A COMPARATIVE INVESTIGATION OF TWO TRAINING MODES IN ALTERING CARDIORESPIRATORY AND BODY COMPOSITION PARAMETERS IN WOMEN

by

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26 Sept 1979
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To my parents, Helen and Daniel Conti, who have been continually supportive of my educational goals.

And to Carolynn, whose love has sustained me throughout this endeavor.

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ABSTRACT

This study compared the alterations in cardiorespiratory fitness and body composition consequent to a jogging program and a Nautilus circuit weight training program. Twenty-five college females participated in the study. A CWT group (n=7) and a jogging group (n=9) underwent a 10 week program of training, 30 min/day, 3 days/week, at an intensity of 75 percent of Karvonen's THR formula.

Significant pre to post test changes were noted for both training groups in treadmill performance time and absolute and relative $\dot{V}O_2max$. The magnitude of change was greater for the jogging group. Between-group differences were noted for absolute and relative $\dot{V}O_2max$ values as the jogging group was significantly different from the control group (n=9) at the termination of training. There was no significant difference in the changes between the jogging and CWT groups. No significant changes changes in body composition were noted for the two training groups. It was concluded that CWT contributes to the development of cardiorespiratory health and is an efficient conditioning activity for altering strength and endurance time to exhaustion.

CHAPTER 1

INTRODUCTION

In a recent review published by the President's Council on Physical Fitness and Sports (14), the majority of reported studies investigating the relationship between physical activity and the incidence of coronary heart disease (CHD) support the theory that physical inactivity is associated with an increased risk for the premature development of CHD. The evidence presented in this review indicated a need to develop and sustain an appropriate level of physical activity as a lifestyle for maintaining a sound cardiovascular system.

Along with its association with CHD, physical inactivity has been proposed as a cause for a deficiency state comparable to avitaminosis and a whole spectrum of inactivity induced somatic and mental derangements. Kraus and Raab (52) have termed these diseases which are directly a result of physical inactivity, "hypokinetic disease". The thesis then evolves that physical activity, with an emphasis on cardiorespiratory endurance training, is a prerequisite for healthful living and necessary for a decreased tendency towards CHD (14, 15, 31, 61, 70).

Increasing numbers of people have become interested in physical activity and endurance training as a means to improve the quality of their lives. However, a major problem which must be resolved relates to the high drop-out rate among participants (49). One possible means of overcoming this problem and encouraging continued pursuit of lifetime activity is to provide a wide variety of training programs from which to choose. Thus, it becomes imperative for the practitioner and professional to be able to identify and develop appropriate conditioning activities or programs that provide a means for gaining improvement in cardiorespiratory fitness and optimal body composition.

The most frequently used endurance training program for the development of improved levels of cardiorespiratory fitness and body composition has been jogging (4, 7, 9, 59, 60, 72, 81). Some of the inherent drawbacks in a jogging program have been lack of motivation due to initial disinterest or eventual boredom and the potential orthopedic complications (77). With the proliferation of new health clubs and with most of these being equipped with the latest in resistive weight training devices, another viable training mode to be considered is circuit weight training (CWT) (33, 34, 103).

The primary purpose of this study was to evaluate and compare the alterations in cardiorespiratory fitness and body composition between a jogging program and a Nautilus circuit weight training (CWT) program.

CHAPTER 2

REVIEW OF THE LITERATURE

This review chapter will concern itself with the effects on cardiorespiratory and body composition parameters that are associated with endurance training. First, what adaptations can we expect in the cardiorespiratory system and in body composition consequent to a training program. Second, in what way do we quantify endurance training programs. Third, a look at mode of training as the variable under investigation. Fourth, a review of studies involving women subjects to determine if there are any differences in the effects of training compared with men.

General Adaptations with Training

Cardiorespiratory Alterations

Maximal oxygen uptake ($\dot{V}O_2max$) has received wide acceptance as the primary determinant of cardiorespiratory endurance capacity (28, 56, 83, 84, 89, 100). Investigations have shown improvements in $\dot{V}O_2max$ subsequent to various cardiorespiratory endurance training programs[1], i.e., significant increases in $\dot{V}O_2max$ have been established (7, 20, 32, 36, 43, 51, 63, 64, 66, 69, 75, 80). Data on ventilation at maximum

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1. Cardiorespiratory endurance training has been defined as a mode of exercise involving large muscle masses and is performed continuously for a sufficient duration and intensity to stimulate the cardiopulmonary systems (72).

workload has shown that maximum ventilation ($\dot{V}_E$max) will generally improve 10 to 20 percent as a result of endurance programs of at least 6 weeks duration and with varied training protocols (27, 28, 74, 75, 78, 85). Some studies have shown no significant change in $\dot{V}_E$max with training, even with substantial increases in $\dot{V}O_2$max (69, 104). A reduction in heart rate at maximum workload (HR max) has been evident in studies where the initial levels are above 180 beats/min (27, 28, 69, 75, 85). Initial HR max values lower than 180 beats/min either remained unchanged or increased slightly (78, 92, 104). Some additional cardiorespiratory alterations associated with endurance training include decreased resting heart rate, increased oxygen pulse, increased blood volume, increased cardiac output and stroke volume at maximal workloads, and decreased lactic acid production at standardized submaximal workloads (2, 38, 72).

Body Composition Alterations

Relative percent of body fat has been shown to decrease due to an increase in body density consequent to an increase in lean body weight (LBW) or a decrease in body fat weight (FW) or a combination of both, directly as a result of endurance training (54, 68, 72). Decreases in body weight and relative fat are related to the increased energy expenditure of the endurance training program (9, 59, 60, 64, 69, 75, 78, 80, 99, 104). Changes are therefore related to the length and the intensity of the training program. Carter and Phillips (12) found consistent and continual body weight and relative fat changes during the first year of a two year study.

Exercise Prescription

To adequately quantify endurance training programs there has to be a standardization in the methodology of the training program. The exercise prescription has been the basic means of quantifying the endurance training program (72). The components of the exercise prescription are: 1) intensity of the exercise, 2) duration of each training session, 3) frequency or number of sessions per week, and 4) the mode of training.

The exercise prescription must consider the individual's initial level of fitness, the "optimal" level of fitness to be obtained, the interests and desires of the trainee, and the facilities available to the trainee. The four components of the exercise prescription are then determined to establish an "optimal" training stimulus for the trainee. As an example, the intensity, duration, and frequency components of a cardiorespiratory endurance training program for the athlete would be far more extreme, i.e., have higher values of intensity, duration, and frequency, than for the non-athlete due to a higher initial level of fitness of the athlete. While the non-athlete may not be able to train at the same extremes of time and energy as the athlete, the non-athlete still has the motivation and desire to enhance his/her physical fitness. Therefore it is important to establish an "optimal" training stimulus for the improvement of cardiorespiratory fitness for each individual. In the following review of the individual components of the exercise prescription, the studies cited were conducted using jogging/running as the mode of exercise, except as noted.

