AN ABSTRACT OF THE THESIS OF

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Title: A Comparison of the Cardiovascular Responses to a Land-Based Aerobic Program Versus an Aquatic Aerobic Program in Adult Females.

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The purpose of this study was to compare the cardiovascular responses to a land-based aerobic program versus an aquatic aerobic program in young adult females. A control group which did not participate in either program served as a constant. The aerobic programs were administered three times a week with each exercise session lasting 50 minutes. The subjects used were young adult female volunteers, ranging in age from 18 to 33 years who participated in at least 90% of their program sessions. Data from seventeen subjects per group were used in the final analysis (n=51). All subjects completed two pre- and post-tests of cardiovascular fitness: YMCA submaximal bicycle ergometer test for determination of maximum oxygen consumption response and the Kasch three-minute step-test for determination of recovery heart rate response. Two separate one-way ANCOVA's showed significant differences existed in the data base for each of the cardiovascular fitness test results. A Tukey post-hoc analysis was used as a follow-up technique to each ANCOVA to distinguish where significant differences existed within the data sets. Results from the Tukey analysis determined that a significant difference existed in the mean values of estimated max VO_2 and recovery heart rate response between the control group and the two experimental groups. No significant differences was found to exist between the means of the water group and land group in either of the cardiovascular fitness test results. It was concluded that cardiovascular response, as measured by predicted max VO_2 from the YMCA bicycle ergometer test, and recovery heart rate response, as measured by the Kasch three-minute step-test, showed significant improvement in both experimental groups over the control group. Furthermore, absence of significant difference in cardiovascular response between the aqua-aerobic group and the land-based aerobic group suggests that an aerobic exercise program may be offered in either environment (in water or on land) with similar cardiovascular responses.

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A Comparison of the Cardiovascular Responses to a Land-Based Aerobic Program Versus an Aquatic Aerobic Program in Adult Females

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Chapter 1

Introduction

Americans are witnessing what may be the most important life-style change in the United States, a dramatic increase in the popularity of physical activity. The number of people who exercise regularly has risen more than 200 percent since the 1960's (Reed and Lang, 1987). According to a survey by the Center for Health Statistics, 44 percent of men and 39 percent of women report they exercise regularly. More people each day are adding regular exercise to their health behaviors.

Part of this enthusiasm for exercise stems from the belief that increased activity is beneficial to one's health. Increased physical activity is especially important because the majority of our population now leads sedentary lifestyles. The ordinary tasks of daily living no longer provide individuals with enough vigorous exercise to develop and maintain good muscle tone, recommended body weight, or cardiovascular fitness. In homes, factories, or farms, machines now supply the power for most jobs, virtually eliminating the necessity of walking, running, lifting, or climbing. The decrease in physical activity, plus poor personal health practices on the part of many Americans, have contributed to wider prevalence of obesity and reduced physical fitness. This in turn, has led to a greater increase in chronic hypokinetic diseases (diseases associated with inactivity), such as cardiovascular disease and diabetes mellitus. Cardiovascular disease is the leading cause of death in our western society; high blood pressure afflicts an estimated 37 million adults; stroke kills nearly 200,000; and atherosclerosis causes more than 500,000 heart attacks each year (Corbin and Lindsey, 1985). Other hypokinetic diseases include back pain and obesity. The leading medical complaint in the United States is low back pain, and nearly one-half of all North Americans are considered to be obese (Corbin and Lindsey, 1985).

The adage that exercise is good for one's health has generally been upheld and the millions of new exercisers in the past two decades attest to the belief in that adage. There is strong evidence that higher levels of physical activity are associated with a reduced risk of cardiovascular disease, obesity, and noninsulin dependent diabetes (Froelicher, 1981; Epstien, 1980). Regular physical activity has also been associated with improved cardiovascular efficiency, decreased body fat, and improved strength and flexibility (Pavlou, Steffe, Lerman, and Burrows, 1985). Other noted benefits of physical activity include providing socialization and recreation opportunities, assisting with weight control, reducing stress, building self-esteem and an overall sense of well-being (Reed and Lang, 1987).

Physical fitness means different things to different people. The evidence of research indicates that physical fitness is "the entire human organism's ability to function efficiently and effectively", (Corbin, and Lindsey, 1985, p.3). The components of physical fitness are classified as performance-related and health-related. Performance-related fitness aspects include power, strength, agility, and speed, all of which contribute to performance of motor skills. Health-related fitness refers to those aspects which are believed to offer protection against hypokinetic diseases and increase one's work efficiency. The basic components of health-related fitness are cardiovascular function, body composition, flexibility, and strength (Falls, Baylor, and Dishman, 1980).

Cardiovascular function is the most important component in the health-related fitness area. Cardiovascular fitness (aerobic capacity) involves the ability of heart, lungs, and circulatory system to deliver oxygen to the muscles during sustained exercise. Considerable evidence indicates that the better fit cardiovascular system provides a decreased risk of the development of coronary heart disease and other hypokinetic diseases (Corbin, Dowell, Lindsey and Tolson, 1983).

Improved cardiovascular efficiency can be accomplished through a well planned fitness program. The components of such a program include the correct intensity, frequency, duration, and type of exercise. The intensity should be between 60 and 90 percent of the individual's predicted maximum heart rate reserve. The heart rate should remain within this heart rate zone for the duration of a 15 to 60 minute exercise session. The frequency of participation should be three to five days per week to insure cardiovascular benefits (ACSM, 1978). The type of activity should be any activity that uses large muscle groups, can be maintained continuously at target heart rate and is rhythmical and aerobic in nature. Examples of effective aerobic activities include: swimming, bicycling, running and aerobic dance programs.

The most rapidly growing fitness activity is aerobic dance. There are an estimated 18.7 million participants in a variety of aerobic dance settings, such as dance studios, church basements, and corporate cafeterias (Hibsch, 1984). Aerobic dance is appealing, particularly to women, because it is performed to music, involves a variety of relatively simple movement forms, and is enjoyable. Furthermore, it requires a moderately high rate of energy expenditure and appears to have the potential to provide the quantity and quality of exercise necessary for developing and maintaining cardiorespiratory fitness and for modifying body composition (Foster, 1975; ACSM, 1978).

The increase in aerobic dance participation has been accompanied by an increase in aerobic dance related injuries. There is an alarming incidence of injuries among instructors as well as students. According to two studies, (Francis, Francis, and Welshone-Smith, 1985; Richie, Kelso, and

Belluci, 1985), injury frequency for instructors ranged from 75.9 percent to 76.3 percent. Forty-three percent of students suffered injuries or aggravated old injuries in their dance exercise class.

Injuries in aerobic dance classes are commonly caused by the shock of impact with a hard surface and, to a lesser extent, by excessive and prolonged pronation during foot support (Francis, Francis, and Welshone-Smith, 1985). The most frequent sites of injuries are the shin, foot, calf, low back, ankle, knee, and neck (Richie, Kelso, and Belluci, 1985; Francis, Francis, and Welshone-Smith, 1985). The most common injuries are muscle strain, muscle sprain, knee problems, shin splints, back injuries, stress fractures, tendonitis, and bursitis (Hart, 1986).

A popular alternative to aerobic dance on a hard surface is aerobic exercise in water, otherwise called aqua-aerobics or hydro-aerobics. This is an exercise program that may provide adequate stimulation to the cardiovascular system and a total-body workout without the joint-jolting and muscle pounding inherent in any vigorous activity on a hard surface.

Aquatic programs have long been an important part of rehabilitation programs for the handicapped individual and for the injured athlete and, more recently, for cardiac patients. The basis of these programs is that the water offers a resistance which makes movement more strenuous than comparable gravity's effect on the body which greatly reduces the weight-bearing stress on muscles and joints (Evans, 1978), while allowing the body to make movements in the water that are not possible on land (Christie, 1985). This makes it possible for individuals with physical impairments such as arthritic, obesity, limb disabilities, and for the elderly to participate in an exercise program. Thus, it seems possible that an aerobic exercise program in water might bring about the same cardiovascular benefits of aerobic exercise on land with reduced risk of injury.

Statement of the Problem

Millions of people are exercising today, including young, old, males, females, handicapped, underweight, and overweight. The exercises people engage in range from simple recreational activities such as walking, running, swimming and bicycling, to the increasingly popular activity of aerobic dance. Unfortunately, participation in many of these activities causes numerous injuries. Many runners have reported having injuries ranging from shin splints to stress fractures (Stamford, 1986). Increased participation in aerobic dance has also caused an increase in similar aerobic dance-related injuries. Therefore, there is a need for a safe alternative to aerobic activities performed on hard surfaces. The ideal alternative would be to have a popular program like aerobic dance, which offers all the benefits of a cardiovascular fitness program, but which reduces the risk of injury. One program that meets these characteristics is an aerobic dance program in water (aqua-aerobics). Very little research has been done regarding the cardiovascular benefits of an aqua-aerobic program. The purpose of this study is to compare the cardiovascular responses of an aerobic dance program conducted on land and a similar aerobic dance program conducted in a water environment. A quantitative study was used to measure the cardiovascular fitness changes in three groups of females; an aerobic dance group on land, an aqua-aerobic group, and a control group. The two experimental groups participated in the aerobic exercise programs three times a week for eight weeks. The YMCA Bicycle Ergometer test and the Kasch Submaximal Bench Step test were used to assess cardiovascular changes.

Statement of the Hypotheses

The substantive hypotheses (null form) for this research were:

1. There was no significant difference in mean cardiovascular improvement as measured by the YMCA bicycle ergometer test between the experimental land group, the experimental water group, and the control group.

2. There was no significant difference in mean cardiovascular improvement as measured by the Kasch three-minute step-test between the experimental land group, the experimental water group, and the control group.

Statement of Significance

The purpose of this study was to compare the cardiovascular responses of an eight week aerobic exercise program conducted on land with the cardiovascular responses of a similar program conducted in water among young adult females and with a control group. Can an aerobic dance program in water offer the same cardiovascular benefits as a traditional aerobic dance program on land? If so, then an aerobic dance program in water might prove to be a valuable alternative to aerobic dance on land, a popular activity but one which holds a higher risk of injury activity. Furthermore, aerobic dance in water may offer a safe alternative form of exercise for the common aerobic participant as well as for physically impaired individuals such as the obese, the arthritic, the disabled, individuals under cardiac rehabilitation, and the elderly. Finally, the results of this research might be valuable in aiding fitness program directors to better meet individual needs and to reduce musculo-skeletal injuries.

Chapter 2

Review of Related Literature

It was the purpose of this study to investigate the cardiovascular responses that participation in an aerobic dance program had on two groups of females: an aerobic dance group conducted in a dance studio and an aqua-aerobic dance group in a swimming pool. A control group, which did not participate in either program was tested also. This chapter includes a summary of the factors which support the theoretical formulation that participation in an aqua-aerobic dance program might bring about the same cardiovascular responses as a similar aerobic dance program conducted on land. The factors that will be discussed are cardiovascular fitness and its components, aerobic exercise and cardiovascular responses, aerobic dance related injuries, principles of aquatic programs, (buoyancy, heat dissipation, water resistance, cardiovascular effects, water temperature, and influence of body position), and validity of testing instruments.

Cardiovascular Fitness

During the past decade, fitness experts have agreed that fitness components of an adult exercise program should be health related. Cardiovascular fitness is widely considered to be the most important health-related component because of its importance to a healthy life. Considerable evidence exists to indicate that people who possess cardiovascular fitness have less risk of developing coronary heart disease and other hypokinetic diseases than people who do not have good cardiovascular fitness (Boyer, 1972). Cardiovascular fitness is defined as "the ability of the heart, blood vessels, blood, and respiratory system to supply fuel, especially oxygen, to the muscles during sustained exercise" (Corbin, Dowell, Lindsey, and Tolson, 1983, p. 18).

Activities that develop cardiovascular fitness are sometimes referred to as aerobic exercises. The term "aerobics" was first used by Dr. Kenneth Cooper in his studies on the conditioning effects of certain types of exercise on young Air Force men (Cooper, 1968). Aerobics refers to "a variety of exercises that stimulate heart and lung activity for a period long enough to produce beneficial changes in the body" (Cooper, 1970, p. 15).

