 0.8 kg.

Lieber et al. (1989) studied 14 men before and after an 11.5-week swim training program where subjects swam for 50 minutes, 3 days per week, training at 75% of their VO_2max. Swimmers experienced a significant decrease in body fat of 2.4%, a significant decrease in total body weight of 1.44 kg, and a significant increase in LBM of 0.9 kg.

Smith and Stransky (1976) studied the effects of a 3-day per week, 7-week bicycle ergometer training on 16 moderately active college-aged females. Each session lasted 16 minutes during which subjects trained at 73% of their maximum heart rate reserve. Subjects significantly increased total body weight by 1.4 kg and LBM by 1.1 kg. However, body fat did not change.

Girandola and Katch (1973) studied 29 college men before and after a circuit training program. The 9-week, 2-day per week program consisted of 11 exercise stations which included calisthenics, running, and weight training. Each subject completed 3 circuits per training session in a limited amount of time. No attempt was made to control the subjects' diets. Total body weight and LBM did not change as a result of the training. Body fat and body density however, decreased significantly by 1.04% and 0.0023 gm/cc, respectively.

Energy cost of aerobic dance. Several studies have been completed examining the energy cost and physiological effects of aerobic dance. Weber (1974) tested 10 women for VO_2 during an aerobic dance routine. He found that high intensity aerobic dance produces an energy cost equivalent to cycling at 13 miles per hour, or running at 5.5 miles per hour. Similarly, Foster (1975) found that aerobic dance is comparable to running at a 12 minute mile pace. Igbanugo and Gutin (1975) examined the energy cost of low, medium, and high intensity aerobics. They found that the energy used during the low intensity routine was similar to walking on the level, the medium intensity routine was comparable to jogging, and the high intensity routine used as much energy as playing hockey. They concluded that at any intensity, "aerobic dance can be useful as a modality for cardiorespiratory training and rehabilitation, as well as for weight reduction and maintenance" (p. 308). However, Williford, Blessing, Olson, and Smith (1989) concluded that low impact dance must be performed at high intensities to meet the minimum guidelines for exercise suggested by the American College of Sports Medicine (ACSM) (1986).

<u>Aerobic dance and body composition</u>. McCord et al. (1989) tested sedentary college-aged women before and after a 12-week low impact aerobic dance training. Subjects exercised 3 times each week for 35 minutes at 75-85% of their maximum heart rate range. Lean body mass increased significantly from 44 to 47 kg, while body fat decreased significantly from 25 to 21%. There was no change in total body weight.

Johnson et al. (1984) studied the effect of a 13-week aerobic dance program. Twenty-three sedentary and overweight college-aged women participated in either the two (2x) or three (3x) day per week groups. Subjects were required to exercise at 70% of their maximum heart rate. Each week the duration of exercise was increased 5 minutes so that by the final week, the 2x group exercised for 2, 45-minute sessions, while the 3x group exercised for 3, 30-minute sessions. Both training groups lost weight, while only the 2x group achieved a significant weight loss (1.3 kg). Body fat decreased significantly in both groups, by 2.1 and 3.1% for the 2x and 3x groups, respectively. No change in LBM was evidenced for either group.

Eickhoff et al. (1983) studied the effects of a 10-week aerobic dance program on the body composition of 39 college-aged women. Twenty experimental subjects met 3 days per week for 30 minutes of aerobic dance. Body composition was determined using the sum of skinfolds method. Subjects in the training group manifested a significant decrease in sum of skinfolds measurements of 7.7 mm, while the control group evidenced no changes.

Contradictory to the aforementioned findings, Vaccaro and Clinton (1981) found no significant change in body fat after a 10-week aerobic dance training where ten college-aged women trained 3 days per week. Hydrostatic weighing was used to assess body composition. The results revealed a nonsignificant increase in body fat from 26.6 to 27.2%. The investigators attribute the lack of significant change to the short duration of the study and the slight increase in percent body fat to measurement error.

The effects of an 8-week rebound aerobic dance were examined by Tomassoni, Blanchard, and Goldfarb (1985). Twenty-one sedentary college-aged women were randomly assigned to either a control or exercise group. The exercise group participated 3 days each week, 40 minutes per session, exercising at 75-80% of their maximal heart rate. No significant changes were found for body fat, total body weight, or LBM even when exercise was performed at intensities recommended by ACSM (1986).

Smith, Bishop, and May (1989) examined the effects of aerobic dance training with and without the use of handheld weights on body composition. Nineteen subjects, 15 females and 4 males, with a mean age of 20.5 years exercised for 30 to 45 minutes each session at heart rates ranging from 70-85% of their predicted maximal heart rate. The groups exercised 3 days per week for 10 weeks. Both groups significantly increased total body weight. No measurements of body fat or LBM were made.

