COMPARISON OF AN AEROBIC DANCE PROGRAM VERSUS A JOGGING PROGRAM ON UNTRAINED COLLEGE FEMALES

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ABSTRACT

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Forty-six untrained female Ss were studied to determine if the cardiovascular benefits from an aerobic dance program equaled those of a jogging program. The Ss ranged in age from 18-29 yrs and included 19 from a jogging class, 15 from an aerobic dance class and 12 from bowling classes used as a control group. Both groups trained 4 days a wk, 30 min per day for 7 wks. All Ss were given pre (T_1) and post (T_2) volitional max treadmill tests using the Modified Astrand Protocol. A target HR based on 75% of the max HR value attained on the initial max test was assigned. Training HR's were monitored and recorded daily. The joggers and dancers worked at an average intensity of 83% and 84%, respectively, over the training period. An ANOVA with Repeated Measures followed by a Scheffé post hoc test was used to analyze the following variables: $\dot{V}_E$ max, max HR, body wt, run time and max $\dot{V}O_2$ in $l \cdot min^{-1}$, and $ml \cdot kg \cdot min^{-1}$. Sig increases ($p < .05$) were found for both the joggers and dancers in $\dot{V}_E$ max, run time and both absolute and relative max $\dot{V}O_2$. A sig decrease ($p < .05$) in max HR was found for both exp groups. No sig diff ($p > .05$) was observed in body wt for either the joggers or dancers. The control group showed no sig diff ($p > .05$) in any of the variables measured from T_1 to T_2. It was concluded that both aerobic dance and jogging are effective exercise modalities for improvement of cardiovascular fitness.

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We recommend acceptance of this thesis in partial fulfillment of this candidate's requirements for the degree: Master of Science - Adult Fitness and Cardiac Rehabilitation. The candidate has completed her oral report.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

As increasing numbers of people have become aware of the benefits of regular exercise, new forms of physical activity have emerged throughout the country. A revival of brisk walking, jumping rope, plus newer trends such as roller skating, rebounding, and aerobic dance have caught hold in numerous areas. Many men and women who have found jogging, cycling and swimming unattractive or impractical are now turning to these newer recreational activities for their cardiovascular conditioning.

One of the above activities, commonly referred to as "aerobic dance", has developed over the past several years into an extremely popular fitness program for women and girls. It is now included in the curriculum of many schools, recreational facilities, and various private clubs. Currently, large numbers of school children and adults are participating in dance classes for either the simple enjoyment of moving to music or to improve posture, lose weight or to increase levels of physical conditioning (Novak, Magill & Shuttle, 1978).

According to Schuster (1976) a key person in the development and promotion of aerobic dancing has been Jackie Sorensen. Sorensen designed this activity in the early 1970's hoping it would improve and maintain strength, circulatory-respiratory endurance and body flexibility. Through her own personal efforts she has popularized aerobic dance throughout the country through writings, television appearances, workshops and clinic presentations (Clarke, 1977a).

Purpose of the Study

The purpose of this study was to compare the effects of an aerobic dance program with those of a jogging program in determining the amount of cardiovascular improvement afforded by each.

Need for the Study

It has been recognized that common leisure-time activities, such as running, walking, swimming or cycling, generally provide an adequate physiological stimulus to elicit a training effect (Foster, 1975). However, there are a wide variety of recreational activities which have yet to be studied in terms of their effects on the cardiovascular system. Dance is one such activity in which the research on physical fitness benefits has been particularly meager. In a book with her husband, Mildred Cooper expressed her belief that dancing has an aerobic benefit. She stated:

> I feel that if the benefits could be measured and charted we would have a program that we could do at home accompanied by a radio or record player, would be fun, would not be boring because it can be varied and integrated with other aerobic activity, could be engaged in regardless of the weather, has aerobic potential plus the bonus of developing grace, poise and rhythm (Cooper & Cooper, 1972, p. 134).

Aerobic activities such as jogging, walking and dancing have become more and more popular over the past several years. As increasing numbers of people participate in these programs each year, there is a need to determine exactly how much cardiovascular conditioning can be obtained from them. In addition, it would be beneficial for individuals to know how an activity such as aerobic dance compares with another large-muscle activity such as walking or jogging.

Many studies have been conducted over the past several years on the effects of jogging on males (Byrd, Smith & Shackleford, 1974; Daniels, Yarbrough & Foster, 1978; Pollock, Miller, Janeway, Linnerud, Robertson & Valentino, 1971; Wallin & Schendel, 1969; Wilmore, Davis, O'Brien, Vodak, Walder & Amsterdam, 1980; Wilmore, Royce, Girandola, Katch & Katch, 1970). In comparison, relatively few studies have been done on the female jogger (Brown, Harrower & Deeter, 1972; Cunningham & Hill, 1975; Edwards, 1974; Eisenman & Golding, 1975; Kearney, Stull, Ewing & Strein, 1976; Kilbom, 1971). According to Cooper (1970):

> Since most exercise research has been conducted on men, we still do not have quite enough information on the special needs and problems of exercising women. I would be grateful for any data my readers can contribute to the subject of fitness testing and exercise programs for women (p. 79).

This statement in itself supports the need for this type of study. Therefore, an investigation using female subjects would seem to be quite appropriate at this time.

Hypothesis

For this study the null hypothesis was assumed. The hypothesis stated that there is no significant difference between the effects of an aerobic dance program and a jogging program on cardiovascular conditioning.

Delimitations

This study was delimited to a group of 46 women at the University of Wisconsin-La Crosse enrolled in Physical Education classes, Winter Semester, 1981. All of the subjects were volunteers with an age range of 18 to 29 years. The study was delimited to a seven-week training program which began early in January and ran through the middle of March. The following dependent variables were obtained prior to and after the training period: maximal oxygen consumption; maximal heart rate; maximal ventilatory volume; time on the treadmill; and weight.

Limitations

Possible limitations to this study were:

1) Volunteers were used rather than a randomly selected group of subjects.
2) The motivational levels of the subjects could not be completely controlled.
3) The training period was only seven weeks.
4) There was a certain amount of learning in the aerobic dance program involving various dance steps, pattern sequences and formations, which was not necessary in the jogging program.

Definitions of Terms

Aerobic - literally means "with oxygen". An aerobic activity is one in which the energy needed is supplied by the oxygen inspired.

Aerobic Dance - a mixture of rhythmic running, hopping, skipping, jumping, stretching and swinging incorporated into routines performed to music.

Cardiovascular Fitness - ability of the circulatory and respiratory systems to adjust to the stress of an activity through efficient transfer of oxygen from the air to the working muscle. In this study it is measured by max $\dot{V}O_2$.

Control Group - group that received only the pre-test and post-test with no intervening treatment.

Experimental Groups - groups that received the treatment of either a seven-week jogging program or a seven-week aerobic dance program.

Jogging - a slow, steady, non-competitive run.

Maximal Oxygen Consumption (max $\dot{V}O_2$) - the highest rate at which oxygen can be consumed by the body per minute during treadmill running to volitional exhaustion. It can be measured in absolute terms of liters$\cdot$minute^{-1} ($l \cdot min^{-1}$) or in relative terms of milliliters per kilogram of body weight per minute^{-1} ($ml \cdot kg \cdot min^{-1}$).

Training Effect - adaptation of different organs or organ systems in the body in response to an overload of work stress. In the present study it was measured by the Modified Astrand Treadmill Test for determination of max $\dot{V}O_2$.

Maximal Ventilation ($\dot{V}E$ max) - the greatest amount of air that a person can exchange in one minute during maximal exercise.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The review of literature has been divided into three main sections. The first section deals with the topic of cardiovascular fitness: what it is, how it can be measured, and how to develop or maintain it. The second and third sections deal with literature related to two specific types of cardiovascular training programs: jogging and aerobic dance.

Cardiovascular Fitness

Definition of Cardiovascular Fitness

The definition of fitness has puzzled physiologists for many generations. In 1946, Johnson wrote:

> Quantitative assessment of physical fitness is one of the most complex and controversial problems in applied physiology. The situation arises, in part, from lack of general agreement on what constitutes fitness for withstanding various types of stress and, in part, from lack of agreement on what measurements allow valid comparisons to be made among different individuals exposed to the same stress (p. 535).

One comprehensive definition stated that physical fitness is dependent on the following factors: maximum oxygen consumption; respiratory capacity; blood pressure; heart response to exertion; forced respiratory capacity; pulse pressure; force efficiency and capacity; heart-rate; and, athletic fitness (Falls, Ismail, McLeod, Weibers, Christian & Kessler, 1975). However, most researchers in defining fitness, will conclude that, out of all the many components of physical fitness, cardiovascular endurance may well be the best measure of general fitness (Clarke, 1975; Foster, 1975; Morehouse & Miller, 1971; Shephard, 1977).

A definition of cardiovascular fitness, as defined by the President's Council on Physical Fitness and Sports (Clarke, 1977a) is as follows:

> Circulatory-respiratory endurance is characterized by moderate contractions of large muscle groups for relatively long periods of time, during which maximal adjustments of the circulatory-respiratory system to the activity are necessary, as in distance running and swimming (p. 2).

A similar definition of cardio-respiratory endurance has also been offered by Mathews and Fox (1976):

> The ability of the lungs and heart to take in and transport adequate amounts of oxygen to the working muscles, allowing activities that involve large muscle groups to be performed over long periods of time (p. 545).

Regardless of the exact definition used, investigators have been and are continuing to make steady advances in their knowledge of cardiovascular fitness. With a more complete understanding of the cardiorespiratory system and its various components, there is great potential for improvement of the health and productivity of all individuals.

Measurement of Cardiovascular Fitness

There have been many tests designed to measure cardiovascular fitness. Nearly all of these tests include either a short period of maximal exercise or a slightly longer period of submaximal effort. During periods of maximal exercise, maximal oxygen uptake, defined as the highest rate at which oxygen can be consumed by the body per minute, is determined. This measure, according to numerous researchers (McArdle, Katch & Katch, 1981; Mathews & Fox, 1976; Pollock, Wilmore & Fox, 1978;

Shephard, 1977; Stewart, Williams & Gutin, 1977), is generally accepted as the best physiological index of cardio-respiratory endurance performance.

As mentioned above, cardiovascular endurance can be assessed by either submaximal or maximal means. Submaximal tests are usually designed to predict maximal oxygen consumption (max $\dot{V}O_2$) from a submaximal variable such as heart rate (Astrand & Rhyming, 1954; Myers, Golding & Sinning, 1973) whereas, maximal tests involve direct measurement using either closed or open-circuit air procedures. Closed-circuit air procedures involve inhaling from a closed container containing oxygen, then exhaling into the cannister while the carbon dioxide is absorbed as it passes through a container of soda lime (Clarke, 1975). The change in the amount of oxygen is a measure of the metabolism for a given period of time. The open-circuit air system involves inhaling atmospheric air and collecting all the expired, which is then analyzed for its oxygen and carbon dioxide content. The difference between the composition of this sample and that of atmospheric air gives a measure of the oxygen consumption (Clarke, 1975).

Tests of max $\dot{V}O_2$ usually involve a stepwise increase in workload until a point is reached at which no significant increase in $\dot{V}O_2$ occurs. After measuring oxygen uptake, the values obtained can then be expressed in liters per minute ($l \cdot min^{-1}$), milliliters per kilogram per minute ($ml \cdot kg \cdot min^{-1}$), or milliliters per kilogram of lean body mass per minute ($ml \cdot kgLBM \cdot min^{-1}$). The latter term is preferred but it is difficult to compute under normal laboratory conditions. This is due to the fact that in calculating lean body mass, an assessment of percent body fat must be made which necessitates skinfold, anthropometric or hydrostatic measurements.