Intensity

The quantification of training intensity has been approached by using a fixed percentage of maximal oxygen uptake ($\dot{V}O_2$max) or by using a fixed percentage of maximal heart rate. Both are equally acceptable as a means of quantifying training intensity since there is a linear relationship between heart rate and oxygen uptake (2, 22, 95). Intensity of training has been shown to be positively related to improvement in $\dot{V}O_2$max (21, 47, 50, 87, 88), i.e., the higher the intensity the greater the training effect. It is therefore necessary to determine the treshold level at which significant training effects will occur.

In a classic study by Karvonen, Kentala, and Mustala (47), the threshold level for training intensity was quantified. In this study young men exercising on a motor driven treadmill at a heart rate of less than 135 beats/min did not improve their $\dot{V}O_2$max. It was concluded that an intensity of at least 60 percent of the difference between resting and maximal heart rate added to the resting heart rate[2] was necessary to reach a significant training threshold. Hollman and Venrath (44) were in close agreement with Karvonen et al. (47) in their study of young men exercising on a bicycle ergometer. Åstrand and Rodahl (2) established a threshold training intensity of 50 percent of $\dot{V}O_2$max which is essentially in agreement with the HR criteria of Karvonen et al. (47), and Hollman and Venrath (44).

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2. Karvonen Formula: Training Heart Rate (THR) = [(HR max - HR rest) x 0.60] + HR rest

Shephard (88), in a study investigating training stimuli for improving cardiorespiratory fitness, concluded that intensity and duration were the most significant training stimuli. He further stated that the threshold of intensity had a wide range of variability for different groups dependent on initial level of fitness and age. Young, moderately active subjects would need a higher intensity of training to reach a threshold level while a lower intensity of training would provide a threshold level in less physically active populations and with sedentary, older groups.

Gledhill and Eynon (37) supported Shephard's findings concerning level of fitness and its relationship to the threshold for attaining a training response. In this study, the groups were subdivided into low and high fitness levels. The high fitness group showed no improvement in $\dot{V}O_2$max at training heart rates of 120 beats/min, while the low fitness group did improve.

Burke and Franks (8), using a 10 week, 3 day/week training session on bicycle ergometer, investigated the effects of intensities of 85, 75, and 65 percent of HR max while keeping the total workload constant. The data showed significant increases between the 85 percent group and the control group, and the 75 percent group and the control group. No significant differences were reported between the 65 percent group and the control group, or between the 85 percent and 75 percent groups.

Kearney et al. (48) trained sedentary college women 3 days/week for 9 weeks at training intensities of either 50 or 65 percent of Karvonen's formula (47) for training heart rate. Results revealed that both training intensities caused significant increases in $\dot{V}O_2max$, and for every dependent variable in which training effects were noted, the absolute gain made by the subjects training at the 65 percent intensity was greater than for those exercising at 50 percent. However, the differences were not statistically significant. The investigators concluded that training at either 50 or 65 percent of Karvonen's training heart rate formula (47) is sufficient to elicite a training response.

Marigold (53) trained college women at predetermined heart rates (125 and 145 beats/min) that were 47 and 63 percent of Karvonen's THR formula and concluded that an intensity of 125 beats/min provided sufficient stimulus to demonstrate training effects. This study is in conflict with earlier studies (2, 44, 47), but possibily can be attributed to the low initial fitness levels (mean $\dot{V}O_2max$ of 27 ml/kg·min) of the women tested.

In prescribing a training heart rate (THR) to establish an intensity that will provide a training stimulus for the development of the individual's cardiorespiratory fitness it is important to assess the trainee's initial level of fitness and actual HR max.

Duration

The duration of the training bout has also been positively related to the magnitude of response to training. Improvements in cardiorespiratory fitness have been reported in studies with durations as low as 5-10 minutes per day (88). Studies have shown more significant improvements in training response with increases in duration, keeping all other parameters constant (67, 96, 104).

A recent study by Milesis et al. (57) investigated the relative effects of training durations of 15, 30, and 45 minutes per day. A 20 week program, 3 days/week at a training intensity of 85 to 90 percent (Karvonen THR formula) showed improvements in $\dot{V}O_2$max and total skinfold fat that were directly proportional to the duration of training. The data showed significant improvements by all groups relative to the control group in relative fat, $\dot{V}O_2$max, $\dot{V}_2$max, and treadmill performance time. While the 45 min/day group improved significantly more then the 15 min/day group, there was no significant difference between the 45 and 30 min/day groups.

When prescribing exercise Pollock et al. (74) has shown the relationship between intensity and duration of training, i.e., decreases in duration can be compensated for with increases in intensity. Jogging for 45 min/day, 2 day/week at 80-90 percent of HR max (74) resulted in similar improvements to those reported in an earlier study (75) where the subjects were jogging 30 min/day, 2 day/week at 95 percent of HR max. Pollock, Ward, and Ayres reported in a later study (81) that a cardiorespiratory fitness maintenance program can be designed by decreasing intensity and increasing duration with the total energy cost remaining constant. Cureton (19), Pollock et al. (74), and Sharkey (86) suggest that the total amount of work accomplished is the important criterion for cardiorespiratory improvement.

Frequency

Frequency can be looked at in two ways; the number of training sessions per week for a limited number of weeks or the total number of training sessions. Hill (42), in an eight week period, trained two groups, one at 3 days/week and the second at 5 days/week. When re-evaluated at the end of the eight week period both groups had improved significantly in $\dot{V}O_2max$ but the 5 days/week group improved significantly more. The 3 days/week group continued to train another 5 weeks in order to equalize the total number of training sessions. When re-evaluated at this point the 3 days/week group's results were identical to those of the 5 days/week group.

Sidney, Eynon, and Cunningham (90), in a study with groups that trained one, two, or four days/week, found that when total work was held constant the 2 and 4 days/week groups had similar results, which supported Hill's (42) findings. However, the group training one day/week showed little improvement. Similar results have been reported in other studies (21, 46, 88).

In a study with low fitness subjects, Jackson, Sharkey, and Johnson (46) showed with both maximal and submaximal tests that training 2 or 3 days per week may be as beneficial as 5 days/week. It was noted that the 5 days/week regimen might have been too extreme for subjects with a low level of fitness leaving them partially fatigued during their testing session.

Fox et al. (30), studying the effects of a 2 days/week training program over 13 weeks and a 4 days/week program over a 7 week period, concluded that there was a significant increase in $\dot{V}O_2max$ that was independent of frequency.

Crews and Roberts (18) investigating the interaction of frequency and intensity used 6 training groups representing all possible combinations of 3 levels of frequency (1, 3, and 5 days/week) and 2 levels of intensity (heart rates of 120 and 150 beats/min). The results indicated a greater training effect for the 150 beats/min groups over the 120 beats/min groups, and the 3 and 5 days/week groups over the 1 day/week groups. The investigators concluded that there was no significant difference betwee the 3 and 5 day groups and no significant interaction effect for any of the dependent variables.