Effects of Step Aerobics on Body Composition

No training studies have yet been published that examine the effects of step aerobic training on body composition. Drs. Lorna and Peter Francis of San Diego State University received a research grant from Reebok Intl. Ltd. to undertake a research study on step aerobic training (Reebok Intl. Ltd., 1990). Oxygen consumption was measured as subjects performed a typical step aerobic routine. It was found that the energy expenditure of step aerobics was almost the same as running 7 miles per hour.

Hydrostatic Weighing

Hydrostatic weighing at residual volume (RV), has become known as the "gold standard" in the determination of body composition (Wilmore, 1983). This procedure, which involves submersion of a subject in a hydrostatic tank, is generally recognized as the most accurate procedure for calculating body density (Bonge & Donnelly, 1989).

Body density is determined by using the Archimedean principle which states "that an object immersed in a fluid loses an amount of weight equivalent to the weight of the fluid that is displaced" (Fox et al., 1989, p. 564). The weight of the fluid (water) that is displaced is equal to body volume.

Density of the body can be expressed as:

$$D_b = \frac{W_a}{B_v}$$

Where: D_b = Density of the body

W_a = Weight in air

B_v = Body volume

However, prior to final calculation of body density, the total body volume must be corrected for the amount of air that remains in the lungs (RV) and in the gastro-intestinal (GI) tract (Wilmore, 1969). Without allowing for these additional volumes in the formula, the subject's weight in water would be less, resulting in an overestimation of body volume (Brooks & Fahey, 1984).

Residual volume can be measured by an oxygen dilution method as described by Wilmore (1969). The standard error of measurement with this method is approximately $\pm$ 100 ml due to air in the GI tract. Therefore, 100 ml is subtracted out of the total in the final calculation.

The formula used for body density, taking RV and GI air into account is:

$$D_b = \frac{W_a}{\dfrac{W_a - W_w}{D_w} - RV - 100}$$

Where: D_b = Body density (gm/cc)

W_a = Weight in air (kg)

W_w = Weight in water (kg)

D_w = Density of water (gm/cc)

RV = Residual volume in (L)

100 = Estimate of GI gas (ml)

When body density has been determined, percent body fat may be calculated. There are a number of formulas that are believed to determine body fat percent. However, the two most commonly used are from Siri (1961) and Brozek, Grande, Anderson, and Keys (1963):

$$\text{Siri:} \quad \% \text{ fat} = \frac{(4.95 - 4.5)}{D_b} \times 100$$

$$\text{Brozek:} \quad \% \text{ fat} = \frac{(4.570 - 4.142)}{D_b} \times 100$$

Summary

Body composition is made up of lean body mass and body fat. Hydrostatic weighing at residual volume is accepted as the most accurate method of determining body composition. Studies have shown that aerobic exercise including aerobic dance may effect both lean body mass and body fat. The significance of these changes are dependent upon the subjects' initial fitness level and the frequency, intensity, and duration of the training program. It has been shown that obese subjects tend to lose significantly more fat than normal weight subjects.

A form of aerobic dance that has been recently developed is step aerobics. Step aerobics involves performing rhythmic dance movements while stepping up and down from a bench step to the accompaniment of music. No published studies are currently available on step aerobic training and its effect on body composition. Studies have been completed on aerobic dance without the step, in which subjects have lost a significant amount of body fat. Additional research is needed to determine the physiological effects of aerobic step training.

CHAPTER III

METHODS AND PROCEDURES

Introduction

This chapter presents the methods and procedures used in the present study. The chapter is divided into the following sections: subject selection, instrumentation, testing procedures, and statistical analyses.

Subject Selection

Experimental Group

The subjects in the experimental group were students enrolled in the University of Wisconsin-La Crosse, 1991 Fall Intramural step aerobics class. The subjects were nonsmoking, apparently healthy women between the ages of 18 and 25 years.

Volunteers for the experimental group were obtained during the Intramural registration, where this investigator was present to solicit all participants. Each volunteer completed a Health History/Current Lifestyle form at this time (see Appendix A). Those volunteers determined to be apparently healthy (ACSM, 1991), were then scheduled for a practice session.

Control Group

The subjects in the control group were college-aged volunteers from the University of Wisconsin-La Crosse. These subjects were similar to the experimental group in anthropometric characteristics, activity level, and age. Signs were posted around the University campus to attract volunteers who fit the subject criteria and wished to be tested for VO_2max and body composition. As a means of screening the control subjects, each volunteer completed the Health History/Current Lifestyle form. As an incentive, an appropriate exercise program was developed for each control group volunteer, based on their posttest results.

Instrumentation

The following instruments were used in the collection of data:

Anthropometer - a Novel Products, Inc. (nd), anthropometer was used to measure the height of each subject while standing barefoot.