Research shows that in order for any aerobic exercise program to elicit physiological changes, certain factors must be considered in designing the exercise program. The four variables that affect the attainment of cardiovascular fitness are frequency, intensity, duration, and the mode of activity. Frequency refers to the number of times one exercises each week; intensity is how stressful the exercise is; duration has to do with the amount of time each exercise bout requires; and mode of activity is the type of exercise training being utilized.

Frequency

Frequency refers to the number of exercises sessions conducted per week. There have been numerous attempts to study the effect of frequency on exercise training. Pollock's study (1978) comparing the improvement of maximum oxygen uptake of one, three, and five days per week resulted in training effects of 8%, 13%, and 17% respectively. Comparisons between two days per week and three days per week regimens show similar cardiovascular improvement, although three days per week does have a significant training margin (Cearly, Moffatt, and Knutzen, 1984). Although research indicates cardiovascular improvement can occur in two day per week programs, subjects rarely lose the body fat or weight they do in a program meeting three days a week (Pollock, Broida, Kendrick, Miller, Janeway, and Linnerud, 1972). In general, fitness experts do not recommend a two day a week program, mainly because missing one session drops the participant below the threshold of training range (Stone, 1987). Training three to five days a week results in a significant improvement in training effects. However, according to Pollock (1978), the effects of training more than three days per week are minimal especially when compared to the dramatic increase in injury rate found in joggers who trained more than three days per week. Research also indicates that it is recommended to have a day's rest between workouts, especially for beginners (Pollock, 1978).

<u>Intensity</u>

It is well established that improvement in aerobic capacity is directly related to the intensity of training. Intensity refers to the percentage of one's maximum capacity that is being used in exercise. The literature tends to agree that 60% of the maximum heart rate reserve or 50% of the maximal oxygen uptake (max VO_2) is the threshold level for conditioning (Stone, 1987; ACSM, 1978). However, there are exceptions. Extremely sedentary individuals or cardiac and pulmonary patients may experience training effects at intensities lower than the threshold level for healthy adults. Cardiac patients have been found to increase their functional capacity by training at 40% to 60% of the maximum heart rate reserve (Stone, 1987).

Research shows that if the training session duration is short (5 to 10 minutes), a low-intensity program may show little (up to 5%) or no improvement in aerobic capacity, while a high-intensity program may elicit up to 15% to 20% increase (Pollock, 1978). However, most adults do not seem to enjoy or tolerate a high intensity program. Studies conducted at the Aerobics Institute in Dallas showed the dropout rate of a high intensity interval training program to be twice that of a continuous jogging program. Intensity of training usually depends on the health status, fitness level, and duration of training.

Duration

Improvement in cardiovascular fitness is directly related to the duration of training. Research has shown improvement in aerobic capacity in training sessions of 5 to 10 minutes of moderate to high intensity training, however, the improvement was significantly lower than from a similar program of 30 to 60 minutes duration (Milesis, Pollock, Bah, Ayres, Ward, and Linnerud, 1976). Further research shows improvement in Max VO_2 of 8.5%, 16.1%, and 16.8% with 15-, 30-, and 45-minute duration groups, respectively. It is important to remember that duration and intensity are interrelated and that the total amount of work (energy cost) accomplished in a training program is the most important factor for fitness development. Most experts agree on the concept of a slower pace and longer duration. People participate in the lower, more enjoyable intensity which also offers less risk of injury. This is especially important for persons with reduced health status, sedentary persons, middle-aged to elderly persons, and persons who are overweight (Pollock, 1978).

The length of the total training program also has an effect on cardiovascular improvement. Programs as short as three weeks have shown improvement in cardiovascular efficiency (Collingwood and Willet, 1971). However, longer periods of eight and sixteen weeks are usually recommended as a minimum length for an aerobic training effect to occur (Pollock, Cureton, and Greninger, 1969).

Mode of Activity

Research indicates that the type of exercise training utilized is relatively unimportant as long as the above criteria are met (Falls, Baylor, and Dishman, 1980). However, it is preferable that the activity be rhythmic, repetitive, dynamic movement which is capable of being sustained for a period of time. The exercise also needs to be aerobic in nature; that is, the type of exercise which steadily supplies enough oxygen to the exercising muscles for as long as the exercise is continued (Zohman, 1981).

In general, studies show that activities that are intermittent and low in energy cost (below the intensity threshold), such as golf, bowling, and moderate calisthenics do not stimulate significant improvement in cardiovascular-respiratory fitness. In contrast, activities with moderate to high energy cost, such as running, brisk walking, swimming, bicycling, cross-country skiing (Pollock, 1978), and aerobic dance programs (Foster, 1975; Cohen, 1984; Schuster, 1979; Vaccaro and Clinton, 1981) show significant increases in cardiovascular fitness.

After extensive research, the American College of Sports Medicine (1978, p. 9-10) made the following recommendations for the quantity and quality of training for developing and maintaining cardiorespiratory fitness and body composition in the healthy adult:

1. Frequency of training: three to five days per week.

2. Intensity of training: 60% to 90% of maximum heart rate reserve, or 50% to 85% of maximum oxygen uptake (max VO_2).

3. Duration of training: 15 to 60 minutes of continuous aerobic activity. Duration is dependent on the intensity of the activity, thus lower intensity activity should be conducted over a longer period of time. Because of the importance of the "total fitness" effect and the fact that it is more readily attained in longer duration programs, and because of the potential hazards and compliance problems associated with high intensity, activity of longer duration is recommended for the non-athletic adult.

4. Mode of activity: Any activity that uses large muscle groups, that can be maintained continuously, and is aerobic in nature.

<u>Aerobic Dance</u>

As mentioned earlier, a variety of activities can be used to improve cardiovascular fitness. Examples of effective aerobic activities include brisk walking, swimming, bicycling, running, jogging, and aerobic dance programs. One of the most rapidly growing of these fitness activities is aerobic dance.

Aerobic dance was first developed by Jacki Sorensen in 1969. From that the Aerobic Dancing, Inc. was developed in 1972 (Schuster, 1979). It has grown to over 50,000 students, is in nearly every state, and is expanding in foreign countries (Sorensen, 1979). Today there are an estimated 18.7 million participants in a variety of dance programs throughout the United States (Hart, 1986). Aerobic dance programs are currently being offered privately through colleges and universities, the health club business, and community recreation programs (Russell, 1983). Many physical educators, recreation supervisors, and physical fitness instructors have incorporated aerobic dance into their exercise programs in hopes of improving participants' cardiovascular fitness (Vaccaro and Clinton, 1981).

Aerobic dance is appealing, particularly to women, because it is performed to music, involves a variety of relatively simple movement forms, and is enjoyable. More specifically, aerobic dance exercise programs are designed to improve cardiovascular fitness and may provide the same psychological benefits as jogging while offering a challenging workout in a social atmosphere (Russell, 1983). Sorensen describes her program as "a complete physical fitness program which whispers exercise, and shouts fun, for participants are given the opportunity to dance freely at their own level, while their bodies undergo a carefully tested, well monitored fitness workout which strengthens the heart and lungs, slims and trims the figure and leaves one feeling exhilarated" (1979, p. 9).

Investigators have found that aerobic dance requires a moderately high rate of energy expenditure (Foster, 1975; Igbanugo and Gutin, 1977; Rockefeller and Burke, 1979; Weber, 1974), and it appears to have the potential to provide the quantity and quality of exercise necessary for developing and maintaining cardiorespiratory fitness and modifying body composition (ACSM, 1978). Based upon data from 10 adult females, Weber (1974) found that aerobic dance can require an average VO_2 of 29 ml/kg/min for durations of 30 minutes. He concluded that such an exercise was of sufficient duration and intensity to elicit a training effect. Foster (1975) collected expired air from women, aged 20 to 38, during one aerobic dance routine. He reported a mean VO_2 of 33.6 ml/kg/min which was approximately 77% of estimated VO_2 max. Maas (1975) found that college women enrolled in an aerobic dance program significantly increased in 12-minute walk/run distances and had a decrease in resting heart rate. Sorensen (1974) also reported improvement in 12-minute run scores as a result of an aerobic training program for women. These studies suggest that aerobic dance meets or exceeds generally accepted minimums for training intensity and duration.

Aerobic Dance Injuries

The increase in aerobic dance participation has been accompanied by an increase in aerobic dance-related injuries.

Helfet, Spear, and Mathews (1985) reported 61 aerobic dance related injuries among the approximately 5,000 patient visits at the Sports Medicine Center of Union Memorial Hospital in Baltimore, during their 18 month study. However, as mentioned earlier, the incidence of reported injuries from several studies shows a high percent of all types of injuries.

Authorities have proposed a number of possible causes for common injuries (Hart, 1986; Stone, 1987; Vetter, Helfet, Spear, and Mathews, 1985; Nash, 1985; Francis, Francis, and Welshone-Smith, 1985). They include exercising on nonresilient surfaces, using improper footwear, using poor body mechanics, having inadequate strength, having poor flexibility, having insufficient or improper warm-up procedures, using incorrect exercise techniques, being obese, allowing temperature and water imbalance to occur, and progressing too rapidly into exercise programs.

Aquatic Principles

The use of water has long been a median for rehabilitation purposes for the injured, arthritic, handicapped and, more recently, for cardiac patients. The aquatic environment has also been a means of aerobic exercise, mostly via swimming. The properties of water make it a unique setting for the above mentioned activities. The unique properties include buoyancy, heat dissipation, and water resistance. An aquatic environment also affects cardiovascular responses through the temperature of the water and the position of the body used in exercising in water.

Physiological Responses to Water Exercise

Physiological factors are influenced by the type of environment in which the exercise is performed (Pollock, Wilmore, and Fox 1984). Physical exercise in water may be expected to produce different physiological responses than exercise in air due both to the hydrostatic effect of water on the cardiorespiratory system, as well as to the heat dissipating quality of water compared to air (Avellini, Shapiro, and Pandolf, 1983). Davies (1975) stated that a water environment may have an influence on the physiological parameters of heart and oxygen consumption.

Water temperature is a factor which must be considered in evaluating cardiovascular responses to exercising in water. During exercise in cold water, venous return and, hence, stroke volume, is affected by the combination of the increased pressure in the lower body regions (Agostoni, Gurtner, Torri, and Rahn, 1966) and the water temperature (McArdle, Magel, Lesmes, and Pechar, 1976) both of which tend to displace peripheral blood volume to the central core area. Since cardiac output is the same in the water and on land, at the same VO_2 (McArdle, Magel, Lesmes, and Pechar, 1976; Rennie, diPrampero and Cerretelli, 1971) individuals exercising in cold water can accomplish the same work output as those on land with significantly lower heart rates (Craig and Dvorak, 1969; McArdle, Magel, Lesmes, and Perchar, 1976).

Water has 25 times the heat conductance capacity of air and convection is the means of heat loss in immersion of the body in water. Immersion in cool water increases heat loss. In one study, body core temperatures were found to decrease at 18° and 26° C and increase at 33° C. Heart rate for submaximal workloads was less at 18° and 26° C but maximal heart rate was the same at all three water temperatures (Nadel, Holmer, Bergh, Astrand, and Stolwijk, 1974). Data from Craig and Dvorak (1969) suggest that heat dissipation is rapid in water temperature of 25° C and that it occurs without compromise of cardiovascular function.

Avellini, Shapiro, and Pandolf (1983) trained three groups of subjects on a cycle ergometer in air and water of 32 degrees celsius and 20 degrees celsius. It was concluded that physical training in water produces similar physiological adaptations (VO_2) as does training on land. In cold water (20° C), VO_2 max was improved despite training with heart rates significantly lower than those attained on land. Training in the warmer water (32° C) did not show significant difference in heart rate but it did elicit a heart rate which was 10 beats/min on the average lower than on land.

A study by Dressendorf, Morlock, Baker, and Hong (1976) investigated the effects of head-out immersion on cardiorespiratory responses to maximal cycling exercise in different water temperatures. They found that water temperature had no significant effect on VO_2 max, although heart rate was 8 beats/min lower in 30° C and 15 beat/min lower in 25° C as compared to 35° C water.