Gettman et al. (35) found significant improvements occuring in direct proportion to frequency of training in treadmill performance time, $\dot{V}O_2$max, and $\dot{V}_E$max in a study of 1, 3, and 5 day/week frequencies. They concluded that frequency of training is an important determinant in eliciting changes in cardiovascular and performance variables, and that these changes can be attributed to a greater total energy expenditure.

These findings suggest that there is greater improvement induced with increased frequency of training when the number of weeks is held constant. When the total number of training sessions is held constant, with the number of weeks as a variable, frequency is less important provided the subjects trained at least two times/week.

From the preceding review, it is important to realize that in prescribing exercise as a lifetime activity, the evaluation of frequency of training should be made in light of the total number of training sessions rather than the number of sessions per week. While holding duration and intensity constant, a better way of prescribing frequency is to look at the total energy cost on a month to month basis instead of on a per week basis. This gives more flexibility to the average worker and allows for changes in health, interest, and weather.

Mode of Training

As this study is a comparative mode study, where the exercise prescription components of intensity, duration, and frequency were held constant with the mode as the variable being examined, the review of this section will break down into sections on comparative mode studies and circuit weight training studies. Studies showing improvements in cardiorespiratory fitness (increased $\dot{V}O_2$max) have mainly used running as the mode of training and have been reported in detail (16, 19, 21, 36, 63, 64, 68, 74, 75, 82, 85, 96, 104) and will not be reviewed in this section.

Comparative Mode Studies. Corbin, Berryhill, and Olree (17) evaluated the modes of running, threadmill walking, and bicycle ergometry as to how they effected cardiorespiratory fitness and body composition. The subjects trained at an absolute HR of 150-160 beats/min, rather than at a relative HR based on a percentage of each individual's HR max which leads to speculation in the interpretation of the results. Each group trained 20 min/day, 5 day/week, for 10 weeks. The results suggested that there were greater improvements in cardiorespiratory fitness and body composition in the running and bicycling modes over the walking regimen.

Harper, Billings, and Matthews (39) compared three modes of training: 1) calisthenics and marching, 2) running interval training, and 3) recreational activities. Training intensity was not quantified which made it impossible to compare the different modes. Only the running group improved significantly in $\dot{V}O_2$max.

Roberts and Morgan (82) studied four modes of training (running, cycling, swimming, circuit training) to determine the effects of various frequencies and training modes on improving cardiorespiratory fitness. The subjects trained at an intensity of 85 percent of the group mean predicted HR max and at varing frequencies and durations. One running group ran 3 days/week and another running group 2 days/week, both on an indoor track, while a third running group ran on a treadmill 3 days/week. Both cycling groups performed 3 days/week, one group cycling cross-country while the other exercised on a bicycle ergometer. One swimming group swam 3 days/week, the other twice week. The circuit training group exercised three times a week. The number of minutes of actual activity engaged in by individual subjects varied considerably. At the conclusion of the study all groups had improved their physical working capacity with the running groups showing the only statistically significant improvements. Conclusions from this study would seem speculative for the following reasons: 1) estimated instead of actual HR max may cause errors in the establishment of a training heart rate, 2) non-random assignment of subjects to exercise groups, 3) observed mean training heart rates were not reported, and 4) variations in durations of the activities.

Pollock et al. (76), in a study of middle-aged men in three training modes (walking, jogging, and bicycle ergometry), found equally significant improvements in decreased relative fat and increased $\dot{V}O_2$max. Subjects trained for 30 min/day, 3 days/week, for 20 weeks at an intensity of 85 to 90 percent of HR max. They concluded that improvement in the experimental groups was independent of mode of training.

O'Brien (66) studied cross-country bicycling and jogging as different modes of altering cardiorespiratory fitness. Males with a mean age of 35 years exercised for 30 min/day, 3 days/week, for 20 weeks. Training intensity was individualized using the Karvonen formula for estimating training heart rate at 75 percent. Significant increases in $\dot{V}O_2$max were reported for both groups with no differences between the groups. It was concluded that both modes were equally as effective in the development of cardiorespiratory fitness.

Circuit Weight Training Studies. Weight training has significant value for increasing muscular strength and endurance (1, 11, 23, 34, 58, 62, 71, 99, 103). In weight training programs designed primarly for strength gains, the emphasis has been on the use of heavy resistance and low repetitions with long and frequent rest periods between exercise bouts. Recent investigations on the ability of weight training programs to improve cardiorespiratory endurance have designed the weight training program as a circuit (CWT) using low resistance and high repetitions with a minimum of rest between exercise bouts. These studies have reported conflicting results.

Peterson (71) conducted a study on weight training, using Nautilus equipment, 3 days/week for 8 weeks with a duration of 23.2 to 27.9 min/session. Cardiovascular endurance was assessed by a maximal test on a bicycle ergometer. The investigators found significantly lower HR at submaximal loads and increased total time to exhaustion. Time to complete a 2 mile run was also significantly reduced. In the area of body composition, the lean body weight decreased 1.9 pounds, fat weight increased 1.0 pounds and relative fat increased 0.6 percent.

The results of this study as far as cardiorespiratory improvements are concerned must be looked at with caution because there was no attempt to quantify training intensity except to state that the training was performed at a high degree of intensity. Also, the subjects in this study were involved in spring football practice during the study.

Allen, Byrd, and Smith (1) trained 66 male subjects for 12 weeks, 3 days/week for 27 min/day and achieved no cardiorespiratory training effects. These results have to be viewed with caution as no effort was made to quantify a training HR. Subjects who had a mean initial $\dot{V}O_2$max of 46.5 ml/kg·min had their HR's drop to 138 beats/min during the resting phase of the program. Also, rest periods were 60 seconds in duration in contrast to work bouts of 30 seconds, indicating that the 27 minutes of training included only 9 minutes of actual work performance.

Wilmore et al. (103) investigated the efficacy of a 10 week CWT program in men and women. Subjects trained 3 days/week for 22.5 min/day. Intensity was quantified with a 2:1 work/rest ratio (30 second work bout/15 second rest). Changes in body composition included a significant increase in lean body weight in both men and women, and a significant decrease in relative fat in the women. Cardiorespiratory factors that exhibited significant changes were an improvement in treadmill performance time to exhaustion for both men and women, and increases in $\dot{V}O_2$max and $\dot{V}_E$max for the women. Differences between improvements in male and female subjects were explained by the lower initial $\dot{V}O_2$max values in the females.

Gettman et al. (34) compared the effects of CWT and running on cardiorespiratory fitness and body composition. Subjects exercised 3 days/week for 20 weeks. HR intensity varied from 79 to 84 percent (Karvonen formula) in the CWT group and was maintained at 85 percent in the running group. Both groups had significant increases in $\dot{V}O_2$max and treadmill performance time, but the running group had greater increases and was significantly different from the CWT group in $\dot{V}O_2$max and treadmill performance time. Both groups showed significant decreases in total skinfold fat and relative fat.