Health-O-Meter Scale - a Health-O-Meter scale - Model #200 (Continental Scale Corporation, 1987) was used to dry land weigh each subject to the nearest 0.25 lb. Subjects were clad only in a swimsuit.

Tape Measure - an Ohause brand tape measurer was used to obtain maximal buttocks, thigh and calf girths.

Residual Volume Determination - a closed circuit oxygen dilution technique was used to measure RV. The percentage of nitrogen in the system was determined using an electronic nitrogen analyzer (Med-Science Model #505 Nitralyzer) (Med-Science Electronics, Inc., nd). An Omega chart recorder - Model #585 (Omega Engineering, nd) was connected to the nitrogen analyzer to provide a graphic recording of all nitrogen values recorded during the test. A 6 L spirometer was used to measure the volume of oxygen which was transferred to a 6 L rebreathing bag.

Hydrostatic Weighing Apparatus - a 4'x4'x4' S.S. Hydrotesting Tank - Model #09771 (S.S. Hydrotesting Tank, nd) was used in the determination of body composition. Hydrostatic weight was determined with the use of an immersed, stainless steel chair weighted with lead shot. The chair was suspended from three electronic Omega load-cells - Model LCJ-200 (Omega Engineering, nd) which were connected to a computer system using a software program developed by the head laboratory technician at the University of Wisconsin-La Crosse Human Performance Laboratory.

Testing Procedures

All testing took place in the Human Performance Laboratory at University of Wisconsin-La Crosse. A practice session was held prior to testing, where subjects were familiarized with the Human Performance Laboratory and testing procedures. At this time, subjects who agreed to be in the study signed the informed consent document (see Appendix B).

Anthropometric measurements, residual volume, and hydrostatic weighing took place the week prior to and immediately following the 10-week training study. This investigator administered all tests for the present study. A joint study measuring the VO_2max of the same subjects was completed concurrently.

Anthropometric Measurements

Subjects were barefoot and clad only in a swimsuit when their height and weight were taken on the Anthropometer and Health-O-Meter scale, respectively. All measurements were rounded to the nearest 0.25 pound and inch. An Ohause tape measure was then used to obtain maximal girth measurements on the buttocks, thigh, and calf. All measurements were rounded to the nearest 0.1 cm. The buttocks was measured with the investigator facing the right hip of the subject. The tape measure was placed around the buttocks, parallel to the floor, at the height of the greater trochanter. The circumference of the right thigh was taken at its maximum point. The distance in centimeters above the superior aspect of the patella was measured and recorded, so that the posttesting measurement would take place at the same point. The circumference of the right calf was taken at its maximum point, and the distance in centimeters below the superior aspect of the patella was also recorded for use during posttesting.

Residual Volume

Prior to RV determination, subjects showered to remove all excess dirt and oil from their skin and hair. Residual volume was then determined while the subject was seated on the scale inside the immersion tank. A 6 L spirometer was filled with pure oxygen by a dispensing valve. This oxygen was flushed through a rebreathing bag to remove any excess nitrogen. The flushing of the rebreathing bag was completed twice. The 6 L spirometer was then filled again with pure oxygen and this volume was transferred to the nitrogen free rebreathing bag. Wearing a nose clip, the subject would breath normally through a disposable mouthpiece attached to the nitralyzer which was then calibrated to room air. The subject took a full inhalation and exhaled through this mouthpiece as forcefully and completely as possible. When exhalation was completed, the subject signaled the investigator by raising one finger. The investigator then connected the mouthpiece to the rebreather and instructed the subject to continue inhaling and exhaling deeply and rapidly, until a nitrogen equilibrium was reached between the rebreathing bag and the subject's lungs. Equilibrium is assumed when the nitrogen reading between inspiratory and expiratory phases reach a minimum on the graph printout. Repeated measures of RV were taken until two readings came within 10% of each other. The average of these two readings was then considered the subject's RV.

Hydrostatic Weighing

Subjects were hydrostatically weighed to determine their body density. Each subject had abstained from food and drink for at least 4 hours prior to testing.

After the RV had been determined, the subject knelt in the tank and remained motionless. When the water became still, the steel chair was calibrated to 0.0 and 4.0 kg. The subject returned to the chair with a nose clip in place and attempted to rid the skin and swimsuit of air bubbles. Just before submerging, the subject began to forcefully expire as much air as possible. The subject then slowly submerged below the surface, still exhaling. While underwater, the subject raised one finger to signal the investigator that they had exhaled as much air as possible. The investigator then obtained the underwater weight from the computer interfaced to the electronic Omega load cells and quickly signaled the subject to surface. This procedure was repeated for a minimum of six trials and continued until a plateau in scale weight was evidenced (Katch, 1969).