It has been shown that performing upright exercise with subnormal body temperatures does not yield as high of values of VO_2 max as does exercising on land or in thermoneutral water (Pirnay, Deroanne, and Petit, 1977). The mechanism for this reduction in VO_2 max is unknown, although studies have stated that it may be a consequence of the lower maximum heart rate during cold water exercise which would limit the maximally attainable cardiac output and therefore effect a decrease in VO_2 max (Dressendorf, Morlock, Baker, and Hong, 1976; McArdle, Magel, Lesmes, and Perchar, 1976).

The type of exercise performed in the water may elicit differences in heart rate and oxygen consumption when compared to land activity and water activity (Johnson, 1977). It was noted by Vickery, Cureton, and Langstaff, (1983) that very little is known about the physiological responses associated with aquatic calisthenics. Johnson (1977) studied the comparison of oxygen uptake and heart rate during land activity and water activity. Four men and four women were tested to determine the difference between heart rate and oxygen consumption during similar calisthenics while on land and in the water. During arm exercise in water the heart rate for men was on the average 7 beats/min higher than on land.

The women elicited a heart rate that was 2 beats/min higher in the water than on land. During leg exercise, the heart rate showed similar responses as during arm exercise. The men elicited an average heart rate of 15 beats/min higher in the water than on land and women demonstrated equal heart rate values for water and land. Johnson concluded that the metabolic requirements of exercise performed in the water is greater than on land due to water resistance and hydrodynamic forces of buoyancy.

The results of Johnson showed that the oxygen consumption during arm exercise for men and women were significantly higher ($p<.05$) during water exercise than land exercise, 6.94 ml/kg/min and 6.25 ml/kg/min, respectively. Oxygen consumption for leg exercise were higher during water exercise than land exercise for both men and women, 8.50 ml/kg/min and 5.43 ml/kg/min, respectively.

Vickery, Cureton, and Langstaff (1983) demonstrated that subjects performing movement in water established by the President's Council of Physical Fitness and Sports in the booklet Aqua Dynamics could elicit a training effect. She indicated that the individual's heart rate and oxygen consumption fluctuated throughout the workout. She did indicate that even with the fluctuations, the average heart rate for her subjects was 70-77% of their maximum heart rate and their oxygen consumptions were 51-57% of their maximal oxygen consumption.

Measuring Cardiovascular Fitness

Cardiovascular fitness is well established as the single most indicative measure of a person's physical condition. Common physiological criteria used for assessing cardiovascular fitness are oxygen intake, heart rate, blood lactate concentration, cardiac output, stroke volume, and pulmonary ventilation. Maximal oxygen consumption (max VO_2) is considered the single most valid measure of cardiovascular efficiency (deVries, 1980; Astrand and Rodahl, 1977).

Aerobic power can be determined with a minimal degree of error through direct measurement. However, the direct measurement of max VO_2 requires an extensive laboratory, considerable motivation on the part of the subject, and is very time consuming (McArdle, Katch, and Katch, 1981). Consequently, these tests are not suitable for measuring large groups of untrained subjects. As a result of this, a number of tests have been devised to indirectly measure or predict the max VO_2 from performance measures such as running endurance, or from easily obtained heart rates during or immediately after exercise. These tests, while not as precise as the maximal tests, are relatively accurate and are useful in determining if an exercise program has been effective in improving an individual's physical working capacity (deVries, 1977). Indirect measures of determining max VO_2 are also more efficient, require minimal equipment and expertise, require moderate work efforts for subjects, and can accommodate large group testing more easily.

The most common tests for predicting max VO_2 use the exercise or post exercise heart rate with standardized regime of submaximal exercise performed either on a bicycle, treadmill, or step test (McArdell, Katch, and Katch, 1981). These tests are based on the principle that heart rate and oxygen consumption are linearly related for various intensities of light to moderately heavy exercise (Pollock, Wilmore, and Fox, 1984; McArdell, Katch, and Katch, 1981; deVries, 1977), that is, that heart rate and work intensity rise linearly with each other. The slope of a line (rate of heart rate increase) reflects the individual's aerobic fitness. Many studies have indicated that elicited heart rates of approximately 125-170 beats per minute are generally linear with increasing work loads, therefore, working heart rates can be plotted against respective workloads and a straight line drawn through them will intersect at a line representing maximum heart rate (predicted as 220 - age of the individual), (Astrand, and Rodahl, 1977; Armstrong and Costill, 1985; Hermansen, Ekblom, and Saltine, 1970; deVries, 1980). The premise is that a more fit person will have a lower heart rate elicited at any given workload.

An individual's heart rate provides a great deal of information regarding the physiological responses to different levels of exercise stress. Heart rate has been shown to be linearly related to oxygen consumption. Thus, estimating max

VO_2 is possible from a single stage work test that lasts approximately five to six minutes and is of such intensity to bring about a steady state heart rate between 125-170 beats per/min (Astrand and Rhyming, 1954). Recovery heart rate has also been shown to return to normal at a quicker rate in trained individuals as compared to untrained individuals (Cotton and Dill, 1935). Furthermore, heart rate is easy to measure and can be obtained rather quickly. These factors enhance the practicality of using heart rate as means of indicating cardiovascular condition.

There have been differences in opinions regarding the advantages of indirect measures of max VO_2 and the accuracy of their predictability. Metz and Alexander (1971) found heart rate during submaximal exercise to be significantly related to max VO_2 in 12-15 year old boys. Baumgartner and Jackson (1982) have found the standard error of predicting oxygen uptake from indirect methods on the basis of heart rate or other parameters to be approximately $\pm$ 10%. McArdle, Katch, and Katch (1981) have stated that the max VO_2 predicted from submaximal heart rate is generally within 10% to 20% of the person's actual value. However, these researchers agree that these tests are well suited for purposes of screening and classification in terms of aerobic fitness.

One type of submaximal indirect exercise testing procedure is the use of a cycle ergometer. The tests are based on the fact that heart rate and max VO_2 are linearly related over a broad range. The most commonly used submaximal cycle ergometer tests used include a multistage physical work capacity test developed by Sjostrand and a single-stage test by Astrand and Rhyming (Pollock, Wilmore, and Fox, 1984). The tests are designed to plot submaximal heart rates versus power output on a cycle ergometer at heart rates between 110 and 150 beats/min. This heart rate has been shown to have the best linear relationship with VO_2 over a wide variety of ages and fitness levels, according to Pollock, Wilmore, and Fox (1984). Once the steady state heart rate and power relationship has been determined, max VO_2 can be estimated. Although both tests have moderate to good predictability, multistage tests have been shown to be more valid than single-stage tests (deVries, 1980). The YMCA of America modified the Sjostrand test by using two or three 3-minute continuous stages to estimate max VO_2. Pollock, Wilmore, and Fox (1984) recommend the YMCA protocol because it provides both explicit, standardized instructions and appropriate norms.

The prediction of max VO_2 can also be determined by a submaximal bench stepping test. The step tests are based on a similar assumption as the submaximal cycle ergometer tests. Given an equal amount of work to accomplish, in this case bench stepping at the same rate and total time, the subject with a lower heart rate will be in better physical condition and therefore will have a higher max VO_2 (Pollock, Wilmore, and Fox, 1984). The heart rate in recovery from a standardized bout of stepping is a practical and effective way to classify people in terms of aerobic fitness (McArdle, Katch, and Katch, 1981). Bench stepping at a predetermined bench height and frequency is a simple method of standardizing work loads.

The Kasch step-test is specifically designed and normed for healthy middle-aged adults. It is a three-minute test conducted at 24 steps/min on a bench 12 inches high. The use of a 12 inch stepping bench makes it more practical for initial testing on sedentary subjects than the more common used 16 inch bench.

Summary

Cardiovascular fitness is widely considered the most important health-related component of fitness. Considerable evidence indicates that the better fit cardiovascular system provides a decreased risk of developing coronary heart disease and other hypokinetic diseases (Corbin, Dowell, Lindsey and Tolson, 1983).

Improved cardiovascular efficiency can be accomplished by following certain guidelines. After extensive research, The American College of Sports Medicine established recommendations for the quantity and quality of training needed for developing and maintaining cardiorespiratory fitness in healthy adults. The guidelines recommend a program that includes a training frequency of three to five days per week, a training intensity of 60% to 90% of maximum heart rate reserve, a training duration of 15 to 60 minutes of continuous aerobic activity, and the training mode of any activity that uses large muscle groups, can be maintained for an extended period of time, and is aerobic in nature (ACSM, 1978).

One popular aerobic activity that has been proven to meet these guidelines is aerobic dance. Several studies have found aerobic dance to meet or exceed the required levels of intensity and duration for effective training benefits (Foster, 1975; Igbanugo and Gutin, 1977; Rockefeller and Burke, 1979; Weber, 1974).

An increase in participation in aerobic dance has brought an increase in aerobic dance related injuries. Two studies by Francis, Francis, and Welshone-Smith (1985) and Richie, Kelso, and Bellucu (1985) found a high rate of injuries in instructors as well as students. The aerobic dance injuries are commonly caused by the shock of impact with a hard surface and overuse (Francis, Francis, and Welshone-Smith, 1985).

A popular alternative to aerobic dance on a hard surface is aerobic exercise in water (aqua-aerobics). The aquatic environment includes unique properties that allow for aerobic activities with reduced weight-bearing stress. Studies indicate that physical training in water produces similar physiological adaptations (VO_2) as does training on land. Avellini, Shapiro, and Pandolf (1983) trained three groups of subjects on cycles in air and water with similar results. Vickery (1983) further supports the use of aqua-aerobics by indicating individuals in an aquatic aerobic program can elicit a training effect.

Maximum oxygen uptake is considered to be the single most valid measure of cardiovascular efficiency (deVries, 1980; Astrand and Rodahl, 1977). A common way of indirectly assessing aerobic capacity is to determine exercise or post exercise heart rate with a standardized regime of submaximal exercise performed either on a bicycle, treadmill, or step test (McArdle, Katch, and Katch, 1981). Studies have indicated a linear relationship between heart rate and max VO_2. It is possible to estimate a max VO_2 value for subjects from a single stage work test (Astrand and Rodahl, 1977). Maximum oxygen uptake can also be determined indirectly by assessing an individual's recovery heart rate (Cotton and Dill, 1935).

Indirect test of cardiovascular fitness can be useful for determining changes in one's level of physical fitness. The error found in indirect methods can remain consistent if careful measurement and standardized procedures are exercised. The indirect tests of aerobic capacity selected for use in this study have been shown to be valid and reliable in estimating max VO_2 (ml/kg/min) (Pollock, Wilmore, and Fox, 1984).

Chapter 3

Methods and Procedures

This study investigated the effect that participation in an aerobic exercise program had on the cardiovascular responses of young adult women. Three groups of women were compared: an experimental group on land, an experimental group in water, and a control group. The methods and procedures used in this study are described in this chapter. Information on the design of the study, population and sampling, materials and instrumentation, and study limitations are also included.

Population and Sampling

Subjects for this experiment consisted of 88 female college students from Emporia State University. The experimental groups consisted of 70 volunteers from two sections of PE 103 Aerobic Dance at the university for the spring semester of 1987. The control group included 18 volunteer students. Volunteers were solicited through notices posted in the University's daily memo and by word of mouth. Participants ranged in age from 18 to 33 years and had not changed their physical activity in the previous three months.

Initially, there were 45 volunteers for the water group and 25 volunteers for the land group. The control group consisted of 18 volunteers, but due to the inability of one of the subjects to attend the post-testing session, only 17 subjects were used in the final analysis. In order to have an equal number of subjects in each group, 17 subjects from the water group and 17 subjects from the land group were randomly chosen from those individuals who completed the pre- and post-testing sessions and participated in at least 90 percent of the experimental program sessions. Data from these 51 subjects were used in the final analysis.