In another recent investigation on CWT, Gettman et al. (33) determined the effects of 8 weeks of CWT followed by 8 weeks of jogging and then 8 weeks of CWT or jogging. Adult men exercised 3 days/week. The CWT involved 2 circuits of reciprocal exercise using isokinetic devices with 10 to 15 repetitions/set and 30 seconds of rest between sets. The subjects jogged 3 miles/day during the jogging program. Significant changes, consequent to the CWT program, included increases in treadmill performance time, $\dot{V}O_2$max, and $\dot{V}_E$max; decreases in relative fat and fat weight; and increases in lean body weight. The jog program showed further significant increases in treadmill time and $\dot{V}O_2$max. During the final 8 weeks of training no statistical significance was found in any variable for either the CWT or jogging group.

Training in Women

Studies showing alterations in cardiorespiratory fitness and body composition with endurance training, have been reviewed in the preceeding sections. This section will concentrate on those studies involving women subjects to determine if there are any differences in the effects of endurance training compared with men.

Maximal oxygen consumption values in trained women athletes have been reported that are higher then non-trained women and non-trained men but lower then trained men (25, 40, 84, 101). Kilbom (50) provided data on the effects of short term training on Swedish females across a wide range of ages. Women divided into three age groups, 19 to 31, 34 to 48, and 51 to 64 years, trained for 7 weeks, 3 days/week, 30 min/day, at 70 percent of their $\dot{V}O_2$max. A second group trained at 50 percent of their $\dot{V}O_2$max. Increases in $\dot{V}O_2$max were significant for both groups, although greater in the 70 percent group, and for all ages. Kilbom concluded that there did not appear to be any sex differences in the ability to profit from physical training.

Brown, Harrower, and Deeter (5), investigating the effects of a running program on pre-adolescent girls, reported an 18 percent increase in $\dot{V}O_2$max after 6 weeks of training and a 26 percent increase after 12 weeks of training. No significant changes in body composition were reported.

Studying the effects of a walk-jog program on overweight college women, Moody, Kollias, and Buskirk (59) reported a significant decrease in body weight. A 6 day/week, 8 week program was used with the intensity controlled by requiring a 500 Kcal per women per day expenditure.

Fringer and Stull (32) trained 44 college women with a maximal effort on a bicycle ergometer 2 days/week for ten weeks. They reported significant increases in both $\dot{V}_E$max and $\dot{V}O_2$max.

Wilmore (99) investigated the effects of an intensive weight training program on body composition and strength. Men and women subjects trained on a ten week program 2 days/week, 40 min/day. Significant changes were found in female subjects in the following areas: increase in lean body weight, decrease in absolute and relative body fat, and strength increases in leg press, curl, bench press, and grip. Wilmore concluded that relative improvement in strength and alterations in body composition were similar and nearly identical for the men and women included in the study.

Burke (7) investigated similar running training programs in males and females for 8 weeks, 3 days/week, at an intensity between 75 and 85 percent of HR max, with the total distance run held equal. The data showed significant increases in $\dot{V}O_2$max and $\dot{V}_E$max for both groups and a significant difference between sexes in response to training. Burke concluded that the greater increases (24 vs. 17 percent $\dot{V}O_2$max) for the females were due to their lower initial levels of fitness.

In a study of young women who jogged for 7 weeks, 16 min/day, 3 days/week at an intensity of 75 percent (Karvonen formula), Smith and Stransky (93) reported significant increases in $\dot{V}O_2$max, $\dot{V}_E$max, and lean body weight. They concluded that young women respond to endurance training in a manner that is qualitatively similar to young men.

It has been noted in this and other reviews (24) that there are physiological differences between men and women, generally women having lower initial levels than men. But the evidence from this review and others (72, 98) also indicates that women tend to adapt to endurance training in the same manner as men. Therefore, it is concluded that the general findings concerning the quantification of physical training programs summarized in this review should apply to women.

CHAPTER 3

EXPERIMENTAL DESIGN

Subjects

Informed consent was obtained from University of Arizona female students who volunteered for this study.[3] A pre-exercise health history form (Appendix A) and an activity questionnaire (Appendix B) were completed by each subject to screen out those subjects who were contraindicated due to health problems or who were currently engaged in a fitness conditioning program. Normal college recreational pursuits, physical education activity classes, or intramurals did not preclude participation in this study. Forty-five females went through the initial series of tests and then were randomly assigned using a table of random numbers to either the Nautilus CWT experimental group, the jogging experimental group, or the control group. Of the original 45 subjects 20 elected to drop out of the study due to illness, lack of interest, or other commitments. This left 7 subjects in the Nautilus CWT experimental group; 3 dropped out due to lack of interest, 3 because of prolonged illness, and 2 due to school commitments that caused them to leave the area. Nine subjects were left in the jogging

3. The nature and purpose of this study and the risks involved were explained verbally and given on a written form to each subject prior to her voluntary consent to participate (Appendix C). The protocol and procedures for this study had been approved by the Human Subjects Committee of The University of Arizona.

experimental group; 3 subjects dropped out due to lack of interest, 2 because of illness, and 1 because of other commitments. Nine subjects remained in the control group; 4 subjects declined to return to be post-tested, and 2 subjects moved from the area. The physical characteristics of those subjects who completed the study are shown in Table 1.

Table 1. Preliminary Group Description

	Joggers (n = 9)		Nautilus CWT (n = 7)		Control (n = 9)	
Variable	$\overline{X}$	SE	$\overline{X}$	SE	$\overline{X}$	SE
Age, years	20.0	3.0	21.3	3.1	23.1	4.3
Height, cm	164.2	11.6	166.5	7.7	165.3	4.5
Weight, kg	62.4	9.3	60.0	7.7	57.4	7.5

Methods and Materials

Of the 25 subjects who remained for the completion of the study, each had selected body composition and cardiorespiratory measurements taken at The University of Arizona's Exercise and Sport Sciences Laboratory prior to the start and at the conclusion of the training pro grams.

The battery of tests began with height and weight measures taken with the subjects wearing bathing suits using a GPM anthropometer and a Homs Beam Scale. The subjects then had their body density assessed by the hydrostatic weighing technique using ten trials as described by Behnke and Wilmore (3). Residual lung volume, used in the calculation of body density, was assessed using a modification of the oxygen dilution technique (97) with the subject out of the water in a sitting position similar to that used when weighed underwater. Pre-training residual volumes were used in the post-training determination of body density, as residual volumes were not expected to change with training (2). Relative body fat was estimated from body density according to the equation of Siri (91). Skinfolds were measured in triplicate for reliability at six sites: thigh, abdomen, chest, triceps, subscapular, and suprailliac as described by Behnke and Wilmore (3). Skinfold data was not used in this study due to the unreliability of the skinfold measures that were taken by different inexperienced testers in the pre and post evaluations.