The formula used to determine body density was:

$$D_b = \frac{W_a}{\frac{W_a - W_w}{D_w} - RV - 100}$$

Where: D_b = Body Density (gm/cc)

W_a = Weight in air (kg)

D_w = Density of water (gm/cc)

RV = Residual Volume (L)

100 = Estimate of GI gas (ml)

Percent fat was calculated using the formula developed by Siri (1961):

$$\% \text{ fat} = \frac{(4.95 - 4.5)}{D_b} \times 100$$

Step Aerobic Training

The duration of the step aerobic training study was 10 weeks, meeting 3 days per week, for a total of 30 training sessions. Each session was 60 minutes in length, consisting of a 10 minute warm-up, 30 minutes of step aerobic training, 15 minutes of floor work, and a 5 minute cool-down. These classes met during the 1991 Fall Semester on Mondays, Wednesdays, and Fridays from 6:45 to 7:45 A.M. Classes were held in the Mitchell Hall dance studio at the University of Wisconsin-La Crosse.

The importance of attending every class was stressed to each subject, and elimination from the study took place when attendance dropped below 90% (27 of 30 classes). Each subject was prescribed a training heart rate (THR) of 70-85% of their maximal heart rate as determined from the treadmill VO_2max test. Prior to training, subjects were taught how to monitor their resting and exercise heart rates using a 10 second count. Each subject was required to maintain their THR during the step aerobic portion of each training session. This was accomplished by altering the step height and degree of arm movements.

Posttesting

Forty-six subjects reported for posttesting procedures which were identical to the pretesting procedures. Anthropometric measurements, residual volume, and hydrostatic weighing took place within 3 days following completion of the step aerobic training program.

Statistical Analyses

Standard descriptive statistics were applied to all data. Paired t-tests were used to determine within group changes from pre to posttesting. A two-way analysis of variance (ANOVA) with repeated measures was used to determine if any significant changes occurred between the control and experimental groups as a result of the training program. The .05 level of confidence was used for all analyses.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

This study was a joint project looking at the effects of a 10-week step aerobic training program on the cardiorespiratory fitness and body composition of college-aged women. This portion of the project looked at changes in body weight, body composition, and girth measurements. Presented in this chapter are descriptive characteristics of the subjects, results of the training study, and a discussion of the results as related to previous literature.

Descriptive Characteristics

Sixty-one healthy, college-aged females between the ages 18 and 25 years served as subjects in the present study. The experimental group subjects were volunteers recruited from a University of Wisconsin-La Crosse Intramural step aerobic class during the Fall Semester, 1991. Control subjects were volunteers who were enrolled at the University of Wisconsin-La Crosse for the Fall Semester, 1991.

Of the 61 subjects, only 46 subjects (28 control and 18 experimental) were included in the final analyses. Seven control subjects failed to complete the posttesting and eight experimental subjects were eliminated from the study due to their attendance dropping below the required 27 out of 30 sessions. Descriptive characteristics of the subjects who completed the study are presented in Table 1. There were no significant ($p > .05$) differences between groups in age, height, weight, body fat, or VO_2max (ml/kg/min) prior to the 10-week training period.

The step aerobic class met three times per week for 10 consecutive weeks. Average attendance was 27 out of a possible 30 sessions (90%). The aerobic portion of each 60 minute class lasted 30 minutes. The average heart rate maintained during this time was 150 beats per minute which corresponded to 76% of the subjects' average maximal heart rate. Training was prescribed to be maintained at 70-85% of maximal heart rate (ACSM, 1991).

Table 1. Descriptive characteristics of the subjects (N = 46)

Variable	Control (n = 28)	Experimental (n = 18)
Age	19.6 ± 2.02	19.6 ± 1.77
Height (cm)	66.3 ± 2.19	65.1 ± 2.72
Weight (lbs)	132.5 ± 14.57	135.4 ± 16.84
Body fat (%)	22.45 ± 4.788	25.63 ± 5.145
VO_2max (ml/kg/min)	51.5 ± 6.38	48.6 ± 5.64

Note. All values represent mean ± standard deviation

Results of the Training Study

A two-way ANOVA with repeated measures was used to determine significant differences between the control and experimental groups from pre- to posttesting for body weight, maximal buttocks girth, maximal thigh girth, maximal calf girth, body density, fat weight, LBM, and body fat. Paired t-tests were used to assess within group differences from pre- to posttesting for the same variables. Results from the analyses are presented in Table 2.

Maximal Girth Measurements

The only significant ($p < .05$) difference for girth measurements between the control and experimental groups was for maximal thigh girth. The experimental group had a 1.0 cm decrease ($p < .05$) while the control group had a 0.20 cm increase ($p > .05$) for maximal thigh girth. No significant ($p > .05$) within or between group differences were found for maximal buttocks girth or maximal calf girth.