Validity of Instrumentation

The two indirect cardiovascular fitness tests used to test the hypotheses include the YMCA submaximal bicycle ergometer test and the Kasch three-minute step-test. When compared to various direct measurement techniques, the values of maximum oxygen consumption estimated from the indirect method of submaximal bicycle ergometer tests have been proven valid and reliable. As mentioned in Chapter 2, the indirect test of the bicycle ergometer and step-tests introduce a greater error in determining cardiovascular fitness than do direct techniques. However, the error introduced by indirect methods can remain consistent if careful measurement and standardized procedures are utilized. Therefore, indirect tests can be useful for determining changes in one's level of physical fitness and for estimating one's present status of physical fitness.

Program Procedures and Methodology of Data Collection

The subjects in the experimental groups participated in an eight-week aerobic exercise program that met three times per week on Mondays, Wednesdays, and Fridays. The times offered were either 10:00-10:50a.m. or 3:00-3:50p.m. for the water group in the swimming pool and 11:00-11:50a.m. only for the land group in the dance studio. Each session lasted approximately 50 minutes. Subjects in the control group did not participate in any of the experimental exercise programs. All groups were encouraged not to change their exercise habits except for participation in the experimental exercise program until after the completion of the post-testing session. All subjects completed pre- and post-tests, measuring physiological variables which might reflect changes due to the experimental program.

The first class session for the experimental groups was used for organization and administrative purposes, mainly for briefing the participants as to the nature of the class and the research involved. It included an explanation of the testing procedures, class content, the risks to each subject, and their responsibilities as subjects if they chose to volunteer for the study. Next, the informed consent form (Appendix A-1) and medical history form (Appendix A-2) were distributed. Time was alloted for questions concerning the forms, the class, or any risks involved. The subjects were instructed to bring the consent form and the completed medical history form with them to the pre-test session. Those subjects who identified any physical limitations or possible complications were also required to return a medical release form from their physician before being tested or participating in the exercise program (Appendix A-3). The subjects completed the pre-tests during the first week of classes. Subjects were asked to refrain from eating, drinking, smoking, or exercising at least two hours prior to the testing sessions.

The variables measured for each participant included heart rate, blood pressure, height, weight, percent body fat, lower back flexibility, and cardiovascular fitness. The test procedures used to test the hypotheses (cardiovascular fitness responses) included the YMCA bicycle ergometer test and the Kasch three-minute step-test. Height and weight were used in the descriptive categorization of the subjects. Blood pressure and heart rate were measured to determine information regarding the general physical health of each subject, in order to eliminate any subject who possessed results which would indicate possible health problems. All variables attained were discussed with the subjects in regards to the results, importance of, and means of improving them. Explanation of the results of the pre-test were also used as a means of motivating the subjects to improve their physical condition through participation in the aerobic programs.

The testing sessions were administered in the Human Performance Laboratory at Emporia State University. The testing session began by discussing the subject's medical history form and signing the informed consent form. Next, resting heart rate and blood pressure were measured. Blood pressure was measured with a standard mercury sphygmomanometer. Blood pressure was assessed in order to help eliminate any subject at high risk of coronary disease. The maximum reading of either 140mmHg for systolic blood pressure for 90mmHg for diastolic blood pressure was the guideline for participation in the study (Pollock, Wilmore, Fox, 1984). Once the subject had met the guidelines for blood pressure, height and weight without shoes was measured using a standard Health-O-Meter scale. Height was measured in inches to the nearest one-half inch and converted to centimeters. Weight was measured in pounds to the nearest one-half pound and converted to kilograms. Next, skinfold measurements were taken to estimate percent body fat. For privacy, skinfolds were taken behind a screen. The YMCA three-site (tricep, suprailiac, and abdomen) protocol was used. The sit and reach test was administered to measure flexibility of the lower back and hamstring muscle group.

The next test administered was the YMCA bicycle ergometer test, used for prediction of aerobic capacity. Prior to each testing session, the Monarch 868 bicycle ergometer was calibrated (Appendix D-1). A brief explanation of the test procedures, purpose, and precautions was given to each subject prior to administration of the test. The bicycle seat height was adjusted so that the subject's leg was slightly bent with the ball of the foot on the pedal. Individuals were required to use the speedometer to maintain a constant pedaling rate of 18 kilometers per hour throughout the entire test. The subjects were able to practice this pace by freewheeling (no resistance on the wheel) for one minute. A baseline heart rate was taken at the end of the one minute, free-wheeling warm up. Subjects with a heart rate exceeding 100 beats per minute were required to relax until their heart rate dropped to 100 beats per minute or less. Comments from the subjects were encouraged periodically during the test to ascertain how they were feeling.

The initial workload for all subjects was set at 150 kilogram-meters per minute. The participant worked at this first workload for three minutes. During the last 15 seconds of each minute of the workload, the subject's heart rate was measured using a stethoscope and stopwatch. The heart rate was calculated from the time it takes for the subject's heart rate to beat thirty times. The time obtained was converted to beats per minute using a heart rate conversion sheet (Appendix D-2). If the heart rate recorded at the second and third minutes differed by more than five beats, the test was continued at the same workload for an additional minute or until a stable heart rate value was obtained. Heart rate values were recorded and new workloads were set according to the YMCA workload guidelines established for females. The workload setting was periodically monitored throughout the test to insure that the friction belt had not slipped, changing the resistance.

The procedures for the second and third workloads were the same as those used for the initial workload. If the first two workloads elicited mean heart rates between 120 and 150 beats per minute, there was no need for a third workload. Upon completion of the test workloads, subjects were required to freewheel on the bicycle ergometer for two minutes, or longer if necessary, until the subject's heart rate returned to 110 beats per minute or less. This helped insure a proper cooling down period for each subject. Lastly, the subject was assisted down from the bicycle and requested to walk around the room and stretch.

The mean heart rate of the last two minutes of the last two workloads completed were plotted against the respective workload on the maximum physical working capacity graph (Appendix D-4), in order to determine an estimated max VO_2 value for each subject. The amount of oxygen needed for any task is a function of body size and weight. Therefore, it was necessary to express the maximum oxygen uptake value in millimeters per kilogram of body weight per minute (ml/kg/min), (Appendix D-5). The use of this relative term allowed for statistical comparisons of all subjects.

A second pre-test session was necessary to complete the Kasch three-minute step-test. Again the subjects were instructed to refrain from eating, drinking, smoking, or exercising prior to the test session. A series of stretching exercises were performed while the researcher then demonstrated the four count stepping pattern the subjects would be completing: right foot up; left foot up; right foot down; left foot down. A 12-inch stepping bench was used for the test, and a metronome set at 96 beats per minute was used to establish cadence. The subject was allowed a few practice steps before beginning the three minute workout. Upon completion of the three minutes of stepping, the subject was instructed to turn around and sit down. Five seconds into the recovery, the researcher began counting the subject's heart rate for 60 seconds using a stethoscope and a stopwatch. This heart rate score was then recorded. Subjects were requested to walk around for several minutes after the test and to stretch to help insure proper cooling down.

Because of time limitations, the subjects in the control group began their testing two weeks after the experimental groups and completed their post-tests eight weeks later. The control group subjects followed the same testing procedures and were given identical instructions as the experimental groups. The same format and guidelines used during pre-tests were used for post-tests. This included pre- and post-testing of the subjects at approximately the same time of day and under the same circumstances. The subjects were requested to follow similar daily activities on both testing days. This included activities such as eating, sleeping, smoking, and exercising. The same workloads and procedures for the YMCA bicycle test were used in both pre- and post-test situations for each individual subject.

The aerobic exercise program was designed in accordance with exercise guidelines established by the YMCA and American College of Sports Medicine (1978). For examples of the workout see Appendix E-1. Both aerobic classes were similar in nature, however, participation in water required some modifications. Examples of these modifications are included in Appendix E-2. Attendance was recorded and resting heart rates were taken before any exercises were started each session.

Water temperature and air temperature were also recorded prior to each session. The water temperature ranged from 74° to 86° F (23.3-30° C). The air temperature ranged from 70° to 86° F(21.1-30° C) for the aquatic program and 60° to 78° F(20-25.6° C) for the land based program.

The sessions lasted 50 minutes and included a warm-up period (5-10 minutes), an aerobic movement period (15-30 minutes), and a period designed to tone specific muscle groups (5-10 minutes). All the exercises and movements were choreographed to music.

The program began at a low level of intensity and progressed according to the responses of the participants. That is, subjects were requested to exercise within their individual target heart rate zones. Subjects were encouraged to progress, in terms of intensity and duration, within their individual ability levels. Intensity was monitored periodically through vocal interaction between subjects and the instructor and by periodical monitoring of heart rate. Each subject calculated her target heart zone during the first designated class session and used that as a guide to aerobic intensity (Appendix F).

Statistical Design

Data collected in this study were analyzed with basic descriptive statistics (means, ranges, and standard deviations). Further data analysis was performed using analysis of covariance (ANCOVA) to study the effect that the treatment (participation in an aerobic exercise program) had on the cardiovascular responses of the three groups. ANCOVA was used to adjust for initial differences between groups and for the correlation between means because of the inability of the researcher to select subjects solely at random. The use of ANCOVA allowed comparison of groups on one variable from information on another variable correlated with it (Isaac and Michael, 1981). The covariate used was a ratio between the subjects' height and weight. This covariate was used because one's physical work capacity is correlated with excess fat or one's percent body fat and thus it is a rough indicator of initial physical condition (Stone, 1987, & Fox and Mathews, 1981). ANCOVA only indicated if there was a significant difference existing in the data base. For further analysis, the Tukey test was performed to determine where the significant difference existed in the data base, while adjusting for experimental error. The null hypothesis was tested at the .05 level of significance.

Substantive Hypotheses
(Null Form)

(1) There is no significant difference between the water group, land group, and control groups mean gain scores for max VO_2 (ml/kg/min) as predicted by the YMCA submaximal bicycle ergometer test.

(2) There is no significant difference between the water group, land group, and control groups gain scores for recovery heart rate response from the Kasch three-minute step-test.

Statistical Hypotheses

(1) H_0: $\mu_{W_1} = \mu_{L_1} = \mu_{C_1}$

H_A: $\mu_{W_1} \neq \mu_{L_1} \neq \mu_{C_1}$

(2) H_0: $\mu_{W_2} = \mu_{L_2} = \mu_{C_2}$

H_A: $\mu_{W_2} \neq \mu_{L_2} \neq \mu_{C_2}$

Limitations of the Study

This research design was classified as quasi-experimental because sampling was not purely by random as some subjects were solicited as volunteers. It should be recognized that the use of human subjects limits the control of every source of noise in the design. An extraneous variable that existed in the research was the difficulty in establishing the motivational level of each of the subjects during testing and throughout the exercise programs. This was particularly of concern during the exercise program conducted in water, as the subjects' movements could not be seen under the water. Another extraneous variable that was difficult to control was the temperature of the air and water. It is also important to realize that the groups in this study were not chosen solely by random but by choice on the part of the subjects.

Chapter 4

Analysis of Data

The purpose of this study was to determine cardiovascular response to an eight week aerobic program conducted in two different environments. The aerobic classes met three times a week and lasted 50 minutes. The study investigated the cardiovascular response as measured by two tests of cardiovascular fitness, the YMCA submaximal bicycle ergometer test and the Kasch three-minute step-test. One experimental group (water group) participated in an aerobic dance program in an aquatic setting (an indoor swimming pool) and the other experimental group (land group) participated in a similar aerobic dance program in a typical dance studio. A control group was also studied, with the same time span of eight weeks between pre- and post-testing. Pre- and post-tests were administered to all three groups in order to analyze gain scores. Gain scores are obtained by subtracting the pre-test score from the post-test score for each subject.

This chapter presents the analysis of data obtained from the two cardiovascular fitness tests (YMCA ergometer test and the Kasch three-minute step-test) given to both experimental groups and the control group. The statistical procedures used for analysis of the mean gain scores of both of the cardiovascular fitness tests include two separate one-way analyses of covariance (ANCOVA) and follow-up analyses using the Tukey test.