Cardiorespiratory fitness, i.e., $\dot{V}O_2max$, was assessed during a continuous walk-run test to exhaustion on a Quinton motorized treadmill. The subjects were told to go to the point of volitional fatigue and were verbally encouraged throughout the test to continue working just as long as possible. The test protocol consisted of a four minute walk at 93.9 m/min (3.5 mph), starting at 0% grade for the first two minutes and increasing the grade by 4% at the end of the second minute. At the end of the fourth minute, the speed was increased to 160.9 m/min (6.0 mph) and remained at this speed throughout the remainder of the test. The grade was increased by 2% at the end of the sixth minute and at the end of each subsequent even numbered minute, through the end of the test. Continously, throughout the test, ECG and heart rate were monitored on a Quinton Model 623A ECG Monitoring System from a single lead (CM5) electrocardiogram, a strip being obtained for ten seconds out of each minute. Metabolic and respiratory function were monitored continuously at 30 second intervals throughout the exercise period using the Beckman Metabolic Measurement Cart (102). The treadmill test was given on two seperate occasions one week apart during the pretest to establish reliability, the criterion being that the two determinations of $\dot{V}O_2$max (ml/kg·min) differed by less than 2 ml as outlined by Taylor, Buskirk, and Henschel (94). If the criterion was not met, a third treadmill test was given. Only one treadmill test was given in the posttest battery. During recovery, at the end of the treadmill test, each subject used the palpation technique (73) to determine their heart rate and was cross-checked on the electrocardiograph to determine their reliability in taking training heart rates. Subjects reported for all testing sessions in the postabsorptive state.

Strength was assessed in the Nautilus circuit weight training group using the 1-repetition maximum (1-RM) technique (13) in the bench press and leg extension movements. All testing was performed on the Nautilus machines. Strength was assessed at the beginning of the 7th exercise session after the subject had been trained in proper technique, and during the last week of the training program.

Training Program

Following the completion of the total test battery the subjects in the Nautilus CWT group and the jogging group started a 10 week program of training, 30 min/day, 3 days/week. Subjects maintained individual training heart rates which were obtained by adding 75 percent of the difference between HR max and HR rest to HR rest, as suggested by Karvonen et al. (47). The peak heart rate on the treadmill test was assumed to be the maximal value. Exercise heart rates were monitored by the subject at approximately the 10th, 20th, and 30th minutes of exercise each training session. Subjects were periodically checked by telemetry, using a Parks model RD 27 ECG telemetry unit, to ensure accuracy in heart rate determination. Exercise intensity was adjusted to maintain the training HR. All training sessions were supervised.

The jogging group trained on both paved and grassy terrain and recorded the length of each exercise session, total distance covered each session, and their heart rate attained.

The Nautilus CWT program consisted of the following 11 stations on the Nautilus equipment: leg extension, leg flexion, hip and back extension, neck and shoulder flexion, pectoral arm cross, decline bench press, shoulder flexion, torso pullover, biceps curl, triceps press, and sit-ups. The subjects used the Nautilus protocol (65), exercising at a resistance they could execute for a minimum of 8 repetitions and a maximum of 12 repetitions before reaching total failure of the involved muscles. Each repetition was executed in a controlled manner through the full range of motion, allowing approximately 2-4 seconds for the concentric contraction and 6-8 seconds for the eccentric contraction phases. The resistance lifted at each station was periodically increased on an individual basis as 12 repetitions was reached to compensate for gains in strength. Situps were executed with the legs bent and secured, and continued until failure. Subjects moved from station to station, without set order, as rapidly as they were able to continue with a maximum of a thirty second rest period. The Nautilus CWT group recorded the length of each session, the amount of resistance and number of repetitions at each station, and the heart rate attained.

Statistics

Resultant data was analyzed by an analysis of variance using the Scheffé procedure to determine intergroup differences. A paired t-test was used to determine pre to post test significance of mean differences. Significance was reported at the 0.05 level of confidence.

CHAPTER 4

RESULTS

Training Program Characteristics

The characteristics of the ten week training program for both training groups are presented in Table 2. The actual training HR for the jogging group was 157.5 beats/min and for the Nautilus CWT group 152.9 beats/min. When expressed as a percentage of Karvonen's formula, the groups were shown to be working at intensities of 76.1 percent for the jogging group and 75.2 percent for the Nautilus CWT group.

The jogging group averaged 29.5 minutes per exercise session and the Nautilus CWT group averaged 28.9 min/session, which adhered closely to the specified duration set at 30 min/session. The attendance for both groups was similar, 97.0 percent for the jogging group and 97.1 percent for the Nautilus CWT group.

The amount of work done by the groups was considerably different due to the nature of the two training modes. The jogging group averaged 2.9 miles per session at 157.9 m/min (5.9 mph). This is nearly equal to the treadmill performance test speed of 160.9 m/min (6.0 mph). Strength increases for the Nautilus CWT group consequent to the training program are noted in Table 3, reporting an increase of 30.7 percent in leg extension strength and 21.3 percent in bench press strength. This is similar with strength gains in women that have been reported previously (6, 99, 103).

Table 2. Training Statistics for 10 Week Training Programs

Variable	Joggers		Nautilus CWT	
	$\bar{X}$	SE	$\bar{X}$	SE
THR[a] (beats/min)	155.1	6.1	152.6	4.9
Actual HR (beats/min)	157.5	8.9	152.9	5.0
Training Intensity (%)[b]	76.1	1.6	75.2	1.2
Minutes/Session	29.6	0.6	28.9	0.7
Miles/Session	2.9	0.2	---	---
Attendance (%)	97.0	3.5	97.1	4.1

a. THR = [(HR max - HR rest) x 0.75] + HR rest

b. TI = (THR - HR rest) ÷ (HR max - HR rest) x 100

Table 3. Strength Measures for the Nautilus CWT Group

	(N = 7)	$\bar{X}$	SE
Leg Extension			
	Initial	10.4[a]	1.4
	Final	13.6	1.9
	Δ	+3.2	
	% Δ	30.7	
Bench Press			
	Initial	5.4	0.6
	Final	6.5	0.7
	Δ	+1.1	
	% Δ	21.3	

a. Numbers correspond to the numbered weight plate on each Nautilus machine. A number of 10 would indicate that the exerciser was lifting 10 weight plates on that machine.

Cardiorespiratory Alterations with Training

Alterations in cardiorespiratory parameters during maximal exercise consequent to the ten week training programs are presented in Table 4. Significant changes from pre to post tests in the jogging group were noted in the following parameters: treadmill performance time (TPT), which increased 43.2 seconds (9.6%); absolute $\dot{V}O_2$max, which increased 290 ml (13.7%); and relative $\dot{V}O_2$max, which increased 4.9 ml (14.4%). Significant changes were noted for the Nautilus CWT group in the following: treadmill performance time, which increased 37.2 seconds (9.1%); absolute $\dot{V}O_2$max, which increased 160 ml (7.9%); and relative $\dot{V}O_2$max, which increased 2.6 ml (7.6%). $\dot{V}_E$max and HR max remained unchanged.

Significant between-group differences were noted for the jogging and control groups. Absolute and relative values for $\dot{V}O_2$max for the jogging group were significantly different from the control group at the termination of training. None of the cardiorespiratory parameters for the Nautilus CWT group were statistically different from the control group at the termination of training. In addition, there were no between-group differences found for the two training modes. The results are confusing since: 1) both experimental groups increased $\dot{V}O_2$max significantly, 2) only the jogging group increased significantly above the control group, and 3) there was no significant difference in the changes between the jogging and CWT groups.

Table 4. Changes in Cardiorespiratory Parameters

Variable	Joggers $\bar{X}$	Joggers SE	Nautilus CWT $\bar{X}$	Nautilus CWT SE	Control $\bar{X}$	Control SE
$\dot{V}O_2$ L/min						
Initial	2.12	0.3	2.02	0.3	2.01	0.3
Final	2.41	0.3	2.18	0.3	2.05	0.3
Δ	+0.29[b]		+0.16		+0.05	
% Δ	13.7		7.9		2.5	
t-value	4.68[a]		5.63[a]		2.0	
$\dot{V}O_2$ ml/kg·min						
Initial	33.9	3.7	33.8	4.2	35.1	4.2
Final	38.8	2.4	36.3	5.3	35.9	4.4
Δ	+4.9[b]		+2.5		+0.8	
% Δ	14.4		7.6		2.1	
t-value	5.35[a]		4.59[a]		2.07	
TM time (min)						
Initial	7.5	1.0	6.8	0.8	7.0	1.2
Final	8.2	0.8	7.4	1.2	7.15	1.0
Δ	+0.7		+0.6		+0.15	
% Δ	9.6		9.1		2.1	
t-value	2.80[a]		3.40[a]		0.81	

Table 4. -- Continued

Variable	Joggers $\bar{X}$	Joggers SE	Nautilus CWT $\bar{X}$	Nautilus CWT SE	Control $\bar{X}$	Control SE
$\dot{V}_E$ L/min						
Initial	93.8	13.1	85.1	6.6	93.0	11.3
Final	97.5	12.7	88.8	5.7	91.4	11.3
Δ	+3.7		+3.7		-1.6	
% Δ	3.9		4.4		1.7	
t-value	1.90		2.13		1.20	
HR beats/min						
Initial	185.3	5.8	184.2	7.5	192.7	7.4
Final	186.3	7.3	185.5	4.2	191.2	6.9
Δ	+1.0		+1.3		-1.5	
% Δ	0.6		0.7		0.8	
t-value	0.57		0.98		1.61	

a. significant at the 0.05 level

b. significantly different from the control group

Body Composition Alterations with Training

Changes in body composition consequent to the ten week training programs are presented in Table 5. None of the parameters of body composition for the training groups were significantly different from the control group at the termination of training. In addition, there were no between-group differences found for the two training modes, nor any statistically significant pre to post test changes for any of the groups.

Table 5. Changes in Body Composition[a]

Variable		Joggers		Nautilus CWT		Control	
		$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Wt/kg	Initial	62.3	9.2	60.0	7.7	57.3	2.5
	Final	61.9	9.1	59.5	7.6	57.4	2.2
	Δ	-0.4		-0.5		+0.1	
	% Δ	0.6		0.9		0.2	
LBW/kg	Initial	45.8	6.7	45.3	4.6	43.0	2.0
	Final	46.1	6.8	45.2	4.6	42.5	1.9
	Δ	+0.3		-0.1		-0.5	
	% Δ	0.7		0.3		1.2	
FW/kg	Initial	16.5	3.3	14.7	4.3	14.3	4.7
	Final	15.8	3.6	14.3	4.6	15.0	4.4
	Δ	-0.7		-0.4		+0.7	
	% Δ	4.2		2.6		4.8	
% Fat	Initial	26.4	3.2	24.1	4.8	24.7	6.1
	Final	25.5	4.2	23.7	5.2	26.0	6.2
	Δ	-0.9		-0.4		+1.3	
	% Δ	3.7		1.8		5.1	

a. No statistically significant changes in body composition were noted for any of the groups.

CHAPTER 5

DISCUSSION

This discussion will focus on the comparison of the relative contribution of jogging and Nautilus CWT to the development of cardiorespiratory fitness and alterations in body composition.

Maximal Treadmill Test

A significant increase in treadmill $\dot{V}O_2$max (ml/kg·min) was demonstrated for both the joggers (14.4%) and Nautilus CWT group (7.6%), while the control group remained essentially unchanged on this and all other maximal values. In past review articles, Grimby and Saltin (38) state that endurance training generally results in a 15 to 20 percent improvement in $\dot{V}O_2$max, and Pollock (72) states that endurance training for ten weeks results in a 4 to 14 percent improvement in $\dot{V}O_2$max. The magnitude of change demonstrated by the joggers in the present study is considered to fall within the normal range of response, and although somewhat smaller, the magnitude of change demonstrated in the Nautilus CWT group fell within the normal range of response as reviewed by Pollock (72). The summarized findings of previous training studies involving a female population are presented in Table 6. As illustrated, a wide range of response has been noted between the results of previous cardiorespiratory endurance training studies. Differences in intensity, duration, frequency, mode, age, and initial level of fitness are the probable sources of this variation.

Table 6. Comparison of Maximal Oxygen Uptake Changes with Training in Women

Investigator	Age yrs	N	Prescription wks	days	mode	$\dot{V}O_2max$ ml/kg min pre	post	%
Brown et al. (5)	8-13	12	6	5	run	46.3	55.6	18.5
Brown et al. (5)	8-13	12	12	5	run	43.1	54.1	26.2
Burke (7)	18-25	8	8	3	run	31.7	39.3	24.0
Edwards (26)	18	12	4	5	run	26.7	34.7	29.7
Fringer - Stull (32)	17-28	44	10	2	bike	33.9	46.5	37.1
Wilmore et al. (103)	18-23	12	10	3	CWT	35.5	39.3	10.7
Present Study	20.0	9	10	3	run	33.9	38.2	14.4
	21.3	7	10	3	CWT	33.8	36.3	7.6

Edwards (26) reported a 29.7 percent improvement in $\dot{V}O_2max$ in college women after only 4 weeks of running, 15 min/day, 5 days/week. This was a greater improvement than that shown in the present study. Perhaps the lower age and initial mean $\dot{V}O_2max$ in the study by Edwards was influential in the greater improvement reported in that study.

Fringer and Stull (32) also reported a greater improvement in $\dot{V}O_2max$ (37.1%) than the present study. This illustrates the potential effect of varying intensity as they used maximal all-out efforts in their training programs compared to a submaximal intensity in the present study.

Burke's (7) training program was similar to that of the present study's jogging program. Their reported greater increase (24 vs. 14.4%) can be attributed to a higher intensity (85 vs. 75%) and a lower initial level of fitness (31.7 vs. 33.9 $\dot{V}O_2max$).

The Nautilus CWT group demonstrated similar increases in $\dot{V}O_2max$ as those of Wilmore et al. (103), who also evaluated CWT in women, i.e., 7.6 vs. 10.7 percent respectively; and demonstrated a greater increase in $\dot{V}O_2max$ than those of Gettman et al., in adult men, i.e., 3.5 (34) and 3.1 (33) percent vs. 7.6 percent in the present study.

Maximal pulmonary ventilation has been found by previous investigators to increase after cardiorespiratory endurance training (38). The increase in $\dot{V}_Emax$ with training is partially the result of an increase in maximal oxygen uptake which leads to an increased production of CO_2 and a higher level of blood lactate (2). The increases in $\dot{V}_Emax$ by the joggers (3.9%) and the Nautilus CWT group (4.4%) were not statistically significant. Pollock (72) states that $\dot{V}_Emax$ will generally increase 10 to 20 percent unless the initial values are high. The initial values in the present study (mean 90.6 L/min) are substantially higher than those reported in a review study (24) for American women of similar age.

HR max did not change significantly in either exercise group. Previous studies have shown that HR max may be reduced (27, 28, 69, 75, 85), or may remain the same or increase slightly (78, 92, 104).

Total performance time (TPT) on the treadmill is the only variable that directly measures change in performance which is the desired end result of a cardiorespiratory endurance training program. Significant increases in TPT was noted for both training groups; 9.6% for the joggers and 9.1% for the Nautilus CWT group. The increased TPT reflects the increase in $\dot{V}O_2max$ for both groups, the magnitude of change in TPT being nearly identical for both groups though the increase in $\dot{V}O_2max$ was almost twice as great for the joggers (14.4 vs. 7.6 percent). This difference in response might signify an increased anaerobic capacity of the Nautilus CWT group. Neither anaerobic threshold or post-exercise blood lactates were assessed to confirm this possibility. The increase in TPT (9.1%) for the Nautilus CWT group is within the range of other recent CWT investigations; Wilmore et al. (103) reported a 5.8 percent increase and Gettman et al. (34) an 11.5 percent increase. Gettman et al. (33) in a later study with adult men had a 3.5 percent increase in treadmill performance time with 8 weeks of CWT.

Body Composition Parameters

The results relative to changes in body composition parameters have to be observed in view of the fact that no attempt was made for dietary control. Re-evaluation of body weight, fat weight, lean body weight, and relative fat at the conclusion of the training program indicated no significant changes for either exercise mode, and no between group differences. Other investigations of cardiorespiratory endurance training programs have reported similar findings, i.e., insignificant alterations in body composition (17, 74, 80). A summary by Pollock (72) suggests that the majority of cardiorespiratory endurance training studies report decreases in total body weight and relative fat, and the longer the duration of the program the greater the magnitude of change. A decrease in lean body weight of 0.1 percent in the Nautilus CWT group was not expected in light of previous weight training studies that reported significant increases in this parameter (1, 29, 33, 34, 55, 103). Two previous studies reported insignificant changes in lean body weight after weight training programs. Brown and Wilmore (6), investigating the effects of 12 weeks of weight training on women athletes, reported an increase of 0.7 percent in LBW in the experimental group but also an increase of 3.3 percent in LBW in the control group. Peterson (71) reported a decrease in LBW of 1 percent in male athletes using similar Nautilus equipment.

Cardiorespiratory Differences between Modes

The exercise prescription components of intensity, duration, and frequency were quantified and equated in the two cardiorespiratory endurance training programs. Therefore differences in cardiorespiratory changes at the termination of the training programs must be examined in terms of the mode of training used in the exercise prescription. Some of the explaniations that have to be given further study follow.

Åstrand and Rodahl (2) explain that an aerobic training effect on the heart may be secondary to primary changes in the skeletal muscles used in the training. Therefore little change would be expected in $\dot{V}O_2$ max during exercise testing which does not involve the trained muscles. This specificity of training and testing concept suggests the possibility that the $\dot{V}O_2$max differences between the groups was due in part to the specificity effect of the treadmill running test used in this study. This test would favor the results for the jogging group as their training pace was nearly identical to test speed, and the test would not be sufficiently specific to reveal any peripheral adaptations that may have resulted from the CWT.

As explained earlier in the review section of this study, investigators (19, 35, 46, 74, 85) have reported that caloric expenditure is perhaps the most important criterion for a cardiorespiratory endurance training program. The estimates (33) for energy expenditure of the Nautilus CWT group were approximately 225 to 250 Kcal/workout, while for the joggers it was approximately 300 Kcal/workout. The lower energy expenditure estimates for the Nautilus CWT group would partially explain their lower aerobic changes.

Another possible explanation for the discrepancies between the training groups in $\dot{V}O_2max$ changes relates to the intermittent nature of the workouts. In the Nautilus CWT group, rest periods up to 30 seconds were taken between exercises due to the high intensity of the work. This reduced actual work time to a minimum of approximately 23.9 minutes which is lower than the 29.5 minutes in the jogging workout. However, the jogging program consisted of intermittent jogging and walking where the walking served as a recovery period much like the rest period for the CWT group. In both training groups the subjects did not let their HR drop more than 6 beats/min below their THR during the recovery phase. Perhaps the difference can be better explained in terms of caloric expenditure. While the Nautilus CWT group's rest period was a time where no work was performed, the jogging group was vigorously walking during their recovery phase, and thus had a higher caloric expenditure.

Another possible explanation for the differences in improvement in $\dot{V}O_2max$ can be examined in the metabolic process of the two training modes. In the Nautilus CWT program the subjects exercised to the point of total fatigue of the involved muscle. This involves anaerobic metabolism to a very high extent which leads to early fatigue of the muscle and limits the involvement of aerobic metabolis. The jogging program has a low-level of anaerobic involvement and promotes efficient aerobic metabolism. Therefore, the stimulus for aerobic improvement during the Nautilus CWT program is less than that for the jogging program. Even though the intensity of the training programs was quantified by using THRs, there may be some discrepancies between the modes used. Pollock et al. (79) has shown that the $\dot{V}O_2$ of arm work is approximately 68 percent of leg work at similar heart rates. During certain phases of CWT the smaller muscle mass of the arms is involved compared to the total leg work of jogging, and the stimulus for the improvement in aerobic capacity is less during arm work. Hermansen, Ekblom, and Saltin (41) and Humphreys and Lind (45) have reported that peripheral blood flow is severely restricted in the limbs during heavy resistive exercise. This muscular impariment of venous return during the resistive contractions of Nautilus CWT indicates that stroke volume would diminish therefore cardiac output would be significantly lower in the CWT group than in the joggers at similar heart rates. Byrd and Barton (10) have reported that despite the elevated HR that is observed during weight lifting an impedance to muscular blood flow caused by high levels of intramuscular pressure may result in lower stimulus for vascular adaptions at the cellular level.

Since the difference in the exercise prescription was in the mode of training and since a major difference in the physiological response to the two modes lies in peripheral rather than central cardiovascular events it appears that the amount or pattern of local blood flow might be the cause of differences in the magnitude of cardiorespiratory changes.

CHAPTER 6

SUMMARY

It is generally concluded that physical inactivity is associated with an increased risk for the premature development of CHD and is a negative factor in the development or maintenance of optimal cardiorespiratory fitness. The thesis then evolves that there is a need to develop an appropriate level of physical activity as a lifestyle for healthful living and for maintaining a sound cardiorespiratory system. The present study has investigated the relative contribution of circuit weight training compared to a jogging program in the alteration of various cardiorespiratory and body composition parameters in college women.

While body composition was not significantly altered in either mode, $\dot{V}O_2$max and other related variables improved significantly as a result of a 10 week cardiorespiratory endurance training program in both CWT and jogging modes. Though the alterations as a result of the jogging mode were of greater magnitude then the CWT mode the difference was not statistically significant. It is concluded that CWT contributes to the development of cardiorespiratory health and is an efficient conditioning activity for altering strength and endurance time to exhaustion.

APPENDIX A

PRE-EXERCISE HEALTH HISTORY

Name: Date:

Please answer the following questions by responding as follows:
(x) Yes - place x ( ) No - leave blank (?) Unknown - place ?

HAVE YOU EVER HAD . . .

( ) Rheumatic fever
( ) Heart murmur
( ) High blood pressure
( ) Any heart trouble
( ) Disease of the arteries
( ) Lung disease
( ) Arthritis
( ) Asthma
( ) Migraine headaches
( ) Operations - describe

( ) Injuries - describe

HAVE YOU RECENTLY HAD . . .

( ) Chest pain
( ) Shortness of breath
( ) Heart palpitations
( ) Cough on Exertion
( ) Back pain
( ) Swollen, stiff, or painful joints
( ) Foot problems
( ) Muscles cramping

HAVE ANY OF YOUR RELATIVES HAD . . .

( ) Heart attacks (under age 55)
( ) High blood pressure
( ) Diabetes
( ) Congential heart disease
( ) Cholesterol (260 or higher)

DO YOU NOW . . .

( ) Drink coffee - tea
cups/day
( ) Drink cola, tabs, etc.
cans/day
( ) Drink beer
cans/week
( ) Drink wine
oz./week
( ) Drink alcohol
oz./week (1 shot = 1 oz.)
( ) Smoke cigarettes
cigarettes/day
( ) Take prescription medicine
if yes list:

HAVE YOU EVER . . .

( ) Smoked digarettes
If yes, how long ago did you quit ? ____months
____years

APPENDIX B

PHYSICAL ACTIVITY PARTICIPATION QUESTIONNAIRE

NAME: AGE: (DOB)

The following questions will be used to determine your past and current level of physical activity. Please answer each question as accurately as possible.

1. In what sports or activities have you been a participant in the last two years ?

2. In what sports or activities are you currently active ?

3. How many days per week do you participate in the above activities ? How many hours per day ?

4. Would you be willing to participate in a Physical Education research study ? The time commitment would entail ten weeks, 3 days/week, one hour/day; plus two hours of pretesting and one hour of post-testing.

YES NO

5. If yes, please list your local address and phone number. This information will remain confidential.

ADDRESS: PHONE:

Thank You,

Dan Conti 6-3407
795-6135

APPENDIX C

INFORMED SUBJECT'S CONSENT

As a subject for a Master's thesis study comparing the physiological alterations between a Nautilus circuit weight training program and a jogging program, in The University of Arizona Department of Physical Education, I understand the following elements of this project:

The purpose of this research is to compare two different training programs as to how they effect physiological alterations in cardiorespiratory fitness and body composition, one a standard jogging program and the other a circuit weight training program. You will undergo a series of tests which are designed to determine your body composition and cardiorespiratory fitness. These tests will be taken twice at the beginning of the project and once at the conclusion of the project and will be approximately one hour in duration. These tests will be given in the Exercise and Sport Sciences Laboratory in McKale Center. A physical activity participation questionnaire and a pre-exercise health history questionnaire will be administered. The body composition tests include: skinfold measurements where six sites on the body are lightly pinched to determine skinfold fat thickness, three trials will be taken; underwater weighing, which involves the subject submerging herself underwater while forcibly expiring as much air as possible and holding this state for approximately 3-5 seconds, ten trials will be taken; and assessing residual lung volume by exhaling completely, inhaling and breathing 100% oxygen for 6 to 8 breaths and again exhaling completely. The testing of cardiorespiratory fitness will involve a walk-run on a treadmill to exhaustion. Heart rate will be monitored through surface electrodes, and the amount of oxygen you are using will be determined. Following the first series of tests each subject will be assigned to one of two training groups, or the control group. The training program will last approximately one hour per day, three days per week for ten weeks. One program will be a continuous walk-jog for 30 minutes at a heart rate of approximately 150 beats per minute. The other program will be resistive strength training on Nautilus equipment which will consist of eleven exercises executed 12 times each with a limited rest time between exercises. Heart rate will again be maintained at approximately 150 beats per minute. The jogging program will take place on the campus of The University of Arizona and the Nautilus training program in McKale Center. The control group will be asked to continue their normal activity routine. The discomforts that may occur during the study are minor and transitory in nature. In preparation of the skin for electrode placement, which involves cleansing with alcohol and rubbing the area with an abrasive pad, you may experience a small amount of stinging at the electrode sites. This will last only a few seconds. There is a chance that you may experience a mild muscle soreness at the beginning of the training programs.

You will receive no compensation and incur no costs in this project. There is a possibility that your cardiorespiratory fitness and body composition may improve.

All questions I have will be answered promptly and honestly. All information obtained will be treated as privileged and confidential and will be known only to Daniel Conti and members of his thesis committee. The results of the study will be reported using a numbered roster. A possibility exists that the study may be published.

I understand that in the event of physical injury resulting from the research procedures, financial compensation for wages and time lost and the cost of medical care is not available and must be borne by the subject. I also understand that Daniel Conti will provide additional information upon request.

I also understand that this consent form will be filed in an area designed by the Human Subjects Committee with access restricted to the principal investigator and/or authorized representatives of the particular department.

I have read and understand the above. The nature, demands, risks, and benefits of the project have been explained to me. I understand that participation in this study is voluntary and I may withdraw from the study at any time without incurring ill will or affecting my University standing.

____________________________ ____________________

Subject's Signature Date

I have carefully explained to the subject the nature of the above project. I hereby certify that to the best of my knowledge the subject signing this consent form understands clearly the nature, demands, risks, and benefits involved in participating in this study. A medical problem or language or educational barrier has not precluded a clear understanding of her involvement in this project.

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Investigator's Signature Date

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Witnessed Date

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