Residual Volume

Posttest RV measures were found to significantly ($p < .05$) increase from pretest RV measures (.85 to .96 L). This investigator attributes the uncharacteristic increase in RV to mechanical errors occurring between pre- and posttesting. Therefore, initial RV measures for each subject were used in the determination of pre- and posttesting body density.

Body Composition

No significant ($p > .05$) difference was found between groups for change in total body weight. However, the control group evidenced a significant ($p < .05$) increase in body weight from pre- to posttesting of 2.25 lbs. Both the experimental group and the control group had significant ($p < .05$) increases in LBM of 1.51 lbs and 1.02 lbs, respectively. However, there was no significant ($p > .05$) difference between the two groups for changes in LBM.

Table 2. Results of the training study for the control group (n = 28) and the experimental group (n = 18)

Variable	Pretesting (x ± SD)	Posttesting (x ± SD)	Change (%)
Weight (lbs)			
control	132.50 ± 14.569	134.75 ± 15.056*	2.25 (1.7)
experimental	135.50 ± 16.836	136.25 ± 16.526	0.75 (0.6)
Buttocks (cm)			
control	95.10 ± 5.251	95.80 ± 5.608	0.70 (0.7)
experimental	97.70 ± 6.970	97.20 ± 6.195	-0.50 (0.5)
Thigh (cm)			
control	57.00 ± 3.726	57.20 ± 3.468	0.20 (0.4)
experimental	58.70 ± 4.113	57.70 ± 3.626*	-1.00 (1.7)$
Calf (cm)			
control	34.70 ± 2.038	34.90 ± 1.761	0.20 (0.6)
experimental	36.10 ± 2.194	36.00 ± 1.954	-0.10 (0.3)
LBM (lbs)			
control	102.33 ± 8.688	103.35 ± 8.399*	1.02 (.01)
experimental	100.27 ± 10.952	101.78 ± 10.610*	1.51 (.02)
Fat weight (lbs)			
control	30.15 ± 9.123	30.93 ± 10.387	0.78 (.03)
experimental	35.11 ± 9.974	34.40 ± 8.547	-0.71 (.02)
Body density (gm/cc)			
control	1.0479 ± 0.01060	1.0474 ± 0.01154	-0.0005 (.05)
experimental	1.0409 ± 0.01118	1.0422 ± 0.00918	0.0013 (.13)
Body fat (%)			
control	22.45 ± 4.788	26.65 ± 5.241	0.20 (0.9)
experimental	25.63 ± 5.145	25.01 ± 4.202	-0.62 (2.4)

* = Significant change within group from pre- to posttesting (p < .05)

$ = Change is significantly different than that of the control group (p < .05)

There were no significant ($p > .05$) changes within or between groups for fat weight, body density, or body fat as a result of the study. However, there was a trend for the experimental group to have favorable changes in fat weight (-0.71 lbs), and body fat (-.62%).

<u>Test of Hypotheses</u>

Based on the results of this study, the following null hypotheses were accepted or rejected:

1. There was no significant difference in the changes in lean body mass exhibited by the experimental and control groups over the course of the 10-week study period, thus the null hypothesis was accepted for this variable.
2. There was no significant difference in the changes in fat weight exhibited by the experimental and control groups over the course of the 10-week study period, thus the null hypothesis was accepted for this variable.
3. There was no significant difference in the changes in percent body fat exhibited by the experimental and control groups over the 10-week study period, thus the null hypothesis was accepted for this variable.
4. There was no significant difference in the changes in maximal calf girth exhibited by the experimental and control groups over the course of the 10-week study period, thus the null hypothesis was accepted for this variable.
5. There was a significant difference in the changes in maximal thigh girth exhibited by the experimental and control groups over the

course of the 10-week study period, thus the null hypothesis was rejected for this variable.

6. There was no significant difference in the changes in maximal buttocks girth exhibited by the experimental and control groups over the 10-week study period, thus the null hypothesis was accepted for this variable.

Discussion

Upon examining the statistical analyses, the only significant between groups difference was for maximum thigh girth. The experimental group showed a decrease in maximal thigh girth that was significantly different from the control group.

Body weight in the control group increased from pre- to posttesting as did LBM for both the control and experimental groups. However, there were no significant differences between groups for these variables. There were no other within or between group changes for maximal buttocks girth, maximal calf girth, fat weight, body density, or body fat as a result of this study.

The literature indicates that changes in body composition are directly related to the subjects' initial fitness level and the frequency, intensity, and duration of the training program.

Initial Fitness Level

The lack of change in body composition may be due in part to the initial body weight and percent body fat of the subjects. The mean body weight and body fat of the 46 subjects in the present study was 134 lbs and 23.73%, respectively, which falls into the normal range for college-aged women (Behnke & Wilmore, 1974). It has been previously shown that changes in body composition with aerobic exercise vary greatly depending upon initial fitness level (Fox et al., 1989; Katch et al., 1969; Pollock & Wilmore, 1990).