Sample Analysis

The subjects in this study consisted of female college students (n=51) from Emporia State University. The subjects ranged in age from 18 to 33 years old. Subjects were volunteers from two scheduled aerobic classes and from the general female population of the University. Initially, there were 45 volunteers in the water group and 24 volunteers in the land group, as well as 18 volunteers in the control group. All groups were required to complete the pre- and post-cardiovascular fitness tests (the YMCA bicycle ergometer test and the Kasch three-minute step-test). In addition, the experimental groups were required to participate in at least 90 percent of their assigned experimental program sessions in order to be included in the study. The inability of one subject in the control group to complete the post-tests resulted in a final control group of 17 subjects. In order to maintain an equal number of subjects in all groups, 17 subjects in each of the experimental groups were randomly chosen from those subjects who completed pre- and post-tests and participated in at least 90 percent of their aerobic program sessions.

The physical characteristics recognized from the pre-tests indicated similarities among all groups, as indicated in Table 1. The mean age and mean height (in inches) were very similar in all groups, however, the mean weight (in pounds) showed some disparity with the water group having the highest

Table 1

Physical Characteristics In Each of the Three Groups

Group	Mean Age	Age Range	Mean Height (Inches)	Height Range	Mean Weight (Pounds)	Weight Range
Water	20.6	18-25	65.0	61.5-69.5	151.3	106.5-280.5
Land	20.3	18-26	64.9	61.0-70.0	132.7	98.0-192.5
Control	21.0	18-33	64.5	59.0-69.0	140.7	109.5-207.0

mean weight of 151.3 pounds and the land group having the lowest mean weight of 132.7 pounds. The observed weights may be misleading, the difference in means may not be as great as it seems. The water group contained one participant who was extremely heavy (280.5 pounds) and the land group contained one subject who was extremely light (98 pounds). By removing the two extremities from the two groups the trimmed means were 143.2 pounds for the water group and 134.7 pounds for the land group. This showed a more accurate description of the participants' mean weights in this study.

Statistical Analysis

Two separate one-way analysis of covariance (ANCOVA) were run to statistically analyze the data in this study. The purpose of using ANCOVA to analyze the data was to study the effect that the treatment (participation in the experimental aerobic programs) had on the cardiovascular responses of the subjects as measured by two cardiovascular fitness tests. Analysis of covariance was used to adjust for any initial differences among the groups on pre-test criteria because of the inability of the researcher to select subjects solely at random. The covariate used was a pre-existing constant that indicated a rough estimate of the subjects' overall beginning physical condition. The covariate used in this study was a ratio between the subjects' height and weight (height divided by the cubed root of weight). This was assumed to be a rough estimate of the subjects' beginning physical fitness.

The independent variable in this study was the treatment of the aerobic dance program administered in the water and in the dance studio. The dependent variables were the cardiovascular responses as measured by the two cardiovascular fitness tests. F-ratios were determined for each variable separately. An F-ratio is the ratio of treatment effect to error and is used to indicate if a significant difference exists among the means of the groups being compared in the study. The F-ratio level of significance used in this study was at the .05 level. F-ratios only indicate whether or not a significant difference exists in the data base, therefore a follow-up statistical analysis designed to determine where the significant difference existed within the data base was performed by use of a multiple comparison test. Multiple comparison procedures adjust the level of significance to reduce the influence of chance due to having more than one comparison. The multiple comparison test used in this study was the Tukey HSD test. The Tukey test was used to make comparisons of the means from the ANCOVA to determine where significant differences existed in the data base, while adjusting for experimental error.

A summary of the ANCOVA results for the predicted max VO_2 from the YMCA bicycle ergometer test is shown in Table 2.

Table 2

Analysis of Covariance of Max VO_2 as Predicted by the YMCA Bicycle Ergometer Test

Source	Degrees of Freedom (df)	Sum of Squares (ss)	Mean Squares (ms)	F-Value
Effect	6	2747.853	457.975	*13.63
Error	44	1477.997	33.591	

*Significant difference exists at $p<.05$

The F-ratio for the predicted max VO_2 from the YMCA bicycle ergometer test was equal to 13.63, which was significant at the .05 level. This ANCOVA shows inequality in the overall gain means exists somewhere in the data base. Therefore, the null hypothesis (HO): $u_{W_1} = u_{L_1} = u_{C_1}$ was rejected, and the alternate hypothesis (HA): $u_{W_1} \neq u_{L_1} \neq u_{C_1}$ was accepted.

In order to determine where the significant differences existed in the data base, the Tukey test was used as a follow-up analysis. The Tukey test determines a quantity ($d_{\bar{T}}$) which indicates the least significant differences, or how far the group means (x) must differ from each other in order for the differences to be significant. If the group mean difference is more than or equal to the value of $d_{\bar{T}}$ then the difference is significant. The group means of this study are actually the group gain means or the group means of the difference between the pre-test and post-test scores.

The results of the Tukey test used to analyze max VO_2 as predicted by the YMCA bicycle test data are illustrated in Table 3. The value of $d_{\bar{T}}$ in this Tukey test was 4.887. The difference between the land group means and the water group means equalled .441; the difference between the land group means and the control group means equalled 6.5; the difference between the land group means and the control group means equalled 6.059. Therefore, this Tukey test showed no significant difference between the land group and the water group, but there was a significant difference between the control group and both experimental groups. This indicates that the cardiovascular response as measured by predicted max VO_2 from the YMCA bicycle ergometer test showed the mean gain score in both experimental groups to improve significantly over the control group.

Table 3

Tukey Test Results for Group Mean Values of Max VO_2 as Predicted by the YMCA Bicycle Ergometer Test

	Mean Water Group 44.071	Mean Land Group 44.512	Mean Control Group 38.012
Mean Water Group 44.071	---	.441	6.059*
Mean Land Group 44.512		---	6.50*
Mean Control Group 38.012			---

*Mean difference significant at the .05 level. The value of d_T in this Tukey test was 4.887.

In order to strengthen the analysis of measuring cardiovascular response of the experimental groups, data from another cardiovascular fitness test (Kasch three-minute step-test) were also analyzed. This cardiovascular fitness test measures recovery heart rate response to exercise.

Table 4 shows the ANCOVA results from the Kasch three-minute step-test. The F-ratio for the step test was equal to 28.21, which was significant at the .05 level. This ANCOVA also shows inequality in the group gain means within the data

Table 4

Analysis of Covariance of Recovery Heart Rate from the Kasch Three-Minute Step-Test

Source	Degrees of Freedom (df)	Sum of Squares (ss)	Mean Squares (ms)	F-Value
Effect	4	17211.456	4302.864	*28.21
Error	46	7015.171	152.504	

*Significance difference exists at $p<.05$

base. Therefore, the null hypothesis of (HO): $\mu_{W_2} = \mu_{L_2} = \mu_{C_2}$ was rejected, and the alternate hypothesis (HA): $\mu_{W_2} \neq \mu_{L_2} \neq \mu_{C_2}$ was accepted.

The ANCOVA only showed if there was a significant difference among the groups, therefore a Tukey test was used to determine where the difference existed. Table 5 illustrates the results of the Tukey test used to analyze recovery heart rate response to the Kasch step-test. The value of $d_{\bar{T}}$ in this Tukey test was 10.259. The difference between the control group means and the water group means equalled 11.00; the difference between the control group means and the land group means equalled 11.70; and the difference between the water group means and land group means equalled .70. The results of this Tukey test showed significant difference existed between the control groups mean gain scores and the

Table 5

Tukey Test Results for Group Mean Values of Recovery Heart Rate from the Kasch Three-Minute Step-Test

	Mean Water Group 112.35	Mean Land Group 111.65	Mean Control Group 123.35
Mean Water Group 112.35	---	.70	11.00*
Mean Land Group 111.65		---	11.70*
Mean Control Group 123.35			---

*Mean difference significant at the .05 level. The value of d_T in this Tukey test was 10.259.

two experimental groups mean gain scores but no significant difference existed between the experimental land and water group mean gain scores. This indicates that the cardiovascular response as measured by recovery heart rate from the Kasch three-minute step-test showed the mean gain score in both experimental groups to improve significantly over the control group.

Summary

A separate one-way ANCOVA was used to statistically analyze each of the two hypothesis in this study. F-ratios were determined for each ANCOVA in order to establish significance or not. Similar results were found in both ANCOVA analyses. Both analyses showed that significant difference existed within the data. Therefore, both of the null hypotheses of this study were rejected and each alternate hypothesis was accepted.

F-ratios could only indicate that a significant difference existed in the data base, therefore, the Tukey test was used as a follow-up analysis to make comparisons of the marginal means from the ANCOVA's to determine where the significant difference existed in the data base while adjusting for experimental error. Tukey test results were also similar for both cardiovascular responses of participation in an eight week aerobic program conducted in a water environment and a typical land environment. The mean change scores for the experimental groups in both tests showed significant improvement over the control group. The maximum oxygen consumption in both experimental groups, as predicted by the YMCA bicycle test, increased significantly over the control group which indicates cardiovascular fitness improvement. Likewise, the recovery heart rate response from the Kasch three-minute step-test for both experimental groups decreased significantly over the control group. This also reflects an improvement in cardiovascular fitness. The results from these analyses indicate that the experimental program administered in both a water environment and a land environment was effective in improving overall cardiovascular fitness.

Chapter 5

Summary, Discussion, Conclusions, and Recommendations

This study was designed to investigate the cardiovascular responses of young adult females to participation in an eight week aerobic dance program conducted in two different environments: aqua-aerobics conducted in a swimming pool (water group) and aerobics conducted in a dance studio (land group). A control group which did not participate in either program served as a constant. The aerobic programs were administered three times a week with each session lasting 50 minutes. The subjects used were young adult females ranging in age from 18 to 33 years. Data from equal groups of 17 subjects were used in the final analysis.

Cardiovascular response was measured by administering pre- and post-tests to all groups. The YMCA submaximal bicycle ergometer test and the Kasch three-minute step-test were the fitness tests used to measure cardiovascular response. The YMCA bicycle ergometer test was used to predict maximum oxygen consumption (ml/kg/min) for each subject and the Kasch step-test measured recovery heart rate response. Two separate one-way ANCOVA's were used to determine if significant differences existed in the data base for each of the cardiovascular fitness tests. A Tukey post-hoc analysis was used as a follow-up technique to each ANCOVA to distinguish where significant differences existed within the data sets.

Discussion

Results from the Tukey analysis determined that a significant difference existed between the mean values of estimated max VO_2 for the control group and the two experimental groups. No significant difference was found between the means of the water group and the land group. The Tukey analysis used to analyze the Kasch step-test revealed similar results. The two experimental groups differed significantly from the control group, but no significant difference was found to exist between the two experimental groups.

It appears from the statistical analysis that individuals who participated in the experimental program, whether in water or on land, improved their cardiovascular fitness over those in the control group who did not participate in either program. Cardiovascular improvement as shown by the results of the analysis of predicted max VO_2 and recovery heart rate response showed improvement by participation in the eight week aerobic program (in water and on land) conducted three times a week with each session lasting 50 minutes and the intensity of 60-80% of predicted maximum heart rate reserve. These results suggest that cardiovascular improvement can be measured by participation in an aerobic program that meets the criteria for adequate frequency, intensity, duration, and mode of activity. This is in agreement with the American College of Sports Medicine (1978) recommendation for the quality and quantity of training for developing and maintaining cardiorespiratory fitness in healthy adults.

The lack of significant difference between the two experimental groups suggests that an aerobic dance program performed in either a water environment or on land would elicit similar cardiovascular responses. This is in agreement with Avellini, Shapiro, and Pandolf (1983) who found physical training in water produces similar physiological adaptations (VO_2) as does training on land.

Conclusions

Within the scope of this study, the following conclusions were made:

1) Cardiovascular improvement can be seen by participation in an eight week aerobic program conducted three times a week with each session lasting 50 minutes and the intensity of 60-80% of predicted maximum heart rate reserve.

2) Cardiovascular response as measured by predicted maximum oxygen consumption from the YMCA bicycle ergometer test and recovery heart rate response as measured by the Kasch three-minute step-test showed significant improvement in both experimental groups compared to the control group.

3) The absence of a significant difference in cardiovascular response between the aqua-aerobic group and the aerobic dance group on land suggests that an aerobic dance program may be offered in either environment (in water or on land) with similar cardiovascular responses.

Recommendations

1) Aerobic dance on land is associated with a high number of aerobic dance related injuries. Thus, a study seems warranted for determining injury rates in an aerobic dance program in water as compared to on land.

2) One of the most popular reasons people exercise, especially women, is to decrease body weight. Therefore, further study needs to examine body weight changes and/or body composition changes in an aqua-aerobic program as compared to aerobic dance on land.

3) Cardiovascular fitness is important to healthy individuals as well as individuals with medical problems or physical limitations. A study seems warranted for determining the effectiveness of a similar aqua-aerobic program for either the elderly, arthritic, handicapped, obese, or cardiac rehabilitation individuals.

4) A similar study should be conducted on the effects of seasonal differences upon motivation and general health of participants in an aqua-aerobic program.

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Appendix A

Informed Consent

Medical History

Physician Release

A-1

INFORMED CONSENT FORM

I, Penny L. Lyter am requesting your voluntary participation in a study designed to evaluate the physiological responses to two types of exercise. The specific objective of this research is to compare the cardiovascular responses to two aerobic programs: one conducted on land as compared to one conducted in water.

The Division of Health, Physical Education, Recreation, and Athletics supports the practice of protection for human subjects participating in research and related activities. The following information is provided so that you may decide whether you wish to participate in this study.

As a subject in this study you will be asked to participate fifty minutes, three times a week, for the duration of the twelve-week program. Two testing sessions arranged at your convenience will be required, one prior to the exercise program and one immediately following the completion of the program. The aerobic programs will be geared towards individuals who have not been regularly engaged in vigorous physical activity during the past three months.

Each exercise session will include a warm-up period (5-10 minutes), an aerobic movement period (15-30 minutes), a period designed to tone specific muscle groups (10-20 minutes), and a cool-down period (5-10 minutes). The program will begin at a low level of intensity and progress according to the responses of the participants. Subjects will be encouraged to progress, in terms of intensity and duration, within their own individual ability levels.

As with any type of physical activity there are dangers that may lead to pain, or injury. There is a possibility of developing soreness, experiencing pain, or suffering some degree of tear, sprain or strain. Dizziness, nausea and fatigue are other possible adverse effects. However, participants who follow the guidelines of the program will be at low risk of incurring serious injury.

The testing for each participant will include the following commonly used test procedures: blood pressure, height, weight, skinfolds, one-minute sit up test, sit and reach test, and the YMCA bicycle ergometer test. The fitness testing sessions will require some physical exertion which might induce temporary discomfort and muscle soreness. A series of stretching exercises will be performed before and after the tests to reduce this effect. The fitness test results provide the researcher and the participants with information needed to identify and set the proper exerise intensity. The procedures for testing and specific risks are as follows in sequential order:

1) Blood pressure will be measured with a standard mercury sphygmomanometer.

2) Height and weight will be measured on a standard Health-O-Meter scale.

3) The YMCA skinfold test will be administerecd to determine percent body fat. The skinfolds will be measured with a Lange caliper in an enclosed area providing privacy. The test sites include the tricep, illiac, and abdominal. A slight pinch is required which may produce momentary discomfort.

4) The YMCA bicycle ergometer test will be administered to predict cardiovascular fitness. This is a sub-maximal multi-stage test that will include three stages each lasting approximately three minutes. Heart rate will be monitored every minute with the workloads adjusted according to the YMCA guidelines. This test holds little risk for serious injury unless the subject were to fall off of the bike or pedal at an improper rate. There is some risk of developing dizziness nausea, or muscular discomfort, but the subject is instructed to cease pedalling if such symptoms appear. In healthy individuals, these effects should be temporary only.

5) The sit and reach test is administered to measure hamstring/lower back flexibility. There is little risk of injury or soreness from execution of this test if the subject is careful to reach slowly and to stretch out properly before attempting a maximal stretch. There might be muscular discomfort of the posterior leg, thigh, and low back muscles during the execution of the maximal stretch, but that discomfort should diminish within minutes of completion of the test.

6) The one-minute sit-up test is a maximal effort test to measure abdominal strength and endurance. This test could result in abdominal, neck, back, and quadricep muscle discomfort/soreness both during and following the test. Such sorness generally persists for only a few days. However individuals with back problems should not take this test because their risk of injury is high.

Your permission to use the data described above is requested for the purpose of conducting research for a thesis. All data will remain confidential. Results will be presented in a manner which will not allow individual identification. Penny L. Lyter, the primary investigator, will possess the list matching code numbers to the names of the participants. If you have any further questions in reference to this research study, please contact Penny Lyter at 343-1200, ext. 5929, or at home, 342-6013.

"I have read the above statements and have been fully advised of the procedures to be used in this project. I have been given sufficient opportunity to ask questions I had concerning the procedures and possible risks involved and I assume them voluntarily. I likewise understand that I can withdraw from the study at any time without being subjected to reproach."

____________________ Date

____________________ Subject

A-2

MEDICAL HISTORY

[cut off]E ______________________________ DATE ____________

[cut off]UPATION ______________________________ AGE ________ SEX ____________

Have you ever had symptoms of or been treated for heart disease? ____ YES ___ NO
If yes, describe the symptoms and/or treatment; ______________________________

____

Has any member of your immediate family been treated for heart disease? ___ YES ___ NO. If yes, identify these members by relationship and describe the type of heart disease; ______________________________

____

Are you a cigarette smoker? ___ YES ___ NO. If yes, how long? ____________
How many cigarettes per day? ____________

Did you ever smoke cigarettes? ___ YES ____ NO. If yes, how long? ____________
How much? ______________________________

Do you smoke anything other than cigarettes? ___ YES ___ NO. If yes, please identify what, how long, and how much; ______________________________

____

Have you regularly (at least three times a week) engaged in vigorous exercise (i.e. racquetball, tennis, jogging, aerobics, etc.) the past three months? ___ YES ___ NO
If yes, identify the activities and frequency of participation; ____________

____

Have you been treated for or had symptoms of :

a) arthritis	___ YES	___ NO
b) asthma	___ YES	___ NO
c) back pain	___ YES	___ NO
d) blackouts	___ YES	___ NO
e) breathing trouble	___ YES	___ NO
f) chest pain	___ YES	___ NO
g) diabetes	___ YES	___ NO
h) epilepsy	___ YES	___ NO
i) joint pain	___ YES	___ NO
j) obesity	___ YES	___ NO

If yes to any of the above, please describe the type and length of treatment and the status of that condition at the present time. Include a clear description of any limitations to physical activity prescribed for you: ____________

____

____

Are you currently taking any type of medication? ___ YES ___ NO. If yes, please describe medication, condition requiring medication, dosage, and possible side effects; ______________________________

____

Have you had surgery within the past two years? ___ YES ___ NO. If yes, explain:

____

Are you pregnant? ___ YES ___ NO. If yes, how long? ____________

Please describe any other physical, mental, or emotional condition that may be affected by or which may affect your participation in this program, or any other information that you feel might be of some benefit to the instructor in designing your program.

EMPORIA STATE UNIVERSITY

1200 COMMERCIAL / EMPORIA, KANSAS 66801 / TELEPHONE 316-343-1200

ESU

Dear Physician:

A Beginner Aerobics class for women will be held this Spring in the Physical Education Building at Emporia State University. The program is designed for apparently health individuals. The basic program consists of 40-50 minutes of exercises focusing on development of cardiovascular fitness, low back/hamstring flexibility and muscular endurance. Each of the sessions includes a warm-up and cool-down period. The aerobic activities will be increased gradually to the point where each indidivual can get to and maintain target heart rate for at least 20 minutes. Participants will be taught and encouraged to exercise within their own capabilities, as determined by heart rate and self-monitoring of perceived exertion.

This program has been designed and will be conducted in accordance with the guidelines established by the American College of Sports Medicine. Penny L. Lyter, a Graduate Student in HPERA at ESU, will lead the program. All participants 35 years of age or older or those who have or have had any cardiovascular respiratory diseases are required to obtain medical clearance to participate in this program.

Please read the attached flier for further information or call Penny Lyter at 343-1200, Ext. 5354.

Sincerely,

I believe that ______________________ is, from a medical
(Participant's Name)
perspective, able to participate in the E.S.U. Beginners Aerboic Program

as described above.

____
(Physician's Name)

____
(Date)

____
(Physician's Signature)

Appendix B

Equipment List

EQUIPMENT

Kasch Step Test

(1) 12 inch stepping bench

(2) Franz metronome (Lafette Instrumint Co., set at 96 bpm)

(3) stopwatch

(4) recording forms

(5) stethoscope

(6) Health o meter weight scale (Continental Scale Corp.)

YMCA Bicycle Ergometer Test

(1) Monark Company Bicycle ergometer (868)
Range of 0-2100 kg/m/min,with major graduation marks present every 300 kg/m/min, and minor graduation marks 150 kg/m/min calibrated to Monark Company specifications.

(2) stethoscope

(3) guideline chart for determining workloads for females for the YMCA submaximal bicycle test.

(4) heart rate conversion

(5) recording sheets

(6) VO max conversion chart

(7) Health o meter weight scale

Appendix C

Subject Testing Form

INDIVIDUAL PROFILE SUMMARY

TIME ____________________ CODE # ____________________

HT __________ IN __________ CM DATE ____________________

WT __________ LBS __________ KG SEX _____ M _____ F _____ AGE _____ YR

BLOOD PRESSURE __________ HEART RATE ____________________

Skinfolds:

Tricep ____________________ mm

Ilium ____________________ mm

Abdomen ____________________ mm

T_3 ____________________ mm

% Fat ____________________

Rating ____________________

Flexibility:

Sit and Reach __________ in

Sit-ups:

____________________ /60 sec.

YMCA Bicycle Ergometer Test

ble # _____ Free HR ____________ Rec. 1 ____________ Rec. 2 __________

Workload #1 __________ kgm/min. #2 __________ kgm/min. #3 __________ kgm/min.

__________ bpm __________ bpm __________ bpm

__________ __________ __________

__________ __________ __________

__________ __________ __________

Max O_2 (L/min) __________ Max O_2 (ml/kg) __________ Rating __________

Kasch Pulse Recovery Test

Total Heart Rate ____________________

Rating ____________________

Appendix D

Bicycle Ergometer Calibration

Heart Rate Conversion Chart

Guide for Setting Workloads for Females
on the Bicycle Erogometer

YMCA Maximum Physical Working Capacity
Prediction Graph

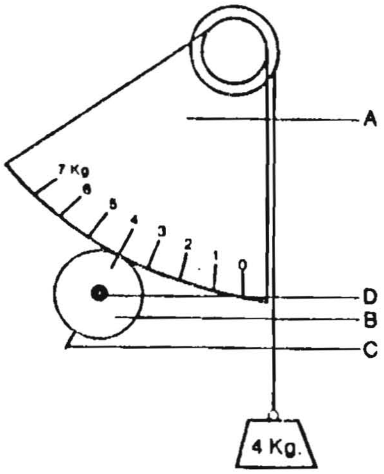
Conversion Equation for VO_2
Max (ml/kg/min)

D-1

BICYCLE ERGOMETER CALIBRATION

(Golding, Myers and Sinning, 1982, p. 92)

Workload Scale On Bicycle Ergometer And Calibration Procedures



2b. The calibration of the bike is done precisely at the factory and unless the adjusting screw (C) has been tampered with, seldom is there a need for recalibration. However, if you suspect incorrect calibration it can be checked as follows.

Set the mark on the pendulum weight (B) at "O". Attach a weight known to be very accurate as shown above. A 1 kg weight should correspond to a reading of 1 on the scale (A); a 2 kg weight should correspond to a reading of 2 on the scale A; and so on. The example above shown 4 kg corresponding to 4 on the scale.

If the numbers do not agree it can be corrected by changing the adjusting screw (C). This screw moves the center of gravity of the pendulum (this screw is locked with the screw D).

Y's Way to Physical Fitness

Table 4-9

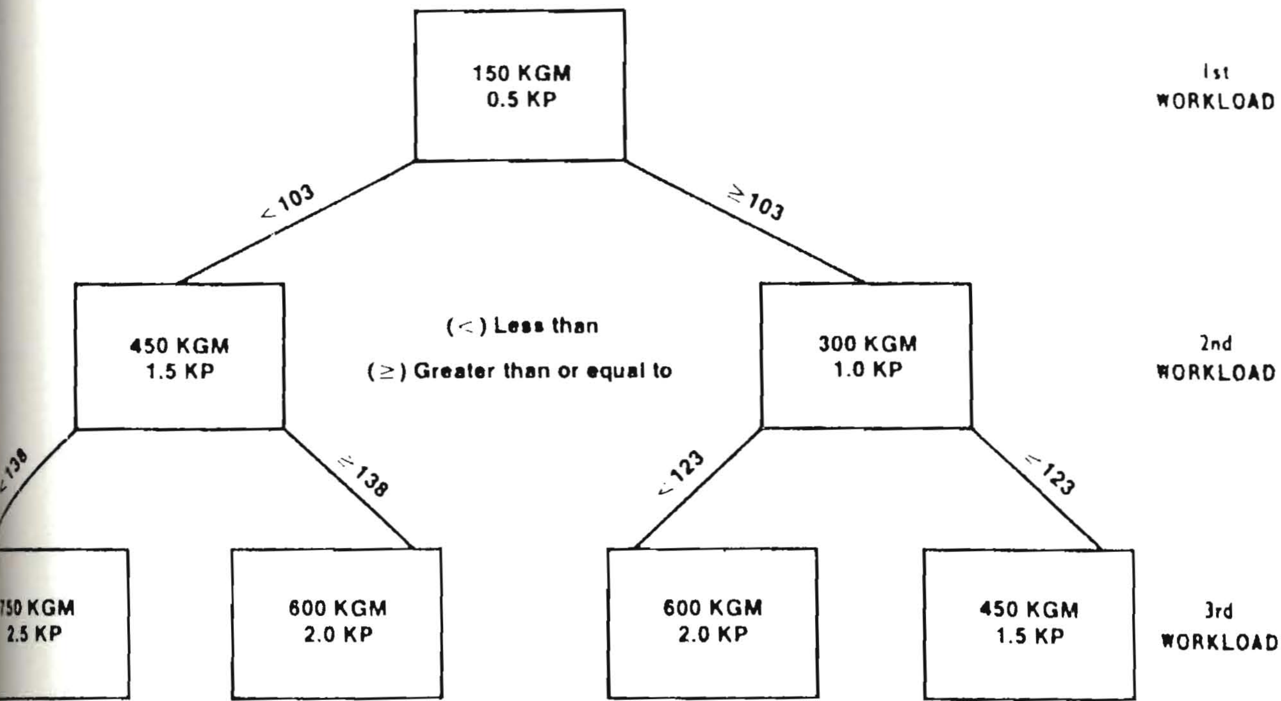
Heart Rate Conversion Sheet (30 Beats to Rate/Min)

Sec.	/Min.	Sec.	/Min.	Sec.	/Min.
22.0	82	17.3	104	12.6	143
21.9	82	17.2	105	12.5	144
21.8	83	17.1	105	12.4	145
21.7	83	17.0	106	12.3	146
21.6	83	16.9	107	12.2	148
21.5	84	16.8	107	12.1	149
21.4	84	16.7	108	12.0	150
21.3	85	16.6	108	11.9	151
21.2	85	16.5	109	11.8	153
21.1	85	16.4	110	11.7	154
21.0	86	16.3	110	11.6	155
20.9	86	16.2	111	11.5	157
20.8	87	16.1	112	11.4	158
20.7	87	16.0	113	11.3	159
20.6	87	15.9	113	11.2	161
20.5	88	15.8	114	11.1	162
20.4	88	15.7	115	11.0	164
20.3	89	15.6	115	10.9	165
20.2	89	15.5	116	10.8	167
20.1	90	15.4	117	10.7	168
20.0	90	15.3	118	10.6	170
19.9	90	15.2	118	10.5	171
19.8	91	15.1	119	10.4	173
19.7	91	15.0	120	10.3	175
19.6	92	14.9	121	10.2	176
19.5	92	14.8	122	10.1	178
19.4	93	14.7	122	10.0	180
19.3	93	14.6	123	9.9	182
19.2	94	14.5	124	9.8	184
19.1	94	14.4	125	9.7	186
19.0	95	14.3	126	9.6	188
18.9	95	14.2	127	9.5	189
18.8	96	14.1	128	9.4	191
18.7	96	14.0	129	9.3	194
18.6	97	13.9	129	9.2	196
18.5	97	13.8	130	9.1	198
18.4	98	13.7	131	9.0	200
18.3	98	13.6	132	8.9	202
18.2	99	13.5	133	8.8	205
18.1	99	13.4	134	8.7	207
18.0	100	13.3	135	8.6	209
17.9	101	13.2	136	8.5	212
17.8	101	13.1	137	8.4	214
17.7	102	13.0	138	8.3	217
17.6	102	12.9	140	8.2	220
17.5	103	12.8	141	8.1	222
17.4	103	12.7	142	8.0	225

Y's Way to Physical Fitness

GUIDE TO SETTING WORKLOADS

FOR FEMALES ON THE BICYCLE ERGOMETER



DIRECTIONS

1. Set the first workload to 150 kgm/min (.5 KP).

2. If steady-state heart rate is $<$ 103, set 2nd load at 450 kgm/min (1.5 KP).
   If steady-state heart rate is $\geq$ 103, set 2nd load at 300 kgm/min (1.0 KP).

3. Follow this same pattern for setting the third and final load.

4. NOTE: If the 1st workload elicits a HR of 110 or more, it is used on the graph, and only ONE more workload will be necessary.

FOOTNOTES

I. The **Y's Way to Physical Fitness** bicycle test is for healthy individuals who have been cleared by a physician to exercise. This test measures cardiorespiratory fitness and is *not* a medical screening test

II. This aid to setting workloads is only a guide; common sense should also be used. Always be conservative Use lower workloads for borderline scores.

III. The two plot points should be in the linear portion of the curve (approximately 110-150 bpm). It is better to have the two points toward the low end of this linearity.

Graph 4-2

Y's WAY TO PHYSICAL FITNESS – TEST BATTERY

MAXIMUM PHYSICAL WORKING CAPACITY PREDICTION

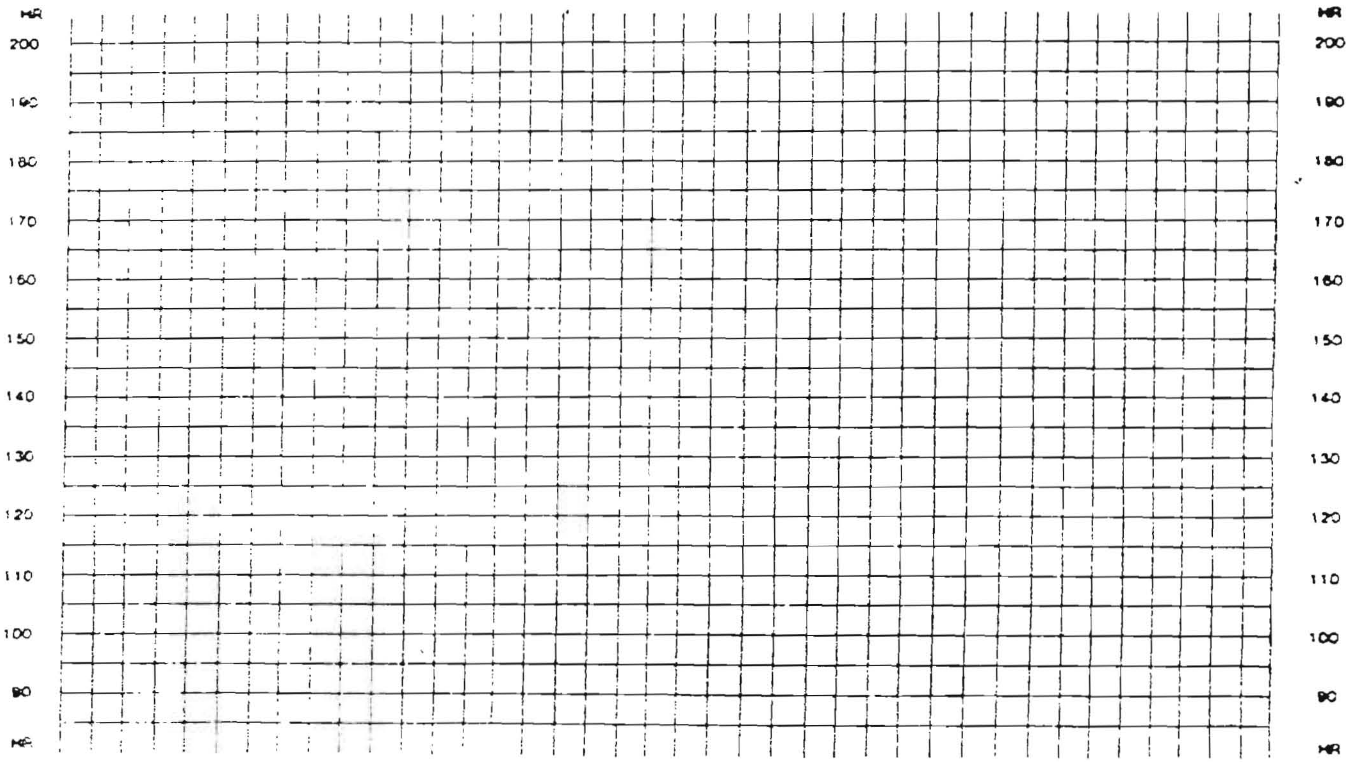
NAME ______________________ AGE ________ WEIGHT ________ LB ________ KG SEAT HEIGHT ________

PREDICTED MAX. HR ________

	DATE	1st WORKLOAD HR USED	2nd WORKLOAD HR USED	MAX. WORKLOAD	MAX O_2 (L/min)	MAX O_2 (ml/kg)
TEST 1						
TEST 2						
TEST 3						

DIRECTIONS

1. Plot the HR of the 2 workloads versus the work (kgm/min)
2. Determine the subject's max HR line by subtracting subject's age from 220 and draw a line across the graph at this value
3. Draw a line through both points and extend to the max HR line for age
4. Drop a line from this point to the baseline and read the predicted max workload and O_2 uptake



WORKLOAD (kgm/min)	150	300	450	600	750	900	1050	1200	1350	1500	1650	1800	1950	2100
MAX O_2 UPTAKE (L/m)	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.8	3.2	3.5	3.8	4.2	4.6	5.0
KCAL USED (Kcal/m)	3.0	4.5	6.0	7.5	9.0	10.5	12.0	14.0	16.0	17.5	19.0	21.0	23.0	25.0
APPROX MET LEVEL (for 132 lbs)	3.3	4.7	6.0	7.3	8.7	10.0	11.3	12.7	14.0	15.3	16.7	18.0	19.3	20.7
APPROX MET LEVEL (for 176 lbs)	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0

CONVERSION EQUATION FOR MAX VO_2

(ml/kg/min)

$$\frac{\text{Predicted max } VO_2 \text{ (L/min)} \times 1000}{\text{Subject's body weight (kilograms)}} = \text{ ml/kg/min}$$

Appendix E

Example Workout

Aqua-aerobic Modifications

EXAMPLE AEROBIC WORKOUT FORMAT

I. Warm-up (5 - 10 minutes)

A. Slow to moderate speed of movements which require the use of large muscle groups. Examples include: walking, exaggerated walking, skipping, marching, and various other steps.

B. All body parts are used in exercise. Some stretching of muscles after the first warm-up movement song.

1. neck
2. shoulder joints
3. trunk
4. hip joints
5. ankles and calves

C. Monitor pulse after warm-up period

II. Aerobic Movement (15 - 30 minutes)

A. Choreographed movements of a higher intensity. Exercise all major muscle groups.

B. A gradual increase in time spent in this segment of the aerobic class.

C. Monitor pulse rate regularly after every one or two songs (approximately every five minutes). Students keep moving during the monitoring of the pulse. Maintain heart rate within target heart rate zone.

D. Gradually decrease intensity of last five minutes.

III. Toning (5 - 10 minutes)

A. Include exercises for toning specific muscle groups.

B. Areas to cover:

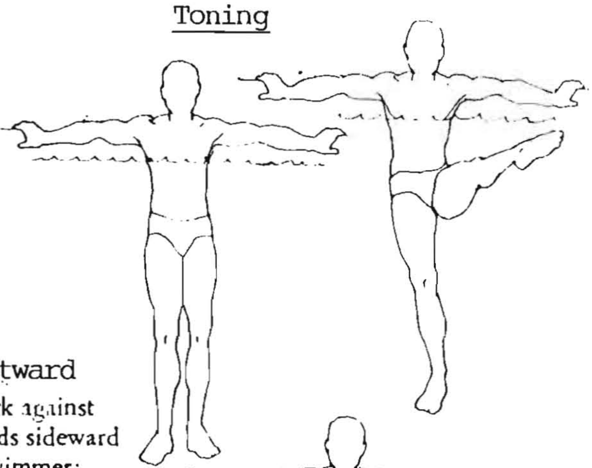
1. Abdomen
2. Back
3. Buttocks
4. Calves
5. Hips, thighs
6. Posterior arms, anterior chest
7. Upper back and shoulder girdle

IV. Cool-down (5 - 10 minutes)

A. Walking and stretching exercises.

B. Return heart rate closer to pre-exercise rate (120 bpm or less).

C. Relaxation and tension relief exercises.



Leg Swing Outward

Standing with back against poolside, and hands sideward holding gutter, swimmer:

(1) Raises left foot as high as possible with leg straight.

(2) Swings foot and leg to left side.

(3) Recovers to starting position by pulling left leg vigorously to right.
Repeat.
Reverses to right leg.
Repeat.

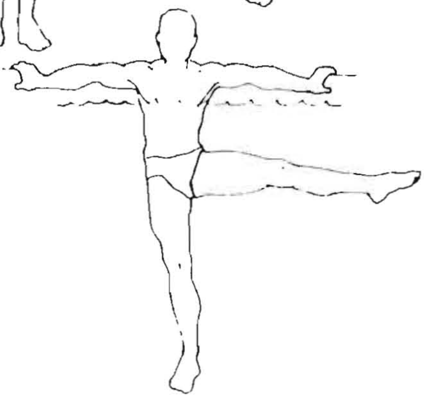
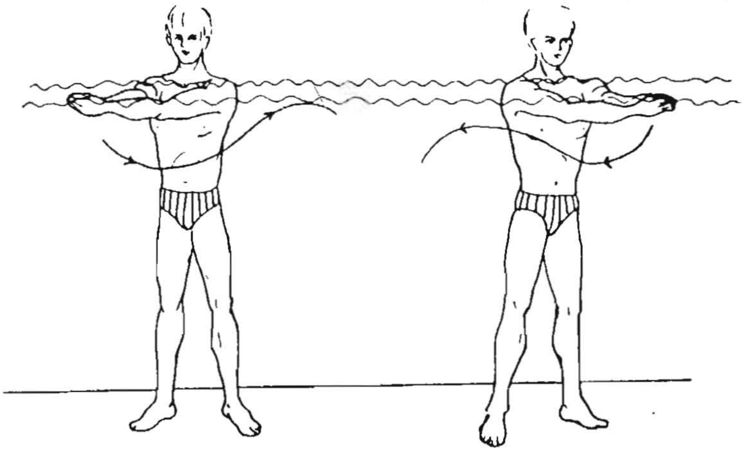
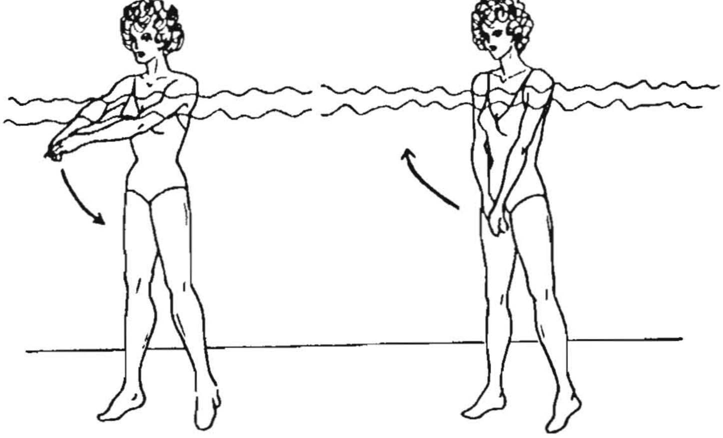


Figure Eight (arms,chest, and upper body)

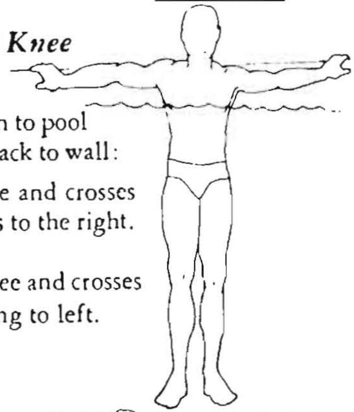


Double Arm Lift and Press (arms, shoulders, and chest)



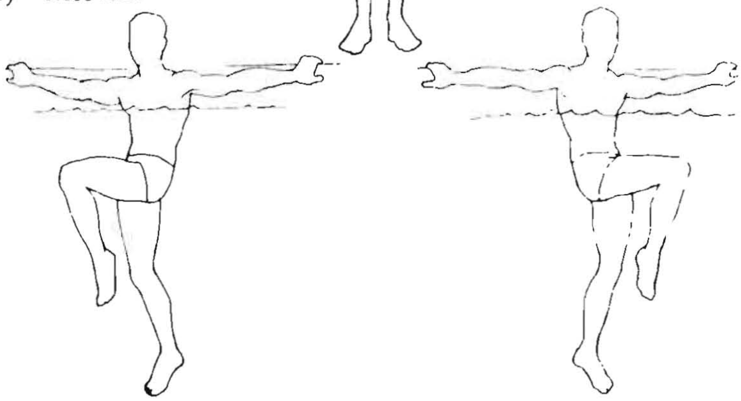
Aerobics

Alternate Raised Knee Crossovers

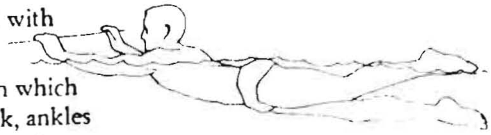


Standing, holding on to pool gutter with hands, back to wall:

(1) Lifts left knee and crosses it over. Twists to the right.
(2) Recovers.
(3) Lifts right knee and crosses it over, twisting to left.
(4) Recovers.

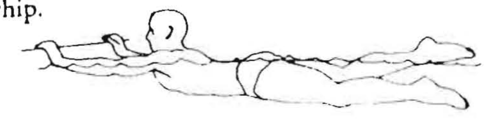


Front Flutter Kicking

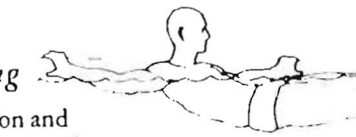


Lying in a prone position and holding on to side of pool with hand(s), swimmer:

(1) Kicks flutter style in which toes are pointed back, ankles are flexible, knee joint is loose but straight and the whole leg acts as a whip.

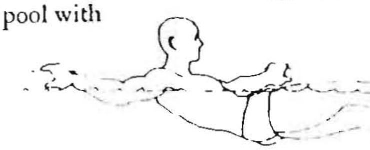


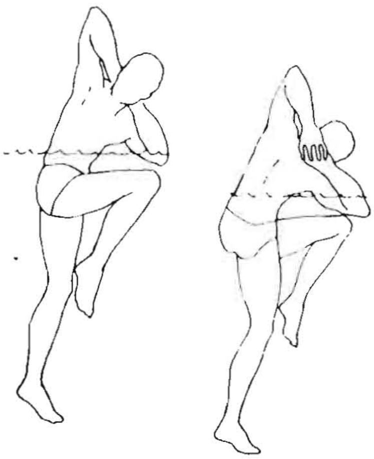
Back Flutter Kicking



Lying in a supine position and holding on to sides of pool with hand(s), swimmer:

(1) Flutter kicks.



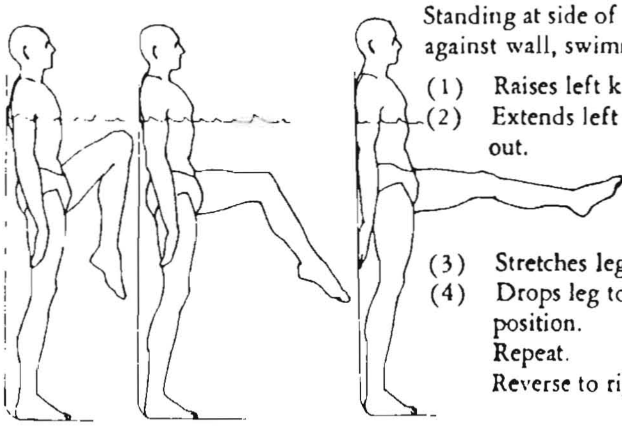


Walking Twists

With fingers laced behind neck, swimmer:

(1) Walks forward bringing up alternate legs twisting body to touch knee with opposite elbow.
Repeat.

Cool-Down



Leg Out

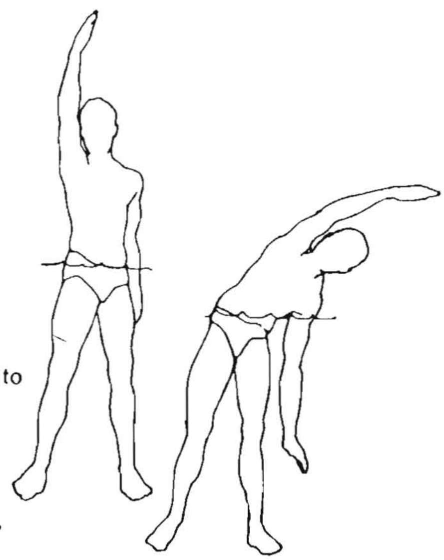
Standing at side of pool with back against wall, swimmer:

(1) Raises left knee to chest.
(2) Extends left leg straight out.
(3) Stretches leg.
(4) Drops leg to starting position.
Repeat.
Reverse to right leg

Side Bender

Standing in waist-deep water with left arm at side and right arm over head, swimmer:

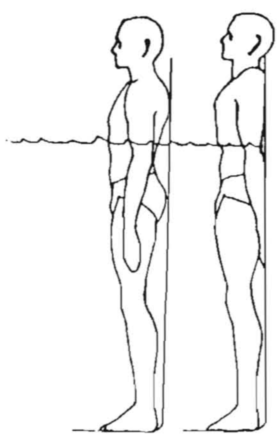
(1) Stretches, slowly bending to the left.
(2) Recovers to the starting position.
Repeat.
Reverse to right arm at side and left arm overhead.



Flat Back

Standing at side of pool in waist-to-chest deep water, swimmer:

(1) Presses back against wall, holding for six counts.
(2) Relaxes to starting position.
Repeat.



Appendix F

Target Heart Rate Tabulation Form

TARGET HEART RATE ZONE

There is an amount (intensity) of exercise which is enough to condition the muscles and cardiovascular system leading to physical fitness, but is not overly strenuous. This is a target zone, enough activity to achieve fitness, but not too much to exceed safe limits.

Each individual's target zone is between 60 and 80% of her own maximal aerobic power. Below 60% of your capacity you will achieve little fitness benefit. Above 80% there is little added benefit from a great deal of extra exercise.

The following formula determines the minimum heart rate you should aim for during an aerobic dance class for a beneficial training effect to occur. Work in lower range in the beginning and gradually increase.

Maximum Target Heart Rate

220 - YOUR AGE = ____________

Resting Heart Rate __________

FORMULA

Maximim target heart rate __________

Resting heart rate - __________ (subtract)

Answer A = __________

Minimum and Maximum working heart rate range

Answer A _________ x .60 = __________ Answer B

Answer A _________ x .80 = __________ Answer C

Add resting heart rate to answer B and C

Answer B _________ + Resting heart rate __________ = Min. working heart rate ___

Answer C _________ + Resting heart rate __________ = Max. working heart rate ___