In determining max $\dot{V}O_2$, the treadmill is one of the most commonly used devices for testing the general population (Pollock, Bohannon, Cooper, Ayres, Ward, White & Linnerud, 1976). This is due to the fact that not only are walking and running familiar activities for most individuals, but cardiovascular fatigue is most often the limiting factor in this modality rather than local muscle fatigue which is often seen in other testing devices such as the bicycle ergometer. In addition, the treadmill has an important advantage over other test modalities since the intensity of effort is predetermined because the subject must keep pace with the belt or he/she will most likely fall.

The exact method or protocol for determining oxygen consumption varies depending on the preference of the individual investigator. Astrand and Rodahl (1977) recommended that a test of max $\dot{V}O_2$ should meet the following general requirements: the work in question must involve large muscle groups; the workload must be measurable and reproducible; the test conditions must be such that the results are comparable and repeatable; the test must be tolerated by all healthy individuals; and, the mechanical efficiency required to perform the task should be as uniform as possible.

Taylor, Buskirk, and Henschel (1955) found that the treadmill could elicit a max $\dot{V}O_2$ value by maintaining a constant speed and increasing the grade in steps of 2.5 percent at given intervals. The major drawback with their procedure was that it required the subject to come back four different days to determine his $\dot{V}O_2$ uptake.

Another group of investigators (Mitchell, Sproule & Chapman, 1958) went one step further and developed a maximal treadmill test which could be administered in one session. After further study they suggested that the speed of the treadmill be set at six miles per hour with elevation increases of 2.5 percent after each two-and-a-half minute run. A ten minute rest interval was permitted between runs.

There are many other maximal treadmill test protocols in use today. In an investigation by Pollock et al. (1976) an analysis of four common protocols was done to evaluate the ability of each protocol to assess maximal cardiopulmonary responses. Out of the four protocols studied, the Modified-Astrand elicited the highest maximal values for heart rate, $\dot{V}O_2$ and ventilatory volume ($\dot{V}E$). In addition, the average test duration per subject was eight minutes compared to 19, 11, and 10 for the Balke, Bruce and Ellestad, respectively. The time period of seven to ten minutes is considered optimal for maximal physiological adjustments to occur (Pollock, Dimmick, Miller, Kendrick & Linnerud, 1975). For these reasons, as well as the warm-up of 3.5 miles per hour at 2.5 percent grade which seemed particularly well-suited to the untrained females in this study, the Modified-Astrand Protocol was selected for use in the current investigation.

Cardiovascular Fitness Training

Intensity. To enhance cardiovascular fitness and thus bring about a training change, a specific exercise overload must be applied (McArdle et al. 1981). By exercising at a level above normal, a variety of training adaptations take place that cause the body to work more efficiently. The appropriate overload for each person is achieved by manipulating combinations of training (i.e., intensity, frequency and duration).

There have been numerous studies (Davies & Knibbs, 1971; Edwards, 1974; Faria, 1970; Rosentswieg & Burrhus, 1975; Sharkey, 1970) dealing with the minimal amount of stimulus necessary to elicit a training effect. Several authors (Cooper, 1968; Karvonen, Kentala & Mustala, 1957; Roskamm, 1967) have documented about 70% of the available heart rate range or approximately 150 beats per minute as the threshold for training changes in normal sedentary young adults. Other researchers (Edwards, 1974; Kilbom, 1971; Rosentswieg & Burrhus, 1975; Sharkey, 1970) have used lower training intensities with somewhat contrasting results.

Kilbom (1971) found that female subjects walking three times per week at a rate designed to obtain a heart rate of 50 percent of their maximal level did not produce a significant change in max $\dot{V}O_2$. Likewise, Rosentswieg and Burrhus (1975) trained three groups of women at intensities of 120, 140, and 160 beats per minute for 15 minutes, three times per week for one month and also found no significant change in max $\dot{V}O_2$ for any of the training intensities. In a similar study Sharkey (1970) showed that pre-post training differences on three cardio-respiratory tests were not significant after a six-week training program using intensities of 130, 150 and 170 beats per minute. Sharkey did find, however, that the fitness changes in his subjects yielded a strong negative correlation with previous fitness levels. Those subjects with low initial fitness levels tended to improve more than those subjects with higher initial fitness values.

In contrast to the above studies, Edwards (1974) trained six subjects at exercise heart rates of 125 beats per minute and six subjects at exercise heart rates of 145 beats per minute. She concluded after four-weeks that both work intensities were sufficient to induce classic training effects. Durnin (1960) also produced substantial gains in endurance fitness, after 10 days, in subjects at training heart rates of 120 to 130 beats per minute. The training, which involved a daily 20 kilometer walk, resulted in significant decreases in $\dot{V}O_2$ values at standardized submaximal levels of work. Change in $\dot{V}O_2$ values at maximal work levels was not studied.

Frequency. Although some investigators have reported that training frequency is an important factor in the improvement of cardiovascular fitness (Gettman, Pollock, Durstine, Ward, Ayres & Linnerud, 1976; Pollock, Gettman, Milesis, Bah, Durstine & Johnson, 1977), others maintain that this factor is considerably less important than either the intensity or the duration (Davies & Knibbs, 1971; Shephard, 1968). Two studies (Fox, Bartels, Billings, Mathews, Bason & Webb, 1973; Fox & Mathews, 1974) using interval training showed that two days per week training resulted in changes in max $\dot{V}O_2$ similar to those observed with five days per week training.

Moffatt, Stamford and Neill (1977) did a study on the placement of tri-weekly training sessions in which one group exercised on Monday, Wednesday and Friday for 10 weeks while another group exercised on Monday, Tuesday and Wednesday for the same length of time. They concluded that the placement of the tri-weekly training sessions was not critical in respect to the enhancement of aerobic capacity. It has been suggested that three times per week is the optimal number of exercise periods necessary to improve or maintain fitness regardless of the placement of the three sessions (Myers et al. 1973).

Duration. The length of time or duration of the exercise period has not really been identified for optimal cardiovascular improvement (McArdle et al. 1981). The reason for this may be that the duration of a workout depends on many factors such as total work done, exercise intensity, training frequency and initial level of fitness. Activity of a lesser intensity will require a relatively longer exercise period, whereas, a high intensity workout will require a relatively shorter exercise period.

In an investigation by Wilmore et al. (1970) one group of men trained for 12 minutes, three times per week at a specific workload while another group trained in a similar fashion for 24 minutes. The results of the study found that there was no significant difference between the two groups in terms of changes in max $\dot{V}O_2$, blood pressure and heart rate. This study indicated that there may be a minimal amount of time required in order for a training effect to occur, but beyond this time period the improvement gains are negligible.

Combining the results of studies done on intensity, frequency, duration and mode, the American College of Sports Medicine in a Position Paper (1978) has made the following recommendations for the amount and type of exercise necessary for developing and maintaining cardiorespiratory fitness in the healthy adult:

> Frequency of three to five days per week; intensity of 60 to 90% of maximum heart rate reserve or 50 to 85% of max $\dot{V}O_2$; duration of 15 to 60 minutes of continuous aerobic activity

> depending on the intensity of the activity; and, mode of activity can be any activity that uses large-muscle groups which can be done continuously and is rhythmical and aerobic in nature (p. vii).

Jogging

Definition of Jogging

Over the past decade jogging has become an increasingly popular activity for many Americans. As the value of regular exercise has become better known, more and more people of all ages and gender are accepting and practicing it as a way of life. The President's Council on Physical Fitness and Sports has long advocated jogging as one of several desirable activities for developing and maintaining cardiovascular fitness (Clarke, 1977b).

In order to define the word jogging, it becomes necessary to speak of the term running. The differentiation between jogging and running is not simple. Actually, a separation of terms may not be necessary since jogging is a form of running. According to McArdle et al. (1981) jogging and running are basically qualitative terms which relate to the speed at which running is performed. They stated that the difference is mainly determined by the relative aerobic energy demands that are required in raising and lowering the body's center of gravity and the acceleration and deceleration of the limbs during the run. For example, at the same running speeds, a highly conditioned runner will run at a lower percentage of his/her max $\dot{V}O_2$ than an untrained person, even though they will be consuming similar amounts of oxygen during the run.

Another concept of jogging is that it is a series of easy-paced runs interspersed with walking (Clarke, 1977b). A definition by Roby and Davis (1970) takes into consideration a person's reason for running. They believed that jogging involves endurance training at a non-competitive level, whereas, running is a competitive form of jogging.

Taking into account the numerous definitions of the words "jogging" and "running", this author has considered both to be a steady-paced, non-competitive run. Both words will be used interchangeably throughout this account.

Research on Jogging

Within the past ten or twelve years, there have been numerous investigations (Daniels et al. 1978; Kasch & Wallace, 1976; Pollock et al. 1971; Wallin & Schendel, 1969; Wilmore et al. 1970) dealing with the physiological effects of jogging upon men.

Wallin and Schendel (1969) investigated the changes in blood pressure and heart rate of 21 sedentary business and professional men from 31 to 60 years of age after engaging in a 10-week jogging program three days a week. Results showed that heart rates were reduced significantly at rest, at six minutes during submaximal exercise and at five minutes post-exercise. The final diastolic blood pressure was significantly lower than the initial mean with no significant difference in the systolic blood pressure. The investigators concluded that the jogging program indirectly resulted in more efficient blood transport, less strain on the cardiovascular system and an increase in submaximal work capacity.

In a study cited earlier, Wilmore et al. (1970) also looked at men between the ages of 17 and 59 years of age engaged in a 10-week jogging program. Throughout the training program, the subjects were encouraged to progressively increase the distance they could cover in their specified time intervals. At the end of the study the men demonstrated significant increases in vital capacity, max $\dot{V}O_2$, and oxygen pulse. Significant decreases in both resting systolic and diastolic blood pressures, resting heart rate and maximal heart rates were also noted.

An investigation by Pollock et al. (1971) studied 16 sedentary males between the ages of 40 and 50 who walked four times a week for 20 weeks. The walking was quite vigorous and by the last week the men were averaging 4.7 miles per hour and covering 3.23 miles in a 40-minute session. Significant improvements were noted in max $\dot{V}O_2$, submaximal heart rate, and resting diastolic blood pressure. The investigators indicated that the changes they found were similar to those in studies using running as the training method, showing that vigorous walking can be effective as a training modality.

The number of jogging studies involving female subjects has not been as plentiful as those involving male participants. Eisenman and Golding (1975) using an exercise regime of jogging and bench stepping studied 16 women and girls. The women were 18-21 years old and the girls were 12-13 years of age. Control groups of similar ages were used. The two experimental groups performed the same exercise program of jogging and bench stepping on an 18-inch bench for 14 weeks, 30 minutes per day, 3 days per week. During the final weeks of the training, the subjects jogged an average of 1.8 miles and completed 150 steps. After training, both groups had a significantly higher absolute and relative max $\dot{V}O_2$. The women and girls also had significant increases in their maximal pulmonary ventilation.

In a study by Edwards (1974) twelve subjects, aged 17 to 21 years, participated in a treadmill training program 15 minutes daily for four weeks. Significant increases in max $\dot{V}O_2$ and run time were noted. In a longer investigation by Kearney et al. (1976), 27 sedentary college females trained on a treadmill 3 times weekly for a period of 9 weeks. The intensity of the work ranged from 50 to 65 percent of the maximal heart rate reserve. A comparison of pre-training and post-training results revealed significant increases in max $\dot{V}O_2$, oxygen pulse at max $\dot{V}O_2$, and a significant decrease in $\dot{V}E_{O_2}$ at max $\dot{V}O_2$.

Cunningham and Hill (1975) studied the effects of jogging on the cardiovascular response of seventeen women whose mean age was 31 years. The training program was divided into an initial 9-week period and a subsequent 52-week period, during which six subjects continued to exercise and the remainder detrained. Improvements in max $\dot{V}O_2$ were significant during the first nine weeks with no significant increase during the final 52 weeks. Four women who stopped training showed a decrease in max $\dot{V}O_2$ during the last phase. The authors also found that the long-term training program resulted in both increased stroke volume and arterio-venous oxygen differences, while the short-term low-intensity program reflected stroke volume changes only.

In another study using younger female subjects, Brown et al. (1972) studied the physiological effects of training through cross-country running on 12 preadolescent girls from 8 to 13 years old. Training sessions, which were held four or five days per week for one to two hours, consisted of continuous running over gradually increasing distances. At the middle and late season the girls were running four to seven miles depending upon their age. Mean max $\dot{V}O_2$ increased 18 percent at six weeks and 25 percent at 12 weeks above pre-training values. Maximum pulmonary ventilation was unchanged. Heart rates at submaximal and maximal workloads showed significant declines.

Several investigations have been devoted to comparisons of the effectiveness of jogging versus various training modes on cardiovascular conditioning. It appears that male subjects have been used predominately in these studies. Pollock et al. (1975) compared the effects of jogging, walking and bicycling on men 30 to 47 years of age. Three groups of 8 to 9 men were assigned to the three modes of conditioning; a control group was used. Each group trained for 30 minutes, three times per week for 20 weeks at 85 to 90 percent of their maximal heart rate. All experimental groups improved significantly in max $\dot{V}O_2$, $\dot{V}E$ max and oxygen pulse. There was a significant decrease in resting heart rate. The control group showed no significant changes for any of the variables. All three modes were found to be effective in improvement of cardiovascular conditioning.

Using 38 sedentary, middle-aged male volunteers, Wilmore et al. (1980) investigated the efficacy of jogging, free-wheel bicycling and tennis. Each training group exercised 3 days per week, for 30 minutes per day. Only the jogging and bicycling groups significantly increased treadmill max $\dot{V}O_2$, even though there was a slight improvement for the tennis group. There were significant increases in $\dot{V}E$ max for the jogging and bicycling groups, while resting blood pressure did not change for any of the groups. The authors concluded that bicycling and jogging appear to provide comparable physiological benefits.

Aerobic Dance

Definition of Aerobic Dance

A relatively new and increasingly popular form of exercise is aerobic dancing. This activity consists of rhythmic running, hopping, skipping, jumping, stretching and swinging incorporated into routines set to music (Clarke, 1977a). Aerobic dance integrates various dance forms such as folk, ballet, rock, modern jazz and musical comedy dance. Skill and technique are not emphasized. Participants are urged to "do their own thing" both in regard to style and intensity. The same basic training principles used in other forms of exercise can be applied as well.

Research on Aerobic Dance

Several studies have investigated the metabolic cost of aerobic dancing and have found similar energy requirements in each case. With 10 adult women as subjects, Weber (1974) showed that the energy cost of aerobic dancing and the heart rates achieved with this activity varied according to the intensity of the exercise. In his study the subjects danced six, three and-a-half minute long routines at low, moderate and high intensities on separate days. The intensities of the routines were pre-determined by the speed of the music, style of the dance and the overall choreography of the routine. The periods of dancing were separated by one and three-fourths minute recovery periods of continuous walking, jogging or dancing practice.

Weber (1974) found the energy costs of the three intensities to be 3.8 kilocalories (kcals) per minute for the low intensity, 6.2 kcal per minute for the medium intensity and 8.8 kcal per minute for the high intensity level routines. It was thought by the investigator that the small energy cost of the low level dancing would not elicit a training effect if performed over an appropriate length of time. However, he concluded that the moderate intensity sessions were equivalent to ice skating at nine miles an hour, walking at three and one-half miles an hour or bicycling at 10 miles per hour. The energy cost of the high intensity dancing was comparable to a half-hour of vigorous basketball, cycling at 13 miles per hour, running at five and one-half miles an hour and swimming freestyle at 55 yards a minute. The average exercise heart rate was 175 beats per minute with a mean oxygen consumption of 29 $ml \cdot kg \cdot min^{-1}$.

Using four female subjects, Foster (1975) also investigated the energy cost of aerobic dancing. In the monitoring of one fairly vigorous routine, a mean oxygen consumption value of 33.6 $ml \cdot kg \cdot min^{-1}$ was obtained. According to Foster, this represented a physiological workload comparable to running at a 12-minute mile pace. The group peak load of 39.2 $ml \cdot kg \cdot min^{-1}$ was comparable to running at a 9.5 mile pace. The mean and peak loads represented 77 and 90 percent of the subject's estimated max $\dot{V}O_2$. Before any measurements were made, Cooper's 12-minute run test was administered for prediction of max $\dot{V}O_2$ and assessment of the subject's fitness level.

The results of a study by Igbanugo and Gutin (1978), likewise, investigating the metabolic requirements of aerobic dancing using non-dancers, compare quite favorably with those of Weber (1974) and Foster (1975). In this study, the subjects danced by following a videotape taken of an experienced aerobic dance teacher. This allowed for uniformity of dance movements and insured equivalent intensity levels. Each subject danced four routines at each intensity level on separate days. The women's oxygen consumption in $ml \cdot kg \cdot min^{-1}$ was 12.97, 20.9 and 27.25 for the low, medium and high intensity dancing, respectively. The two male subjects had slightly higher values for each level. Mean heart rates were 114, 145, and 156 beats per minute for the women and 106, 129 and 141 beats per minute for the men, for the low, medium, and high intensity dancing, respectively. The authors concluded that aerobic dance can be useful as a modality for cardio-respiratory training and rehabilitation as well as for weight reduction and maintenance.

In a study designed to investigate whether aerobic dancing could elicit and maintain a heart rate capable of producing a training effect, Maas, as cited by Clarke (1977a), used 31 college women enrolled in a 12-week conditioning class. The conditioning class consisted of a 10-minute warm-up and then 30 to 40 minutes of aerobic dance. The results of the study found there was a significant decrease in resting heart rate and a significant increase in the mean distance travelled on the 12-minute run/walk test. The mean working heart rates clustered between 173 and 175 beats per minute. However, no control or jogging groups were compared.

Informally, Sorensen (1972), one of the originators of aerobic dance, also reported the effect of aerobic dancing as evaluated by Cooper's 12-minute run/walk test for 15 women and girls ages 13 to 51 years. Part of the group served as a control while the rest participated in a 12-week aerobic dance session. After the first 12-minute test, 61% were in Cooper's Very Poor or Poor fitness categories. After participating in the aerobic dance sessions, only 27% were in these categories; 25% were in the Good and 3% were in the Excellent categories. The controls showed little change.

The lack of longitudinal studies involving assessment of max $\dot{V}O_2$ before and after a training period of aerobic dance indicates a real need for this type of study. One such study (Durrant, 1975) compared jogging, rope skipping and aerobic dancing. One-hundred and twenty women were assigned to one of the three activities or a control group. The subjects participated in their assigned activity for 12 minutes a day, 3 times a week for 14 weeks. Heart rates between 140 and 150 beats were maintained throughout the workout. The results of the study showed that the three activity groups had a significant increase in max $\dot{V}O_2$ over the control group as well as a significant increase in the amount of lean body mass. Change in percent body fat was not significant for any group. There was also no significant change in max HR over the 14-week training period.

Summary

In summary, numerous researchers agree that a test of max $\dot{V}O_2$ is one of the best physiological indices of cardio-respiratory endurance. In determination of this measure, the treadmill is one of the most commonly used devices for testing individuals. There are numerous treadmill protocols of varying intensities and durations in use today.

Investigators have found that cardio-respiratory endurance can be developed and maintained through a proper combination of training intensity, frequency and duration. A multitude of studies have manipulated these training variables in order to establish minimal but beneficial exercise levels. A recommendation incorporating these studies stated that three to five times per week at 60 to 90 percent of one's maximal heart rate reserve for 15 to 60 minutes is an optimal exercise level (American College of Sports Medicine, 1978).

Jogging, defined as a steady-paced non-competitive run, has become increasingly popular over the past decade. A number of studies using both men and women have indicated that a regular jogging program will provide cardiovascular improvements such as increased max $\dot{V}O_2$ and $\dot{V}E$ max, along with decreased heart rates at submaximal workloads.

Another relatively new exercise modality is aerobic dance which consists of basic loco-motor skills such as running, hopping, and jumping incorporated into routines set to music. Investigations of the metabolic cost of this activity have indicated that aerobic dance can be effectively used as a modality for cardio-respiratory training. A lack of longitudinal studies involving an assessment of max $\dot{V}O_2$ before and after a training period of aerobic dance indicates a real need for this type of study.

CHAPTER III

METHODS

Subject Selection

Forty-six untrained females, all of whom were enrolled in Physical Education classes at the University of Wisconsin-La Crosse during the second semester of the 1980-1981 school year, participated in this study. These subjects ranged in age from 18 to 29 years and included 19 from a jogging-fitness class, 15 from an aerobic dance class and 12 from bowling classes.

Out of the initial group of 56 volunteers, the above subjects were selected on the basis of information received from a questionnaire regarding their previous exercise habits (see Appendix A). Those individuals running over three miles total per week or engaging in a similar, rhythmic, large-muscle activity two or more times per week with a duration greater than 10 minutes were eliminated. Also, subjects with an initial max $\dot{V}O_2$ greater than 43.0 $ml \cdot kg \cdot min^{-1}$, which according to Astrand and Rodahl (1977) would have put them in an above average fitness category, were not allowed to participate. In addition to the above criteria, individuals who smoked were screened out of the study. Medcal clearance from the University of Wisconsin-La Crosse Student Health Center was a prerequisite for participation in the investigation.

Out of the original group of 51 girls who qualified to participate in the study, one became pregnant, two were eliminated because their initial max $\dot{V}O_2$ exceeded the previously determined criterion for untrained subjects, one dropped out for personal reasons and one was eliminated due to poor attendance. The remainder (n = 46) completed the entire seven-week program with a minimal number of absences, ranging from zero to four per subject. The importance of abstaining from any regular physical activity outside of class was heavily stressed to the subjects at the onset of the investigation.

Testing Procedures

All testing took place in the Human Performance Laboratory at Mitchell Hall. The subjects were required to attend a practice session at least one day prior to their first treadmill test. This practice session consisted of putting on the head-gear and mouthpiece, getting on and off the treadmill and walking and running at testing speeds. At this time the subjects were also given a short list of procedures (see Appendix B) to follow on the day of their test.

Upon arrival for their initial treadmill test, a consent form (see Appendix C), explaining the nature of the study and the risks involved, was signed by each participant. The subject's weight was recorded to the nearest quarter of a pound. Preparation of the skin area for electrode placement included abrasion followed by cleansing with an acetone towlette. Four electrodes were then placed on the following sites: superior aspect of right pectoralis major distal to sternum; superior aspect of left pectoralis major distal to sternum; right sixth rib distal to sternum; and, left sixth rib distal to sternum.

Once the electrodes were connected, the subject performed a maximal treadmill run for determination of the following variables: total treadmill time; max $\dot{V}O_2$ ($l \cdot min^{-1}$ and $ml \cdot kg \cdot min^{-1}$); maximal heart rate; and, maximal ventilatory volume. The Modified Astrand Protocol was used and includes the stages presented in Table 1.

Table 1

Modified Astrand Treadmill Protocol

	Minutes	Speed	Grade
Warm-up	5	3.5 mph	2.5%
Stage I	3	6.0 mph	0.0%
Stage II	2	6.0 mph	2.5%
Stage III	2	6.0 mph	5.0%
Stage IV	2	6.0 mph	7.5%
Stage V	2	6.0 mph	10.0%
Stage VI	2	6.0 mph	12.5%

(Pollock et al. 1976 p. 40)

Throughout the test the speed was held constant at 6 miles per hour while the elevation increased 2.5 percent every two minutes after Stage I.

Measurements of oxygen uptake and ventilation were made every 30 seconds during both the warm-up and exercise periods. All measurements were taken with the Metabolic Measuring Cart (MMC, Beckman Instruments) which consists of a carbon dioxide analyzer (LB-2) and an oxygen analyzer (OM-11). Calibration of the MMC was performed prior to each test with a known gas sample previously determined by the Scholander technique.

Heart rate monitoring was done with a Viagraph electrocardiographic machine. Heart rates were taken during the last 10 seconds of every stage, at maximal effort and every two minutes after that until the subject's heart rate returned to a level below 100 beats per minute. The heart rate was determined by counting the R to R interval for a six second period of time and multiplying by 10.

The test itself was terminated when one or more of the following criteria was met: leveling off or decrease in $\dot{V}O_2$ with increasing workloads, RER greater than 1.0; heart rate in excess of 190 beats per minute; and, volitional exhaustion (Mathews & Fox, 1976, p. 506).

Training Program for Jogging Group

The training program for the jogging group consisted of a 45-minute class which met four days a week for seven weeks. The classes were held Monday through Thursday from 11:00 to 11:45 a.m. in the Field House at Mitchell Hall. The subjects ran indoors on an eighth-of-a-mile tartan track with a large pace clock in one corner. Each class session started with an eight to ten minute group warm-up followed by 30 minutes of non-stop walking and jogging. A brief cool-down was done on an individual basis following the exercise session.

At the beginning of the training program each subject was instructed by the investigator to take her pulse rate at either the carotid or radial artery. A target heart rate representing 75 percent of the maximal heart rate achieved on the initial treadmill test was then assigned. The range of assigned heart rates was 138 to 156 beats per minute (see Appendix D). Subjects were asked to monitor their heart rates and report them to the investigator after each mile of walking or jogging.

At the end of each class a final heart rate was also taken before the cool-down period.

The length of time or duration of the exercise session remained at a constant 30 minutes throughout the seven-week period. Initially, the subjects were unable to jog continuously for the entire class period; thus, a walk-jog combination was employed. The distance covered by the subjects during the half-hour time period gradually increased as they were able to jog for longer periods of time without walking. By the end of the session all subjects were able to jog continuously for a distance of two or more miles. Sprinting or short interval running was discouraged; continuous movement was encouraged at all times.

Training Program for Aerobic Dance

The training program for the aerobic dance group consisted of a 45-minute class which met four days a week for seven weeks. The classes were held Monday through Thursday from 1:00 to 1:45 p.m. The class met in the dance studio on Tuesdays and Thursdays and in the northwest gym on Mondays and Wednesdays. All sessions consisted of an eight to ten minute warm-up period, 30 minutes of continuous dance movements and a brief cool-down period at the end. An average of six to seven dance routines were performed daily during the 30 minutes of continuous movement (see Appendix E).

At the beginning of the study each subject was instructed by the investigator to take her pulse at either the carotid or radial artery. A target heart rate representing 75 percent of the maximal heart rate achieved on the initial treadmill test was then assigned. The prescribed heart rates ranged from 138 to 162 beats per minute (see Appendix D). Heart rates were taken two to three times daily and recorded at the end of each class by the investigator. Continuous movement was maintained as much as possible throughout the class session. When taking heart rates or during a change of music, the women were encouraged to continue walking around the room.

Procedure for Control Group

The subjects serving as the control group came from several bowling classes which met either two or four times per week depending on the length of the class. All subjects were tested and re-tested with the same procedure that was used for the joggers and dancers. In addition, the control group was asked to refrain from participating in any regular physical activity outside of their bowling class for the duration of the investigation.

Statistical Analysis

Upon completion of the post-test, the results were analyzed to determine whether or not significant changes had occurred over the course of the training period in any of the groups. A Mixed Design Analysis of Variance with repeated measures (BMD program) was used for these analyses. The .05 level of confidence was chosen to test the hypothesis for this study. When the Analysis of Variance yielded a significant F ratio, a Scheffé post hoc test was employed to determine which groups were significantly different. In addition, an independent t-test was calculated on the daily heart rate averages of the jogging and dancing groups to assess the variability of the means.

CHAPTER IV

RESULTS AND DISCUSSION

Introduction

The purpose of this chapter is to present an analysis and interpretation of the raw data collected from the pre (T_1) and post (T_2) testing of the experimental and control groups. The intent of the study was to compare the training effect of a jogging program with that of an aerobic dance program, using untrained female subjects.

The statistical model used in this investigation was a Mixed Design Analysis of Variance with Repeated Measures. The .05 level of confidence was the critical statistical value used for the acceptance or rejection of the null hypothesis. After computer analysis (BMD) the Scheffé post hoc test was employed to determine the exact areas of significance. In addition, an independent t-test was utilized to compare the daily heart rate averages of the two experimental groups.

The remainder of this chapter consists of the presentation of results and a discussion of findings for each variable. The findings are presented in the following order: subject characteristics, training intensity; maximal heart rate; $\dot{V}E$ max; max $\dot{V}O_2$; and, run time.

Subjects

Data was collected on 46 college students who were screened before their acceptance as subjects. All subjects attended the University of Wisconsin-La Crosse during the Second Semester of the 1980-81 academic year and were between the ages of 18 and 29 years. Descriptive data for these subjects can be found in Table 2.

Table 2

Means and Standard Deviations for Physical Characteristics of Subjects

Group	Height (cm)	Weight (kg)	Age (yr)
Joggers	167.5[a]	63.2*	19.3
	6.6[b]	9.2	1.8
Dancers	164.3	62.2*	21.4
	8.8	11.8	2.6
Control	164.6	58.9*	20.3
	4.7	7.4	1.7

a = mean
b = standard deviation
* = significant difference between joggers and dancers, joggers and controls, and dancers and controls

<u>Body Weight</u>

No significant changes ($p > .05$) in body weight from T_1 to T_2 were found among groups over the seven week training period (see Figure 1). There were, however, slight increases of less than one percent for the jogging and control groups and less than one percent decrease in the body weight of the dancers.

Because the factor of body weight is not only influenced by exercise but also by diet, it becomes quite difficult to strictly control this variable in most training studies. In the present study there was

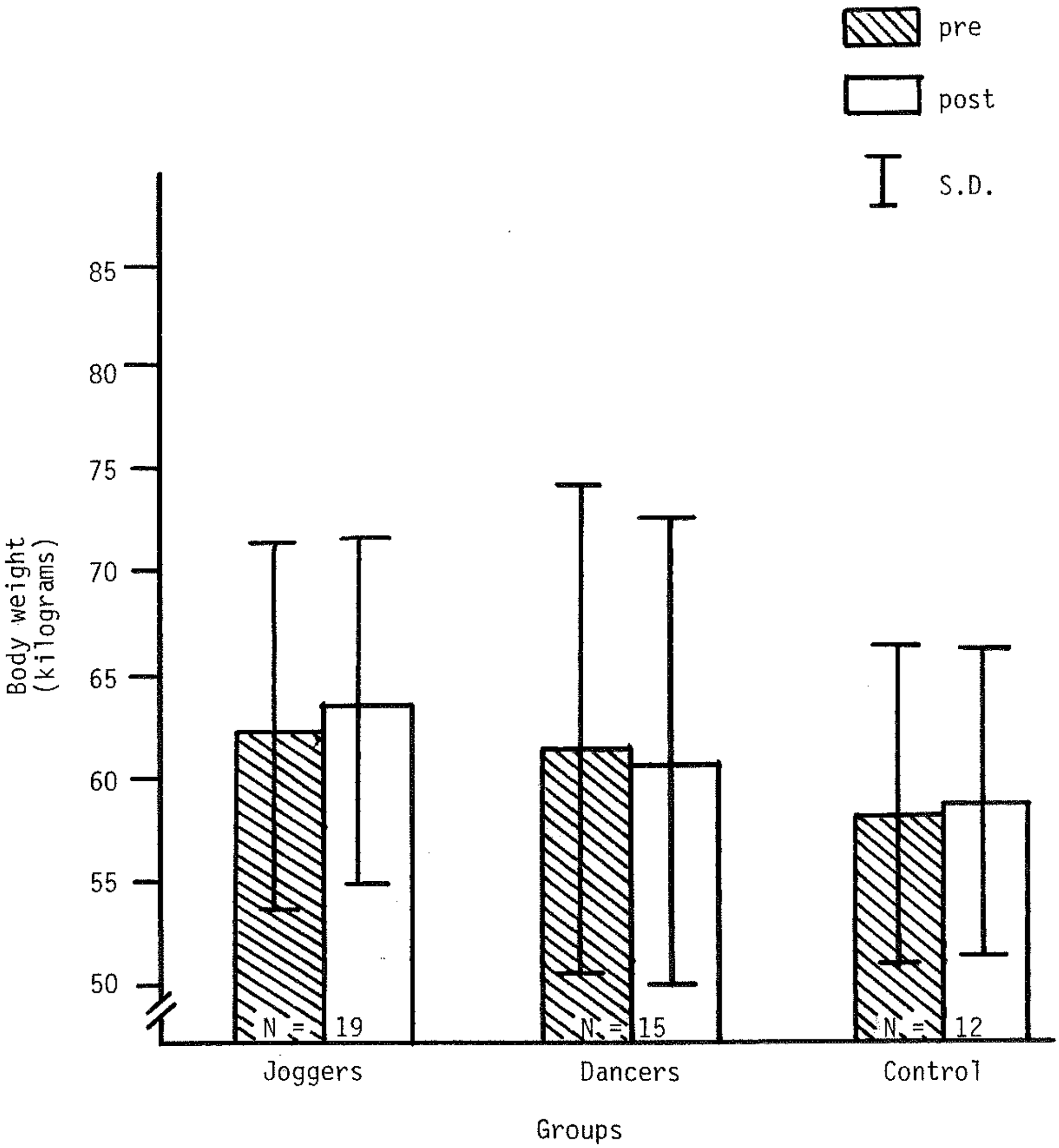

Figure 1. Pre-post test body weight values for joggers, dancers and controls.

no attempt made to control for diet and this may be the reason that a significant weight loss in the subjects was not seen.

Just as training studies have often shown conflicting results in terms of max $\dot{V}O_2$ improvements, there have also been numerous training studies showing mixed results in regard to changes in body weight. In agreement with the results of the current study, several investigators, in studies of similar frequency, intensity and duration, have documented little or no change in body weight (Brown et al. 1972; Fringer & Stull, 1974; Kilbom, 1971). In contrast to this, several long-term studies lasting 20 weeks or longer (Pollock et al. 1975; Wilmore et al. 1980) found substantial decreases in body weight.

Another consideration in discussing body weight is the individual components of percent body fat and lean body mass. These must both be determined at the onset of an investigation if any conclusions regarding percent body fat or lean body mass are to be made. It could be possible in the present study that the subjects had an increase in lean body mass and a decrease in percent body fat without an outward change in gross body weight.

Training Intensities

According to McArdle et al. (1981) training induced physiologic changes depend primarily on the intensity of the work. Intensity can be applied on either an absolute or relative basis. Absolute intensity involves all individuals doing the same work at the same rate. However, in doing this, a considerable stress for one person might be above or below the optimal training threshold for another person. For this reason, training is usually assigned based on the relative stress placed on a person's physiologic systems. Relative intensity can be assigned as some percentage of maximum function, such as max $\dot{V}O_2$, maximum heart rate or maximum work capacity.

In the present investigation, an intensity of approximately 75 percent of the subject's maximal heart rate achieved on the initial treadmill test was assigned throughout the study. A range of 157 to 167 beats per minute, with a mean intensity of 83 percent of their maximal heart rates was reported for the joggers. A very similar range of 152 to 176 beats per minute with an almost identical intensity of 84 percent of their maximal heart rates was reported for the dancers.

An independent t-test comparing the mean daily heart rates of the two experimental groups found no significant difference (p .05) between the heart rate values reported for the two groups. The critical value of t was 1.697 with 32 degrees of freedom. The test value of t was 0.336.

Based on the reported heart rate ranges it appears that both jogging and aerobic dance can be performed at almost identical intensities for a comparable length of time. It also appears that an intensity of 83 to 84 percent of one's maximal heart rate is a sufficient stimulus for providing training improvements.

<u>Maximal Heart Rate</u>

An analysis of variance revealed a small but significant (p .05) decrease in maximal heart rate for both the jogging and dancing groups from T_1 to T_2 (see Figure 2). This drop amounted to 2.9 and 2.8 beats per minute for the joggers and dancers, respectively. The control group

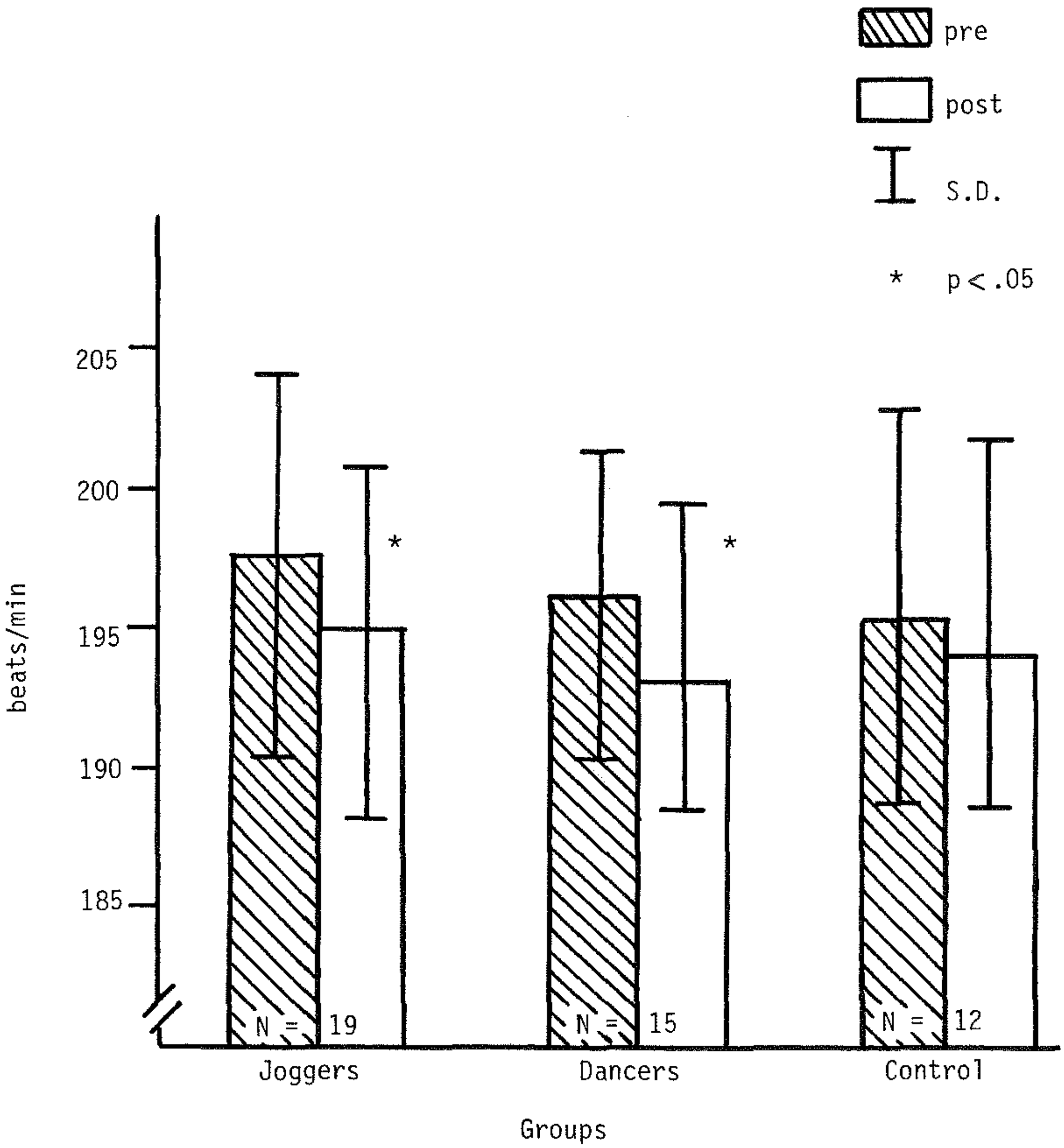

Figure 2. Pre-post test maximal heart rate values for joggers, dancers and controls

also showed a slight decrease from pre to post-tests but this was not significant ($p > .05$).

A well-documented change associated with training is a reduction in resting and submaximal heart rates at known workloads (Astrand & Rodahl, 1977). A much less-documented occurrence is a small reduction in maximal heart rate which has been known to occur with training. Investigations by Brown et al. (1972), Pechar et al. (1974) and Pollock (1969), as well as the current investigation, have all shown a decrease in maximal heart rate with training programs of a similar length and frequency.

Pollock, as cited by Wilmore (1980), summarized the results of previous studies by stating that maximal heart rate reductions are generally found only in studies involving subjects whose initial maximum heart rate exceeded 180 beats per minute. This generalization appears to be consistent for the results of this study as well.

The mechanism behind this decrease in maximal heart rate is unknown. It has been suggested by Hall (1963) that training reduces the intensity of several mechanisms known to cause cardiac acceleration such as the intensity of muscular activity at any given workload, a decrease in the production of the acid products of exercise, and a cardioaccelerator that might be experienced reflexly from respiration. Saltin and Astrand (1967) suggested that the lower mean maximal heart rates found in athletes engaged in endurance events may be due to constitutional factors.

Another possible explanation for a decrease in heart rate from T_1 to T_2 for both experimental groups is that a true maximal level of work effort was not achieved by the subjects on the post test. However, in light of other criteria, RER in excess of 1.0, leveling off or decrease in $\dot{V}O_2$ at increasing workloads and volitional exhaustion of the subjects, the investigator felt that the subjects had reached their maximal level when the tests were terminated. It would also follow that a subject would be more likely to reach a maximal workload on their second test having previously experienced an identical maximal test. Also, from T_1 to T_2 the control group showed no significant change in reported maximal heart rate values. Therefore, it seems possible that an exercise program utilizing jogging or aerobic dancing modalities may produce a slight decrease in maximal heart rate as a result of the training program itself.

Maximal Ventilation

In addition to the variables already discussed, adaptation to training was also reflected by the changes in maximal ventilation. From pre to post-tests there were significant (p .05) gains for both experimental groups (see Figure 3). The joggers demonstrated a 9.4% increase while the dancers showed an increase of 8.4% over the course of the study. This amounted to a 7.9 and 6.8 $l \cdot min^{-1}$ increase for the joggers and dancers accordingly. The control group showed no significant (p .05) increase in maximal ventilatory volume.

The results of the present study are in accordance with the findings of many other investigators who reported increases in maximal ventilatory volume with training (Fringer & Stull, 1974; Kilbom, 1971; Pechar et al. 1974; Pollock et al. 1975; Wilmore et al. 1980; Wilmore et al.

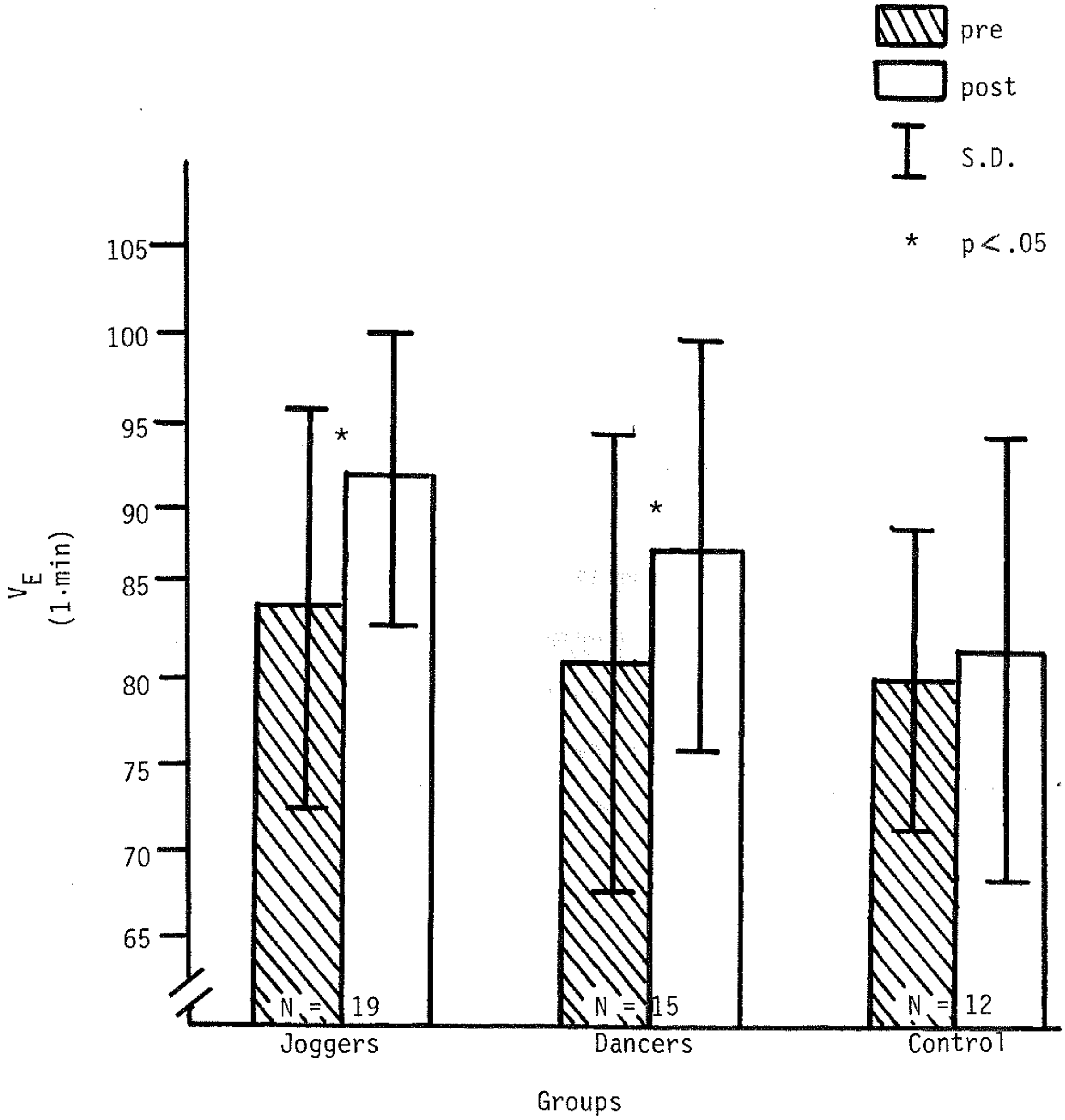

Figure 3. Pre-post test maximal ventilatory volumes for joggers, dancers and controls

1970). Of those studies which demonstrated an increase in maximal ventilatory volume with training, over half of them reported gains larger than the 9.4 and 8.4% which were found in the present study.

An increase in maximal ventilatory volume which often accompanies training has been explained by Astrand and Rodahl (1977) to be caused partially by an increase in max $\dot{V}O_2$ uptake which leads to an increased production of carbon dioxide and a higher level of blood lactate. In view of the significant increase in ventilatory volumes, as well as the improvement in max $\dot{V}O_2$, the results of this study would seem to provide support for this explanation.

The slight but not significant difference in maximal ventilatory volume between the two experimental groups at T_1 and T_2 can perhaps be attributed to the larger size of the joggers in terms of height and weight. Both of these factors have a definite influence on lung capacity and could account for this variation.

Max $\dot{V}O_2$

Significant ($p < .05$) gains in both relative and absolute oxygen consumption were realized for the jogging and dancing groups alike (see Figures 4 & 5). Increases amounted to .19 and .20 of a $l \cdot min^{-1}$ for the joggers and dancers, respectively. Relative increases ranged from an average of 3.0 $ml \cdot kg \cdot min^{-1}$ for the joggers to an average of 3.6 $ml \cdot kg \cdot min^{-1}$ for the dancers. There was no significant change in the control group.

Pre-test means among all three groups were characterized by a significantly higher absolute oxygen consumption by the joggers in comparison with the dancers and the control groups. Most likely, this

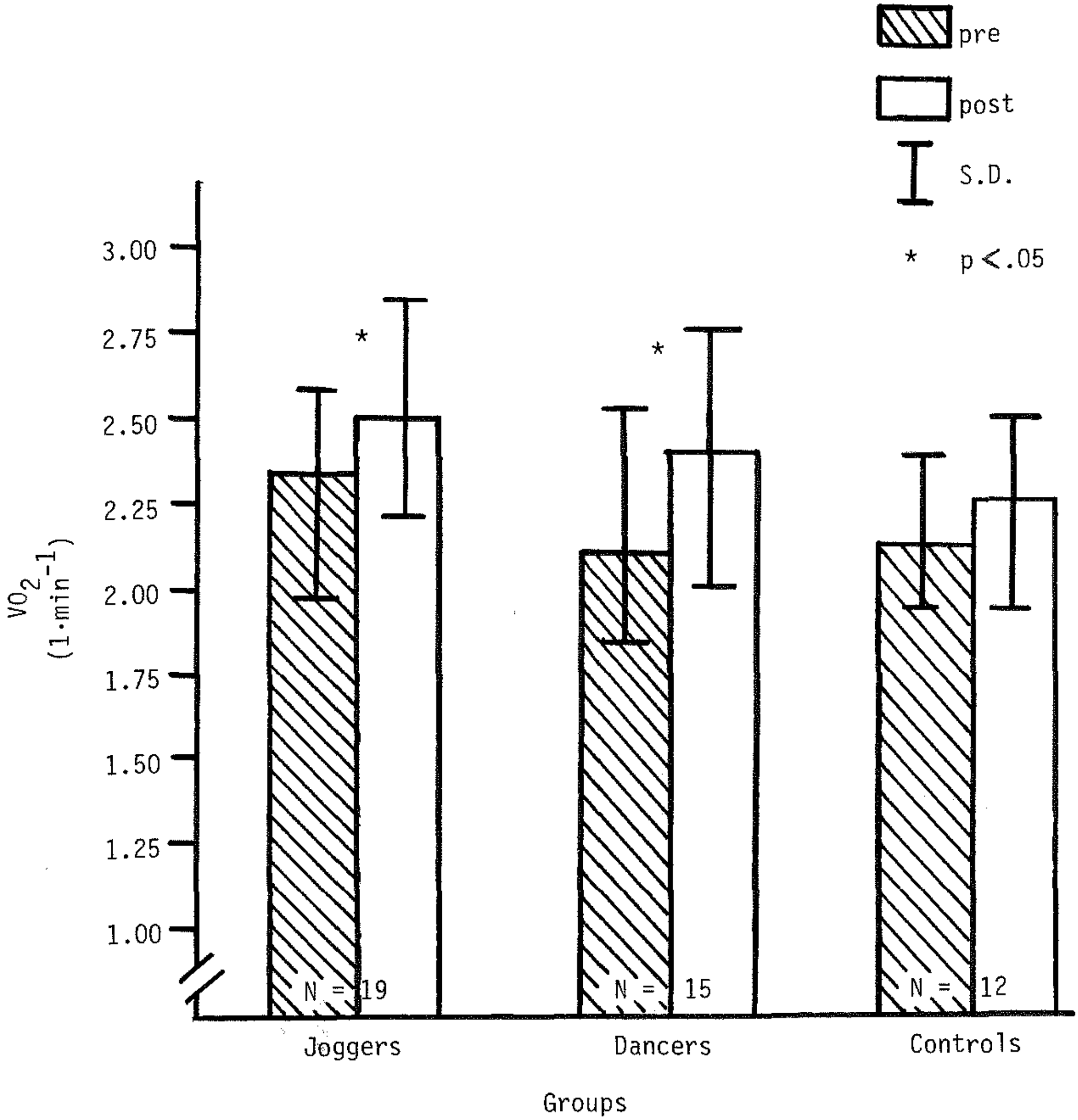

Figure 4. Pre-post max VO_2 values ($l \cdot min^{-1}$) for joggers, dancers and controls

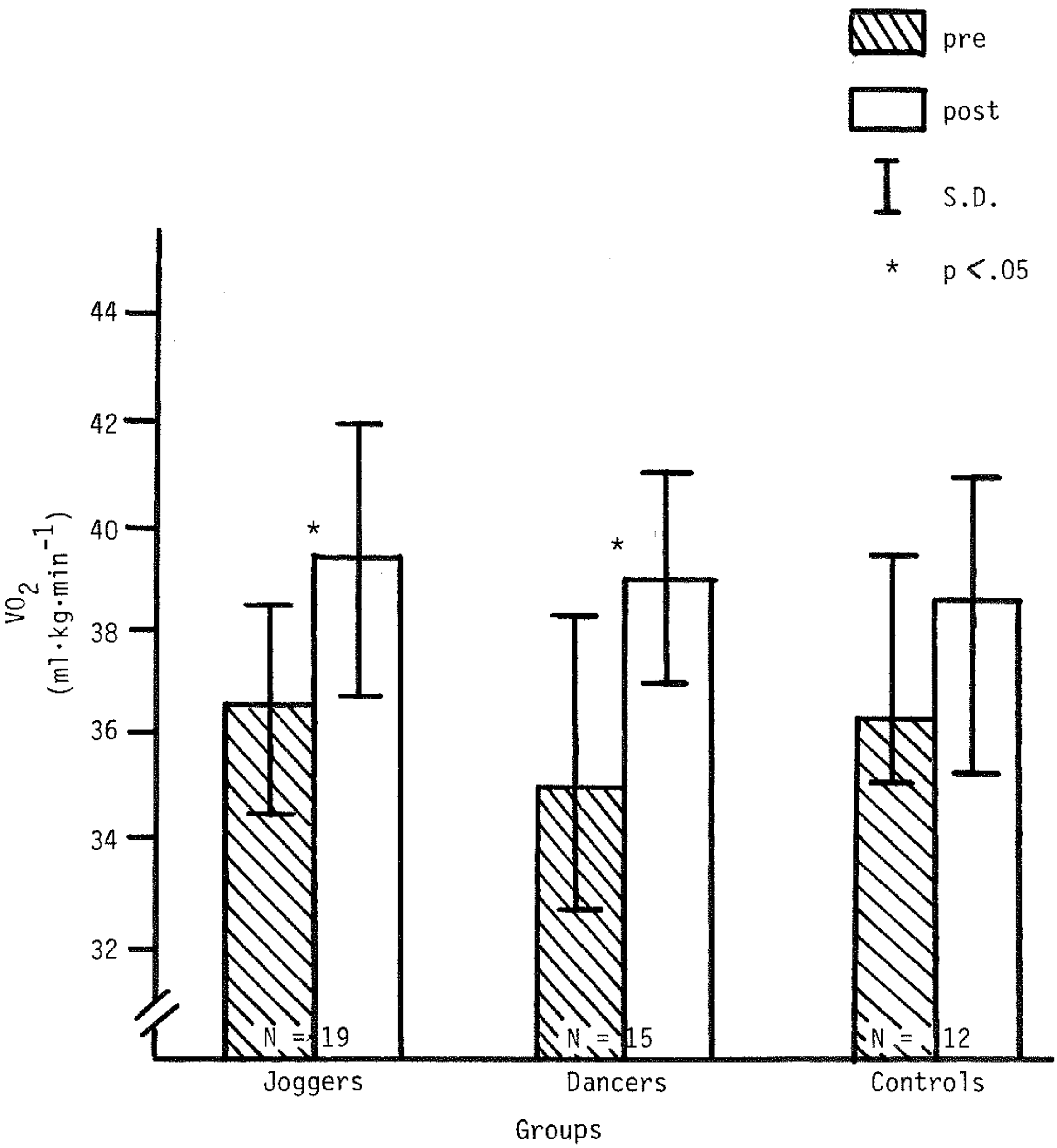

Figure 5. Pre-post test max VO_2 values (ml·kg·min^{-1}) for joggers, dancers and controls.

was due to the significant difference in weight between these three groups. This variation in absolute oxygen consumption, which was also noted at the end of the investigation, did not appear when looking at relative oxygen intake among any of the groups during T_1 or T_2.

In comparison with other studies (Davies & Knibbs, 1971; Edwards, 1974; Fringer & Stull, 1974; Michael & Horvath, 1965), the pre-test values of 2.31 and 2.19 $l \cdot min^{-1}$, as well as 36.4 and 35.4 $ml \cdot kg \cdot min^{-1}$ for the joggers and dancers, respectively, appear to be somewhat on the high side of the range for untrained college females. Michael and Horvath (1965), who recorded an average of 1.78 $l \cdot min^{-1}$ and 29 $ml \cdot kg \cdot min^{-1}$ for untrained California coeds ages 17 through 22 years, reported this to be a fairly typical value for this type of group. Eisenman and Golding (1975), however, found pre-test values similar to those of the present study in their max $\dot{V}O_2$ findings of 2.2 and 2.3 $l \cdot min^{-1}$ and 38.1 and 39.0 $ml \cdot kg \cdot min^{-1}$ for young women of a similar age and fitness level.

Pollock, as cited by Lamb (1978), stated that changes in maximal oxygen consumption as a result of aerobic training range from no improvement to increases as great as 43% and more. According to Wilmore et al. (1980) the probable sources of this variation are due to differences in intensity, duration, frequency, mode and initial level of fitness. Therefore, in comparing max $\dot{V}O_2$, it is important to compare studies of similar design.

Studies ranging from four to 20 weeks with exercise sessions averaging three times per week, have reported max $\dot{V}O_2$ gains of over 25% in untrained individuals (Brown et al. 1972; Edwards, 1974; Fringer &

Stull, 1974; Pollock et al. 1971). Six women in a study by Roskamm (1967) showed gains ranging as high as 40%.

Other investigators (Eisenman & Golding, 1975; Kilbom & Astrand, 1978; Pechar, McArdle, Katch, Magel & DeLuca, 1974; Sinning & Adrian, 1968; Wilmore et al. 1980; Wilmore et al. 1970) have found much smaller increases in max $\dot{V}O_2$ which compare quite favorably with those in the present study. Gains ranging from 6.0% to 17.6% have been found by the above investigators in studies also ranging from four to twenty weeks with exercise sessions averaging three times per week.

Very few studies have found no significant improvement in max $\dot{V}O_2$ as a result of training. Rosentswieg and Burrhus (1975) reported no significant gains in max $\dot{V}O_2$ from a four-week program that elicited a heart rate of 160 beats per minute for 15 minutes three times per week. The subjects were all untrained female college students.

In looking at the results of the present study, comparable increases in both relative and absolute oxygen consumption were found in both experimental groups. The absolute oxygen consumption of the joggers increased 8.2% while the dancers oxygen consumption in $l \cdot min^{-1}$ rose 9.1%. Likewise, the relative oxygen consumption of the joggers increased 8.2% while the dancers reflected a similar 10.2% gain. These comparable increases can perhaps be attributed to similar intensities at which both groups worked. The joggers worked at an intensity of 83% while the dancers worked at 84% of their maximal heart rate. All other factors such as frequency, duration and initial level of fitness as measured by oxygen uptake in $ml \cdot kg \cdot min^{-1}$ were constant.

According to Astrand and Rodahl (1977), the improvement in max $\dot{V}O_2$ as a result of training can be attributed to a greater maximal cardiac output, an increased arteriovenous oxygen difference or both. Kilbom (1971) stated that in a training study of short duration, four to ten weeks, the increase in a female's max $\dot{V}O_2$ is a result of a greater maximal cardiac output rather than to an increased arteriovenous oxygen difference. In agreement with this, Lamb (1978) also wrote that the improvement in maximal cardiac output with aerobic training is at least as important as any other change in maximal cardiovascular function and may be the only significant change observed in some subjects. Taking this into consideration, it is possible that the improvement in max $\dot{V}O_2$ by the subjects in this study may have been caused by a greater maximal cardiac output as a result of the jogging and aerobic dance training programs.

Run Time

Test results indicate that both the joggers and dancers significantly ($p < .05$) increased their mean run time on the treadmill from T_1 to T_2 (see Figure 6). An improvement of 65 seconds (14.4%) and 85 seconds (20.7%) was recorded for the joggers and dancers, respectively. Although, at the onset of the investigation the joggers were able to run for a significantly longer time period than the dancers, there was no significant ($p > .05$) change noted in the control group from T_1 to T_2.

The improvement in run time by both experimental groups in this study is quite comparable to that found in an investigation by Edwards (1974) which cited a 138 second (20.9%) increase in total run time as a

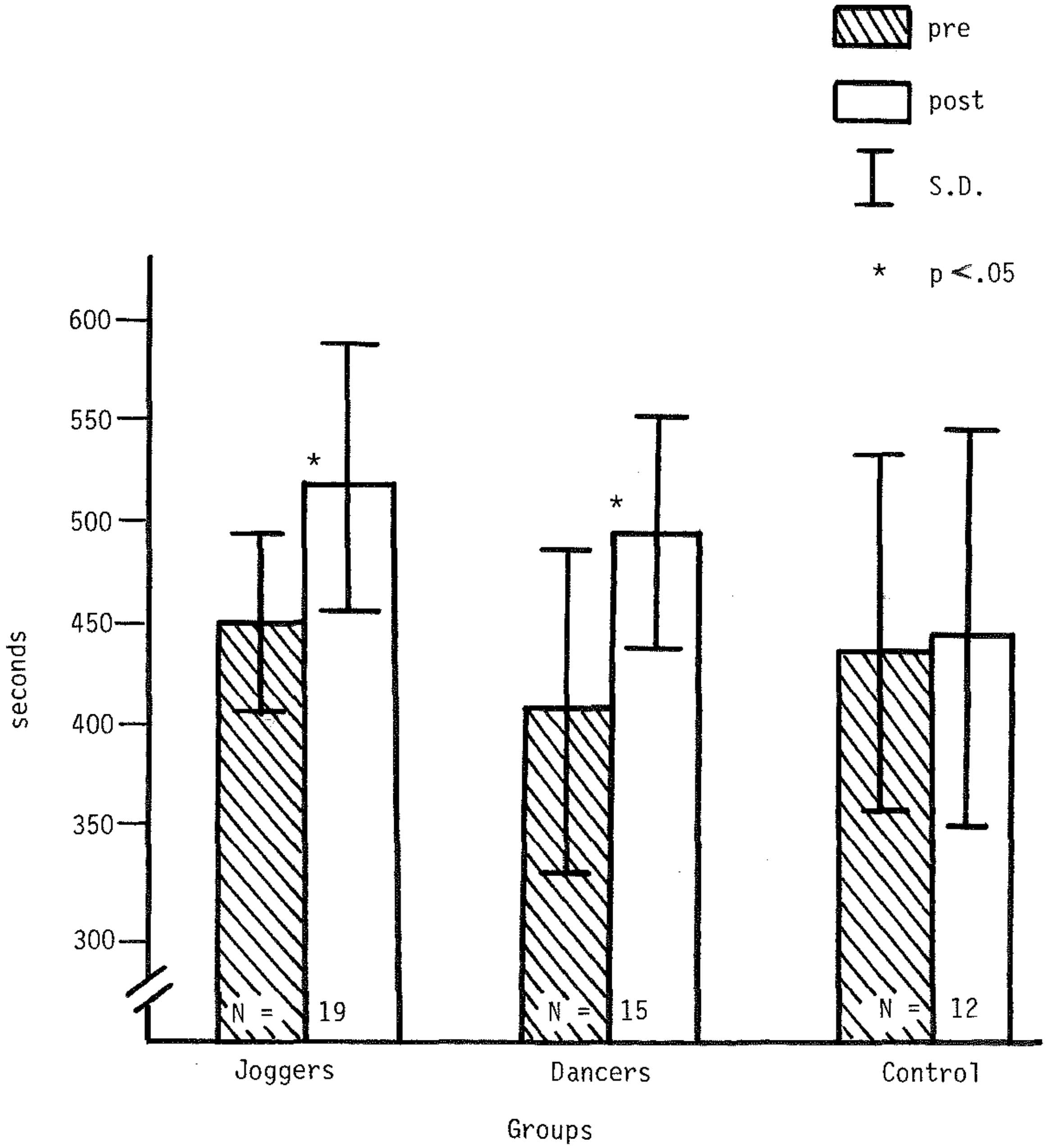

Figure 6. Pre-post test run time values for joggers, dancers and controls.

result of a four-week training program. The initial fitness level of the subjects in the present study was somewhat higher than those in the above study which may account for the slightly lower increases in run time seen in the jogging group in the present investigation.

In contrast to the above findings, Wilmore and co-workers (1980) found no significant increase in treadmill run time for two groups of men who trained by jogging and playing tennis three times a week for 20 weeks. They did, however, note a significant lengthening of a treadmill run time in the group who trained by cycling for a similar amount of time. This finding parallels that of the present study in that the dancers were able to improve their run time to a greater extent than the joggers. This is rather surprising due to data reported on specificity of training in regards to testing modalities. One would expect the joggers to have improved more because their training modality was running. However, in terms of total time on the treadmill, there was no significant difference between the two groups.

In view of the accompanying increases in max $\dot{V}O_2$, the increased run times in this investigation seem to provide supportive evidence for an improved work capacity of the subjects. Training programs involving aerobic dance and jogging would appear to enhance one's cardiovascular endurance as measured by time or distance covered on a treadmill.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to compare the effects of an aerobic dance program with those of a jogging program in determining the amount of cardiovascular improvement afforded by each. The subjects in the investigation were 46 untrained females all of whom were enrolled in physical education classes at the University of Wisconsin-La Crosse. Ranging in age from 18 to 29 years, these subjects included 19 from a jogging-fitness class, 15 from an aerobic dance class and 12 from bowling classes who were used as a control.

Each subject was administered a pre and post-test Modified-Astrand maximal treadmill run for determination of run time, max $\dot{V}O_2$ in $l \cdot min^{-1}$ and $ml \cdot kg \cdot min^{-1}$, maximal heart rate, $\dot{V}E$ max and body weight. During the seven-week training program exercise sessions were held four times a week for 30 minutes, excluding warm-up and cool-down periods. Subjects in the jogging and dancing groups monitored their heart rates at specified times throughout each daily class session. The jogging and dancing groups worked at average intensities of 83% and 84% of their maximal heart rates, respectively.

A Mixed Design Analysis of Variance with Repeated Measures was used to determine if there were significant differences between the two training programs. A Scheffé post hoc test was employed to determine areas of significance. Significant increases ($p < .05$) in run time, relative and absolute maximal oxygen consumption, and maximal ventilatory volume were found for both experimental groups. Findings also included a significant ($p < .05$) decrease in maximal heart rate and no change in body weight. There were no significant differences between the two experimental groups for any of the variables as a result of the training program. Furthermore, the control group showed no change from T_1 to T_2 for any of the variables.

Conclusions

Within the limitations of the study and based on the statistical analysis of the data, the following conclusions were made:

1) The null hypothesis, stating that there is no significant difference between the cardiovascular training benefits of a jogging program versus those of an aerobic dance program, was accepted.
2) There was a significant increase in run time for both experimental groups ($p < .05$) as a result of the training program.
3) There was a significant increase in both absolute and relative oxygen consumption for both experimental groups ($p < .05$) as a result of the training program.
4) There was a significant decrease in maximal heart rate for both experimental groups ($p < .05$) as a result of the training program.
5) There was a significant increase in maximal ventilatory volume for both experimental groups ($p < .05$) as a result of the training program.
6) There was no significant difference in body weight for either of the experimental groups ($p > .05$) as a result of the training program.

7) Aerobic dance can be an effective, alternate, exercise modality for improvement of cardiovascular fitness.

8) Aerobic dance can be substituted for jogging with no significant difference in the resulting cardiovascular benefits.

9) Training effects appear to be independent of mode of activity if the various combinations of intensity, duration and frequency are the same. Therefore, a variety of aerobic activities can be interchanged for improving and maintaining physical fitness.

Recommendations

Based upon the conclusions of this study and the related review of literature, the following recommendations are made in regard to future studies.

1) Because gross body weight does not always reflect changes in percent body fat and lean body weight, a study should be conducted to determine percent body fat and lean body weight before and after an aerobic dance training program.

2) Studies using other exercise modalities have shown cardiovascular improvements with exercise training intensity levels lower than those in the present study. An investigation should be conducted using the same training modalities with a lower work intensity such as 50 to 60% of the maximal heart rate.

3) Several studies have shown varying rates of max $\dot{V}O_2$ improvement ranging from two weeks after the onset of the investigation to significant changes occurring only after 10 weeks of training. A study should be conducted to examine the rate of max $\dot{V}O_2$ improvement with testing periods placed throughout the study.

4) Because a large number of the females involved in aerobic dance classes throughout the country are women older than 18 to 29 years, a study should be conducted assessing the cardiovascular benefits of aerobic dance to older females.

5) Other activities such as bicycling and swimming which are known to improve cardiovascular fitness levels should be compared with aerobic dance to see if the results are similar to those in the present study.

6) A study involving athletes or other highly-trained subjects should be conducted to determine whether aerobic dance and jogging can cause similar cardiovascular increases in these individuals.

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APPENDIX A

SUBJECT QUESTIONNAIRE

1. Name ______________________________

   Social Security No. ______________________

   Phone ______________ Rank and Major _______/_______

2. Are you currently involved in a regular exercise program? _______

   If so, what type? ______________________

   How many times per week? ______________________

   How long does each exercise session usually last? ___________

   ____

   If involved in a running program, do you run over 3 miles total per week? ______________________

3. Are you on any University athletic teams? _______________

   If so, what and when is your season? _______________

4. Do you smoke? ___________ If so, how often? _________

   ____

5. Do you consider yourself to be in (check one of the following):

   _____ a) poor physical condition (never exercise at all)

   _____ b) fair physical condition (rarely exercise)

   _____ c) good physical condition (occasionally exercise)

   _____ d) excellent physical condition (regularly exercise)

6. Are you interested in being in the study? _______________

APPENDIX B

SUBJECT PROCEDURE LIST

Testing Information

1) Bring or wear shorts (or stretch pants), a t-shirt or loose blouse and gym shoes.
2) If you eat before your test - eat at least two hours prior to the test. Your meal should be light.
3) Do not consume alcohol at least 3 hours before your test.
4) Do not engage in heavy exercise 24 hours prior to the test.
5) Testing location: Human Performance Lab
   225 Mitchell Hall
   (It is upstairs on the southeast side of the building)

- -

You are scheduled for your treadmill test on ______________________ at ____________________. Please keep this appointment. If you cannot, please call me at 782-4464 (home) or at 785-8685 (lab) and leave a message for Suzanne Milburn.

APPENDIX C

SUBJECT CONSENT FORM

INFORMED CONSENT FOR JOGGING/AEROBIC DANCE STUDY

In conjunction with my jogging/aerobic dance class I, ______________________________, am willing to participate in the jogging/aerobic dance study conducted by Suzanne Milburn at the University of Wisconsin-La Crosse. I understand that participating in this study involves regular attendance throughout the scheduled class as well as a maximal treadmill test at the beginning and end of the 8-week course. I understand that the treadmill test consists of running to voluntary exhaustion on a motor-driven treadmill. After an initial warm-up of 3.5 mph at 2.5% grade, the speed of the treadmill will be 6 mph with a starting elevation of 0%; the grade will then be increased 2% every two minutes until exhaustion. During the test, heart rates will be monitored continuously through an electrocardiogram (ECG). This will involve the placement of 4 electrodes on the skin surface. Oxygen consumption will also be monitored through the use of a Beckman Metabolic Cart. This will involve breathing through a mouth-piece so that expired air can be collected and measured. The increase in workload will continue until a maximal oxygen consumption is reached or until I feel I cannot continue any longer. I am free to stop the test or withdraw from the study (not class) at any time.

As with exercise, there exists the possibility of adverse changes occurring, i.e., dizziness, staggering, difficulty in breathing, etc. during the test. In addition, I will feel tired at the end of the exercise. If any abnormal observations are noted, the test will be immediately terminated.

During my jogging/aerobic dance class I will be expected to follow a personalized exercise program based upon my initial treadmill test. I will be expected to work at that prescribed intensity throughout the study. In addition, I agree not to engage in any other cardiovascular activity on a regular basis.

In signing this consent form, I acknowledge that I have read the foregoing and I understand it; any questions which may have occurred to me have been fully explained to my satisfaction. The potential risks have been fully explained to me and I understand their implications. I hereby acknowledge that no representations, warranties, guarantees or assurances of any kind pertaining to the procedures have been made to me by the University of Wisconsin-La Crosse, the officers, administrators, employees, or by anyone acting on behalf of any of them. To my knowledge, I am not infected with any disease or have any limiting physical condition or disability, especially with respect to my heart, that would prevent me from participating in such strenuous exercise.

Signed: ______________________________ Date: ________________

Witness: ______________________________ Date: ________________

APPENDIX D

TRAINING HEART RATES

TRAINING HEART RATES*

Joggers

1/20/81	1/22/81	1/27/81	1/29/81	2/3/81	2/5/81
23	22	24	26	25	25
25	22	25	27	26	26
30	25	28	26	27	30
27	25	30	32	28	28
27	25	25	30	28	30
27	24	26	25	26	29
25	15	26	21	25	25
24	27	29	27	26	27
27	28	28	25	25	28
29	25	26	26	24	29
30	29	25	24	25	29
31	30	27	29	26	31
31	28	29	21	29	28
31	26	29	28	29	28
29	29	31	26	31	26
26	24	26	26	28	26
27	25	28	29	30	27
27	28	26	28	26	27
25	26	28	30	26	27
25	29	26	27	31	30
28	24	24	25	28	25
33	28	25	26	28	26
28	28	26	26	26	26
29	28	28	29	26	29
31	26	26	29	26	28
25	28	28	25	28	28
26	28	29	25	28	32
30	29	30	30	29	29
28	20	24	28	29	25
23	30	24	26	30	26
25	30	31	27	29	30
30	22	32	26	25	28
27	22	24	32	26	30
27	25	25	30	27	29
27	25	28	25	28	25
25	25	30	21	28	27
24	24	25	27	26	28
27	15	26	25	25	29
29	27	26	26	26	25
	28	29	24	25	27
	26	28	29	24	
	25		21		
			28		

*10-second counts

TRAINING HEART RATES

Joggers

2/10/81	2/12/81	2/17/81	2/19/81	2/24/81	2/26/81
27	27	28	28	30	29
29	28	28	29	30	28
30	25	33	27	28	28
25	35	30	25	29	32
26	28	29	30	32	30
25	27	32	32	28	29
27	28	26	26	25	30
28	29	28	28	26	35
29	25	24	22	32	26
25	26	27	23	29	23
26	28	30	24	27	24
26	26	29	31	24	30
28	27	29	30	22	30
27	28	25	27	21	27
25	25	27	28	30	26
26	24	25	27	29	27
25	27	26	27	27	24
28	25	27	26	24	24
26	22	26	24	22	26
29	25	27	23	29	26
29	25	26	26	28	29
28	29	27	26	26	29
26	28	26	29	26	24
29	26	28	29	25	25
28	26	26	26	26	25
27	27	28	25	27	25
29	30	26	29	27	28
30	27	28	29	32	28
25	28	28	28	29	28
26	25	30	29	25	28
25	28	28	27	25	28
27	27	28	25	25	28
28	28	30	30	29	29
29	29	33	32	29	28
25	25	29	26	30	28
26	26	32	28	30	32
26	28		23	28	30
28			22	29	29
27			26	32	30
25				28	23
26				25	24
				26	

TRAINING HEART RATES

Dancers

1/20/81	1/22/81	1/27/81	1/29/81	2/3/81	2/5/81
22	22	29	30	27	31
25	29	31	31	28	33
23	31	19	24	25	29
31	19	20	23	30	25
28	20	29	35	28	26
28	29	26	32	27	29
22	26	27	29	28	30
28	28	28	28	28	31
24	27	25	28	26	31
26	28	27	26	28	30
28	27	29	29	27	29
25	27	28	28	29	29
25	25	22	25	30	28
26	28	25	28	21	27
23	29	26	28	26	26
26	25	25	29	28	30
26	22	25	29	26	30
27	25	23	27	27	29
29	26	28	28	27	30
24	23	30	26	28	29
25	25	26	27	26	30
28	28	27	28	30	20
30	30	30	28	32	25
26	26	28	29	27	26
25	26	29	31	27	32
22	30	26	30	30	31
25	28	29	29	29	28
23	22	31	26	29	26
31		19		26	27
28		20		26	30
		29		28	32
				27	29

TRAINING HEART RATES

Dancers

2/10/81	2/12/81	2/17/81	2/19/81	2/24/81	2/26/81
30	29	30	30	28	31
29	31	33	21	30	30
26	26	26	22	30	21
25	29	27	31	32	23
28	28	31	32	30	28
31	31	31	26	29	30
27	27	27	26	28	26
28	28	27	26	27	26
29	26	30	29	28	26
28	30	33	27	31	27
26	28	27	28	28	27
29	32	32	25	27	29
25	27	27	26	28	28
27	31	27	27	28	30
28	26	30	26	31	30
30	29	33	26	30	25
28	29	28	27	24	25
28	32	27	28	30	28
29	25	30	28	24	25
31	28	31	29	26	27
27	26	31	30	30	27
28	31	34	30	30	27
28	28	29	21	30	27
30	30	29	22	30	29
27	29	29	31	28	29
28	31	31	32	30	31
30	26	26	26	30	30
29	29	30	26	32	
26	28	32	26	30	
25	31		29		
28	26		27		

APPENDIX E

AEROBIC DANCE MUSIC

AEROBIC DANCE MUSIC

"Carousel Waltz" from Lester Lamin's Everybody Dance - Columbia Records

"Fame" theme song from the movie Fame - Columbia Records

"Hanky Panky" from Sandy Nelson's Beat That Drum - Imperial Records

"Hi Lo Polka" from Polka Party - Tops Music Enterprises

"Everybody's Dancing" album by Jackie Sorensen

"Sandy" from Sandy Nelson's Drumming Up a Storm - Imperial Records

"They're Playing Our Song" original cast recording - Casablanca Records

"Whipped Cream" from Herb Alpert's Greatest Hits - A & M Records

MEANS AND STANDARD DEVIATIONS FOR TEST VARIABLES

		Joggers	Dancers	Control
Run Time	pre	451[a]	410	442
		39[b]	71	87
	post	516	495	445
		64	54	94
$\dot{V}O_2$ ($l \cdot min^{-1}$)	pre	2.31	2.19	2.17
		.34	.36	.24
	post	2.50	2.39	2.26
		.30	.38	.31
$\dot{V}O_2$ ($ml \cdot kg \cdot min^{-1}$)	pre	36.4	35.4	36.9
		2.1	2.8	2.0
	post	39.4	39.0	38.4
		2.6	2.0	3.0
Max HR	pre	197.1	196.3	195.6
		6.8	6.1	7.2
	post	194.2	193.5	194.5
		6.6	5.4	7.4
V_E Max	pre	84.0	80.9	80.0
		11.3	13.2	8.5
	post	91.9	87.7	81.3
		8.1	12.0	13.0
Body Weight	pre	63.2	62.2	58.9
		9.2	11.8	7.4
	post	63.8	61.6	59.1
		8.8	11.5	7.1

a = mean
b = standard deviation