Results of this study are in agreement with those of previous studies which found no significant changes in body fat after aerobic training programs (Moody et al., 1972; Smith & Stransky, 1976; Stransky et al., 1979; Tomassoni et al., 1985; Vaccaro & Clinton, 1981; Wallace, 1975). Moody et al. (1972) found that after a 15-week jogging program on "normal" weight subjects, body fat nonsignificantly decreased from 24.2 to 23.24%. Smith and Stransky (1976) and Stransky et al. (1979) found that after 7 weeks of bicycle ergometer and swim training, body fat changed nonsignificantly from 21.4 to 21.1% and 21.9 to 19.8%, respectively. Wallace (1975) studied relatively lean women whose mean initial body fat was 21.41%. After a 4-month running program, body fat decreased to only 20.05%. Vaccaro and Clinton (1981) studied women whose mean initial body fat was 26.57%. Following a 10-week aerobic dance program, there was no significant change in body fat (26.57 to 26.20%). Tomassoni et al. (1985) also found no significant change in body fat in sedentary but lean women after an 8-week rebound training program. Initially the subjects' mean body fat was 21.01%; the posttesting mean was 21.07%.

It should be noted that female subjects within the optimal range for body fat (20 to 27%) who do not follow strict dietary control during training will fail to significantly change body composition (Katch et al., 1969). The subjects in the present study already had body fat values (23.73%) which would be considered within the ideal range for their age.

Most studies that have shown training to decrease body fat have used either sedentary and/or obese subjects. The following studies investigated the effects of aerobic training on sedentary and/or obese subjects and found significant decreases in body fat ranging from 0.74 to 10.1%: Johnson et al. (1984), Lieber et al. (1989), McCord et al. (1989), Milesis et al. (1976), Moody et al. (1969), Moody et al. (1972), and Wallace (1975). Moody et al. (1969) observed a significant decrease in body fat (10.1%) for obese subjects participating in a walk/run program of 8 weeks. Wallace (1975) found a 16-week running program for sedentary women to decrease body fat (5.5%) and McCord et al. (1989) also found a significant decrease in body fat (3.9%) for sedentary subjects after a 12-week aerobic dance program.

Total Energy Expenditure of a Training Program

The total energy expenditure of a training program is of critical importance to body fat reduction. In programs where fat loss is desired, a given amount of energy (3,500 kilocalories for each pound of fat) must be expended. Individuals who wish to lose body fat are usually advised to expend 300 to 500 kilocalories per exercise session. If food intake remains constant, it is then possible to lose a pound of fat within 7 to 12 exercise sessions (Pollock & Wilmore, 1990).

Subjects in the present study averaged an exercise intensity of 76% of maximal heart rate for 30 minutes. The average energy expenditure was estimated to be 368.4 kilocalories per session. This estimation is based upon data from Howley and Glover (1974), where women weighing

133.75 lbs (average for present study) expend 368.4 kilocalories while running 3.5 miles. Energy expended running this distance has been found to be similar to energy expended in 30 minutes of step aerobics (Reebok Intl. Ltd., 1990).

Subjects in the present study attended an average of 27 sessions. The total energy expended for the entire study should have equaled 9,936 kilocalories (27 X 368.4), which without diet modification would result in a 2.83 lbs fat loss. However, a fat loss of only .71 lbs was observed. It is common for women to gain weight during their freshman year in college, in part due to a change in diet. The majority of subjects in the present study were freshman, and diet was not controlled. This may account for the nonsignificant fat loss observed in the experimental subjects.

Duration of the Training Program

The duration of an exercise program is also of critical importance to the total energy expenditure and total body fat reduction. Of nine studies that found decreases in body fat, six had training program durations longer than the present study (Johnson et al., 1984; Lieber et al., 1989; McCord et al., 1989; Milesis et al., 1976; Moody et al., 1972; Wallace, 1975). With a longer training program it is logical that energy expenditure and fat losses would be greater.

The present study found no significant difference between groups for change in LBM. Lieber et al. (1989), Moody et al. (1969), Moody et al. (1972), and Smith and Stransky (1976) all found significant increases in LBM following aerobic training programs. The magnitude of these changes were 1.31, 2.9, 1.13, and 1.1 kg, respectively. However, both the control and experimental subjects in the present study evidenced significant increases in LBM within their respective group.

The present study found no significant change in buttocks girth or calf girth, but did however, find a significant change in thigh girth after the 10-week training. The experimental group showed a significant decrease in thigh girth while the control group showed a nonsignificant increase in thigh girth from pre to posttesting. The magnitude of these changes, only -1.0 cm for the experimental group, and +0.20 cm for the control group, are of no real practical significance. A longer training period may be necessary to achieve significant changes in girth measurements.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The primary purpose of this training study was to determine the effects of a 10-week step aerobic program on the body composition of college-aged women. Forty-six apparently healthy females (18 experimental and 28 control) between the ages of 18 and 25 years successfully completed the present study. Immediately prior to and upon completion of the 10-week step aerobic training, each subject was measured for maximal buttocks, thigh, and calf girths, followed by hydrostatic weighing at residual volume. The variables analyzed in the present study included body weight, maximal buttocks girth, maximal thigh girth, maximal calf girth, residual volume, LBM, fat weight, body density, and percent body fat.

No significant between group changes were evidenced for body weight, maximal buttocks girth, maximal calf girth, LBM, fat weight, body density, or body fat. However, maximal thigh girth in the experimental group decreased significantly compared to the control group. Within group analyses showed a significant increase in body weight for the control group, as well as significant increases in LBM for both the control and experimental groups. However, there were no significant differences between the two groups for these variables.

Conclusions

Based on the results of this study, the following conclusions were reached:

1. A 10-week step aerobic training program will not effect the body composition of college-aged females who have normal body composition for their age.
2. A 10-week step aerobic training program will decrease maximal thigh girth in college-aged females.

Recommendations

Based upon the results of this study it is recommended that future studies:

1. Investigate the effects of step aerobic training using subjects who have a higher percent body fat.
2. Investigate the effects of step aerobic training in an older population.
3. Investigate the effects of a step aerobic training program of longer duration.

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APPENDIX A

HEALTH HISTORY/CURRENT LIFESTYLE FORM

HEALTH HISTORY/CURRENT LIFESTYLE FORM
Step Aerobic Training Study

NAME ______________________ S.S ____________ DATE ______
(Please Print)
ADDRESS ______________________ CITY/STATE ______________
PHONE ______________ AGE ______ BIRTH DATE ____________
HEIGHT ________ WEIGHT _______
IN CASE OF EMERGENCY, PLEASE CONTACT ______________________

PHONE ______________________

Check if you have or have had the following:
_____ Family history of coronary or other atherosclerotic disease in self, parents or siblings prior to age 55.
_____ Shortness of breath
_____ Chest Pain
_____ Blood Pressure ≥ 140/90 mm Hg
_____ Heart arrhythmias
_____ Diabetes Mellitus
_____ High Cholesterol≥240 mg/dl

_____ Asthma
_____ Seizures
_____ Bone or joint injury
Explain ______________________
____
_____ Dizzy Spells
_____ Coughing up blood
_____ Hospitalization
Explain ______________________
____

DO YOU CURRENTLY SMOKE? ___ Yes ___ No

PHYSICAL ACTIVITY

I participate in the following activities:
____ None ____ Walking ____ Running ____ Biking ____ Swimming
____ Strength Training ____ Aerobic Dance

How long do you exercise for?
____ None ____ 15 minutes or less ____ 16-30 minutes ____ 31-45 min
____ 46-60 minutes ____ More than 60 minutes

How many days per week?
____ None ____ One ____ Two ____ Three ____ Four ____ Five
____ Six ____ Seven

Do you experience any discomforts (shortness of breath, dizziness or pain) with exercise? ___ Yes ___ No
If yes, please explain: ______________________________
____

I hereby certify that all the above statements provided by me in this form are complete and true to the best of my knowledge.

Signature ______________________ Date ______________

Witness ______________________ Date ______________

APPENDIX B

INFORMED CONSENT

INFORMED CONSENT
University of Wisconsin-La Crosse

Project Title: The effects of a 10-week step aerobic training program on VO_2max and body composition of college-aged women.

Principle Investigators: John P. Porcari, Ph. D., Constance Chapek and Elizabeth Huntley

Subject name: ______________________________

You are invited to participate in this research study which will evaluate the physiological effects of a step aerobic training program. This study is open to females between the ages of 18 and 25 who meet the following criteria: 1) have no cardiovascular or orthopedic problems, 2) are on no medications which affect heart rate or blood pressure responses to exercise, 3) are non-smoking individuals, 4) are willing to complete testing procedures before and after the step aerobics training.

The training program will be 10 weeks in duration beginning September 4th, 1991 and ending November 14th, 1991. If you agree to participate in the step aerobic training group, you are required to attend each session; Mondays, Wednesdays, Fridays, 6:45-7:45 AM. Subjects missing more than three classes will be eliminated from the study. Your test results will remain confidential between yourself and the three investigators.

In conjuncture with the UW-L Intramural step aerobic class I, ________________________ have volunteered to be a subject in this step aerobic training study conducted by Constance Chapek and Elizabeth Huntley. I understand that the benefits of participating in this research study include a free fitness evaluation and exercise prescription. I understand that participation in the **experimental group** involves regular attendance to the training program as well as undergoing the testing procedures prior to and upon completion of the training study. I also agree to work at the specified intensity indicated by my prescribed training heart rate. If I am a subject in the **control group**, I will be required to undergo testing procedures scheduled prior to and upon completion of the study.

I understand that I will have my body fat assessed by hydrostatic weighing and my maximal oxygen consumption (VO_2max) measured by a maximal treadmill test. I further understand the hydrostatic weighing procedure consists of being briefly submerged underwater with the option of my surfacing at any time. Potential risks include infection, accident, and possible drowning. I understand that the treadmill test consists of running to voluntary exhaustion on a motor driven treadmill. The initial speed of the treadmill will remain at a self-selected pace with an initial elevation of 0%; the grade will then increase 2.5% every 2 minutes until I reach exhaustion. Oxygen consumption will be monitored through the use of a Quinton Q-Plex metabolic cart. This will involve breathing through a mouthpiece so that expired air can be collected and measured.

As with any exercise, the possibility of adverse reactions exist, such as dizziness, shortness of breath, leg fatigue, chest pain, and even sudden death. I will feel tired at the end of the test. If any abnormal observations are noted, the test will be terminated immediately. I am free to stop any of the tests, or withdraw from the study at any time.

In addition, I agree not to modify my current diet or exercise habits for the duration of the study, other than for the training if I am so involved.

I, ______________________________, being of sound mind and body at the age of ________, do hereby consent to, authorize and request the persons named above (and co-workers, agents, and employees) to undertake and perform on me the proposed procedure, treatment, research or investigation (herein called "Procedure"). To the best of my knowledge I am not infected with a contagious disease or have any limiting physical condition or disability, especially with respect to my heart that would preclude my participation in the exercise testing or training. I have read the above document and I have been fully advised of the nature of the Procedure and the possible risks and complications involved, all of which risks and complications, I hereby assume voluntarily. I hereby acknowledge no representations, warranties, guarantees or assurances of any kind pertaining to the Procedure have been made to me by the University of Wisconsin-La Crosse, the officers, the administration, employees or by anyone acting on their behalf. I understand that I may withdraw from the study at anytime.

Signed at ______________________________, this ______________ day of ______________, 1991, in the presence of the witnesses whose signatures appear below opposite my signature.

Witnessed by:

______________________________ ______________________________

____

APPENDIX C

TESTING PREPARATION FORM

TESTING PREPARATION FORM

Hydrostatic Weighing and Treadmill Test Information

1. Please bring shorts, t-shirt, gym shoes, swimsuit, and towel.
2. Please abstain from food, caffeinated beverages, drugs, alchohol, and tobacco for at least 4 hours before testing.
3. Please do not engage in heavy exercise for 24 hours prior to testing.
4. Testing location: UW-L Human Performance Lab
   225 Mitchell Hall
   (2nd floor on southeast side
   of the building).

NAME ______________________________

Your Underwater Weighing and Treadmill Testing time has been scheduled for
_______________ at ____________AM / PM.

PLEASE keep this appointment. Testing must be completed this week. Your promptness is appreciated. If there is a conflict, please feel free to call Connie or Lisa at home, or leave a message at the lab.

Connie - 785-7105
Lisa - 782-7031
Lab - 785-8685

APPENDIX D

BODY COMPOSITION DATA SHEET

BODY COMPOSITION DATA SHEET
THESIS STUDY
LISA HUNTLEY

Subject Name ______________________ age ________
Control/Experimental
Pretest/Posttest

ANTHROPOMETRY - Subject in swimsuit

Height:________inches Weight:_______lbs.

Girth Measurements - maximum circumference

max buttocks:_________cm

max thigh:___________cm [________cm above superior aspect of patella]

max calf:____________cm [________cm below superior aspect of patella]

Vital lung capacity: #1_______ #2________ #3_________ liters(.1)
subject shower

RESIDUAL VOLUME	TEST 1	TEST 2	TEST 3	TEST 4
Bag Volume O_2 (BV):	______	______	______	______
Alveolar Nitro (AN):	______	______	______	______
Impurity Nitro (IN):	______	______	______	______
Equilibrium N (EN):	______	______	______	______
Final Nitrogen (FN):	______	______	______	______
RESIDUAL VOLUME:	______	______	______	______

AVERAGE RV= __________L

HYDROSTATIC DENSIOMETRY:

Trials #1 _______kg #2 _______kg #3 _______kg #4 _______kg

#5 _______kg #6 _______kg #7 _______kg #8 _______kg

#9________kg #10________kg

AVERAGE KG=________kg (to .01)

PERCENT FAT: