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The Effect of Step Height and Upper Body Involvement on Oxygen Consumption and Energy Expenditure during Step Aerobics

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THE EFFECT OF STEP HEIGHT AND UPPER BODY INVOLVEMENT ON OXYGEN CONSUMPTION AND ENERGY EXPENDITURE DURING STEP AEROBICS

by

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The purpose of this study was to determine the effects of step height and arm involvement on oxygen consumption (VO2), VO2 as a percentage of VO2max, and energy cost during step aerobics. VO2 and Respiratory Exchange Ratio were measured as 12 subjects completed 6 experimental conditions, which consisted of 3 step heights, 4, 6, and 8 in., and 2 arm conditions, with and without arms. Measured VO2 values were also analyzed as a percentage of maximal oxygen consumption to determine if subjects were within the ACSM recommended range of 50% to 85% of VO2max. ANOVAs revealed significant differences in each variable for step height and arm involvement. The 4 in. step height without arms was the only condition not within the recommended range. Results showed that increasing step height and the addition of arm involvement increased VO2, VO2 as a percentage of VO2max, and energy cost.

TABLE OF CONTENTS

Table of Contents—Continued

CHAPTER

Table of Contents—Continued

LIST OF TABLES

CHAPTER I

INTRODUCTION

Aerobic dance may be the most popular form of exercise for women in the United States. The introduction of videotaped routines and the growth of instructor-led classes have had a great impact on the popularity of this activity. Aerobic dance consists of sequences of choreographed movements performed to music. The two main styles of aerobics are high impact and low impact. These styles have been examined in terms of their effects on cardiovascular fitness and training (Berry, Cline, Berry, & Davis, 1992; Garber, McKinney, & Carleton, 1992). Aerobic dance has been shown to elicit relatively high heart rates and oxygen uptakes, indicating that it is an effective training activity. However, some researchers have proposed that the changes in oxygen consumption due to aerobic dance are less pronounced than the changes seen in activities such as running and cycling (Scharff-Olson, Williford, & Smith, 1992).

Need for the Study

As more styles of aerobic dance evolve, there is a need for more research concerning the benefits and detrimental effects of this activity. The latest innovation in aerobic dance involves a platform or step and is called step aerobics. This form of aerobic dance is becoming exceedingly popular in classroom settings as well as in the home. The fundamental movement is simple; the step used has the same effect as going up stairs or using a stepping machine such as a Stairmaster. The degree of difficulty in step aerobics can be affected by the instructor, because the pace or cadence is usually set by the instructor. However, the step height and "power" of the movement are determined by each individual. In step aerobics participants use a step height that can vary from 4 in. to 12 in. It is generally considered to cause less impact than a high-impact aerobic dance class and, therefore, to place less stress on the joints.

Little research has been done concerning the effects of step aerobics on oxygen consumption and energy cost. Step aerobics may provide a viable alternative to other established forms of aerobic activity. Because the step height can vary, the effort needed to complete the movement varies. The degree of arm movement also affects the effort expended in this activity.

Problem Statement

The problem in this study was to determine the effects of step height and arm involvement on oxygen consumption and energy expenditure during step aerobics. The oxygen consumption achieved during each of the test conditions was compared with the range recommended by the American College of Sports Medicine (ACSM) for an aerobic activity.

Delimitations

The following delimitations were identified for the study:

1. All subjects were male and female volunteers between the ages of 18 and 25 years.

2. The subjects had at least 1 year of step aerobics experience.

3. The subjects participated in the same videotaped routine and maintained a cadence of 122 to 128 beats per minute (bpm), the recommended cadence for step aerobics (Olson & Williford, 1996).

4. Subjects were measured through the use of a metabolic cart on three dependent variables: oxygen consumption (VO2), oxygen consumption as a percentage of maximal oxygen consumption (VO2 as a percentage of VO2max), and energy cost.

5. Subjects performed at three step heights: 4, 6, and 8 in.

6. Subjects performed one trial for each of the six experimental conditions.

Limitations

The following limitations could affect the interpretation of the results of the study:

1. Because the volunteer subjects were not selected by random sampling techniques, they may not be representative of the population of individuals who participate in step aerobics.

2. Subjects performed only one trial for each of the six experimental conditions. Additional trials could have produced a more reliable result.

3. Only 12 subjects participated in the study. A larger sample would increase the external validity of the study.

4. Magnitude of the movements by the subjects was not controlled.

Assumptions

The following assumptions were made for the study:

1. All subjects were able to follow along with the instruction video.

2. Arm involvement was not hindered significantly by the measurement equipment or by the subjects' clothing.

3. Subjects responded similiarly to the repeat cycles in the step aerobic routine.

Hypotheses

The following hypotheses were formulated:

1. As step height increases, oxygen consumption will increase during participation in step aerobics.

2. Adding arm involvement will result in an increase in oxygen consumption during participation in step aerobics.

3. As step height increases, energy cost will also increase during participation in step aerobics.

4. Adding arm involvement will result in an increase in energy cost during participation in step aerobics.

5. In each of the experimental conditions, oxygen consumption as a percentage of VO2max will fall within the range, 50 to 85%, recommended by the ACSM for improving aerobic capacity in an aerobic activity.

Definitions

The following terms were defined for the study:

1. Aerobic activity: An activity that provides a sufficient cardiovascular overload to stimulate increases in stroke volume and cardiac output (Brooks & Fahey, 1985).

2. Borg's Rating of Perceived Exertion Scale (RPE): A scale, with values ranging from 6 to 20, developed by G. A. Borg, that can be used to establish exercise intensity for the purpose of training (McArdle et al., 1991).

3. Energy expenditure: The total energy that is expended through physical activity due to the metabolic production of adenosine triphosphate (ATP).

4. Maximal oxygen consumption (VO2max): The maximum capacity for the aerobic resynthesis of ATP. Maximum aerobic capacity determines the percentage of maximum at which one is exercising during a given dance routine. It is affected by physical training, therefore it partially reflects an individual's fitness level (McArdle, Katch, & Katch, 1991).

5. Oxygen consumption (VO2): VO2 values that are measured every 20 s and averaged over a 5-min cycle.

6. Respiratory exchange ratio (R): The ratio of carbon dioxide produced to oxygen consumed when the exchange of oxygen and carbon dioxide at the lungs no longer reflects actual gas exchange from nutrient metabolism in the cell. R values are representative of substrate utilization during steady state exercise; a value of 1.0 represents 100% carbohydrate metabolism, and 0.7 represents 100% fat metabolism (McArdle et al., 1991).

7. Step aerobics: A form of aerobic dance that uses a platform or step of varying heights, usually 4 to 8 in.

CHAPTER II

REVIEW OF RELATED LITERATURE

Aerobic dance may be the most popular organized fitness activity for women in the United States. There are an estimated 23 million participants, the majority of whom are women, who use this form of aerobic training (Williford, Scharff-Olson, & Blessing, 1989). Even more extraordinary than the immense popularity of this activity is that prior to 1969 this exercise form did not exist (Garrick & Requa, 1988). Physicians, exercise physiologists, entertainment personalities, and professional athletes have joined the movement by producing videotaped dance programs or television shows that use this type of aerobic activity. The training benefits of aerobic dance appear to mimic those of other known cardiovascular activities, spurring on new variations of aerobic dance from step aerobics to aerobic boxing classes.

Background of Step Aerobics

In the early 1970s Jacki Sorensen developed aerobic dance in an effort to combine the recreational pastime of dancing with cardiovascular training (Cohen, 1984). The purpose was to elevate the heart rate to a target level and maintain it by moving to music. Aerobic dance has evolved from that conception into one of the most popular forms of cardiovascular training, especially for women. Aerobic dance became a mainstay in the fitness field, with celebrity exercise videos and a permanent spot in health clubs across the country. High- and low-impact style aerobics are commonplace. High-impact aerobics involves jumping, running, and bouncing movements, but in low-impact aerobic dance the performer maintains one foot in contact with the floor at all times. Because low-impact routines typically involve fewer jumping and bouncing movements, they were found to produce a lower rate of injury than high-impact routines (Garrick & Requa, 1988; Williford, Scharff-Olson, et al., 1989).

Step aerobics was an offshoot of low-impact aerobics. Step aerobics was designed to raise the intensity level of low-impact aerobics without producing high-impact forces and, consequently, injury levels. Step aerobics participants use a platform with risers that allow step height to vary between 4 and 12 in. When step aerobics is used properly, a benefit is low impact forces. As in low-impact aerobics, step aerobics places an emphasis on the lower body for elevation of the heart rate. Step aerobics involves a much slower cadence, 118-128 bpm, and produces less stress on the joints than high-impact aerobic dance (Olson & Williford, 1996). Little research has been completed on the physiological effects of step aerobics.

Physiological Responses

High and Low Impact

The majority of research pertaining to these forms of exercise, namely high- and low-impact aerobic dance, support their application as a valid cardiovascular training alternative. Several studies have shown that aerobic dance can significantly improve cardiovascular endurance. Rockefeller and Burke (1979) noted a statistically significant improvement in VO2 for 21 untrained students following a three-times-a-week aerobic dance program. In another study the researchers found a significant improvement on the Cooper 12-min run test after a 6-week, three-times-per-week dance program (Watterson, 1984). Other investigations with similar 3-days-per-week training programs have also demonstrated significant improvements in VO2 following several weeks of aerobic dance exercise (Blessing, Wilson, Puckett, & Ford, 1987; Dowdy, Cureton, DuVal, & Ouzts, 1985; Garber et al., 1992; Parker, Hurley, Hanlon, & Vaccaro, 1989; Williford, Blessing, & Smith, 1989). Blessing et al., Parker et al., and Garber et al. used high-impact aerobic routines, and Dowdy et al., and Williford et al. used low-impact aerobic routines. None of these researchers used step aerobics as a dance condition.

Arm Involvement

A number of studies have shown that when the impact of upper body and lower body involvement are compared there is a higher heart rate per given level of VO2 with upper body involvement, specifically arm work. Arm involvement is usually determined by the shoulder range of motion and position relative to heart level. Astrand, Guharay, and Wahren (1968) showed that the position of the arms during arm exercise exerted an influence on the heart. These investigators demonstrated that when arm exercise was performed above shoulder height, the heart rate was higher than when the arm exercise was performed below shoulder height. Dance exercise research has also shown that the heart rate:oxygen consumption (HR:VO2) relationship of choreographed aerobic dance is different than the HR:VO2 relationship for lower body dominant activities such as running.

Arm involvement has been used to raise or lower the intensity of the aerobic dance exercise. A study by Darby, Browder, and Reeves (1995) involved four conditions: (1) high impact with arms, (2) high impact without arms, (3) low impact with arms, and (4) low impact without arms. The high-impact-with-arms condition resulted in a significantly greater relative VO2 than the other three conditions. The low-impact-without-arms condition resulted in a lower relative VO2 than the other three conditions. In addition, the low-impact-with-arms condition had a significantly higher heart rate than the other three conditions.

Similar results have been reported by Carroll, Otto, and Wygand (1991). They reported no significant differences for VO2 for various arm positions during low-impact aerobics. However, there were differences in heart rate. The conditions that involved arm work resulted in higher heart rates than the conditions that did not involve arm work. It has been suggested that the extensive use of the arms overhead during aerobic dance results in an increase in sympathetic outflow that disproportionately increases the heart rate in relation to VO2 (Parker et al., 1989). If this is so, then heart rate would not be a satisfactory guide to exercise intensity. A higher heart rate without a corresponding increase in VO2 may lead some aerobic dance participants to believe they are working harder and expending more energy than they actually are.

However, Berry et al. (1992) found that the use of arms in low-intensity aerobic dance elicited a response in heart rate similar to the heart rate response elicited in running. Bell and Bassey (1994) also found evidence that high- and low-impact aerobic dance done with and without arm work did not elicit a relationship between heart rate and VO2 that was different from the relationship found in running. The discrepancies between the studies may have been due to differing levels of fitness among subjects and varying intensities of the aerobic dance condition.

Comparative Effects

Milburn and Butts (1993) compared the training responses of aerobic dance to jogging. Two exercise groups, a jogging group and an aerobic dance group, each exercised for 30 min a day, 4 days per week, for 7 weeks. The training intensity, based on heart rates, was similar for each group. The results indicated that aerobic dance could produce a cardiovascular training effect comparable to jogging if performed at a similar intensity, duration, and frequency. The results from a study by Garber et al. (1992) also found evidence confirming these results. Improvements in aerobic capacity by an aerobic dance exercise group and a walk/jog group were significant in both groups but were not significantly different from each other. The researchers concluded that the magnitude of the changes in maximal oxygen uptake due to aerobic dance are comparable to those elicited by a traditional walk/jog program. Berry et al. (1992) suggested that aerobic dance training produces heart rates similar to heart rates of running at approximately 50% of VO2max.

When comparing heart rates, researchers have found evidence demonstrating a difference among aerobic dance exercise and other forms of cardiovascular training. Studies have shown aerobic dance heart rates up to 10% higher than those found for treadmill running at the same rate of oxygen consumption (Scharff-Olson et al., 1992). In the majority of studies, investigators compared subjects running with subjects performing aerobic dance at similar VO2 levels. Heart rates during running were significantly less than heart rates during aerobic dance (Berry et al., 1992). Parker et al. (1989) concluded that aerobic dance improves aerobic capacity, however, increases in VO2 appeared to be less than the increases reported from running and cycling at similar levels of initial fitness, exercise durations, frequencies, and target heart rates. The smaller increase in VO2 may be attributed to the lower VO2 relative to heart rate during aerobic dance than during running. The smaller increases in VO2 have been explained by suggesting the use of the arms may elevate heart rate disproportionately so that the use of target heart rates for exercise prescription would overestimate the training stimulus.

Energy Expenditure

The metabolic requirement of aerobic dance can be measured through the use of gas collection apparatus connected to subjects as they perform dance exercise routines. The subjects breathe through an apparatus that collects and analyzes their expired air. In terms of total caloric expenditure for a traditional 30-min aerobic dance session, an approximate cost of 240 kcal was first reported (Williford, Scharff-Olson, et al., 1989). Rockefeller and Burke (1979) estimated that, including the warm-up and cool-down segments, an entire 40-min session of aerobic dance elicited an expenditure of 289.3 kcal. These investigations employed a continuous dance design that allowed no recovery periods during the entire dance bout. Dance method did have an impact on energy cost. High-impact, high-intensity aerobic dance and low-impact, low-intensity aerobic dance were found to have energy costs of 10.44 and 4.93 kcal/min, respectively (Williford, Scharff-Olson, et al., 1989). This metabolic load represents approximately 10 to 10.5 METS and is comparable to running at a 9.6 km/hr pace.

Williford, Blessing et al. (1989) reported that similar heart rates can be produced for low-impact and high-impact aerobic dance. Four aerobic dance conditions were matched for music and choreography: (1) high impact, high intensity; (2) high impact, low intensity; (3) low impact, high intensity; and (4) low impact, low intensity. In all of the dance styles, subjects were required to exercise at approximately 83% of the maximum heart rate reserve. The high-impact, low-intensity aerobic dance elicited the same mean relative heart rate response as the low-impact, high-intensity routine. However, the mean relative metabolic cost was significantly greater for the high-impact aerobic routines when compared to the low-impact aerobic routines. The researchers in the study concluded the differences in energy cost, despite comparable heart rate responses, were due to the incorporation of large muscle mass activity characteristic of high-impact dance.

Summary of Related Literature

The literature suggested that aerobic dance is a viable alternative for cardiovascular training. Numerous research studies have shown that after an aerobic dance training period, there are improvements in oxygen consumption similar to improvements found after a training period involving running or other known aerobic activities. High- and low-impact aerobics have been widely researched in terms of their physiological effects, whereas, step aerobics is a relatively new style of aerobic dance and has not been extensively researched. Step aerobics is designed to raise the intensity level of low-impact aerobics without inducing high-impact forces common in high-impact aerobics.

A number of studies have focused on the effect of arm movements in aerobic dance. Instructors often incorporate arm movements to increase the intensity level of the class. However, research has found that arm movement may disproportionately raise the heart rate in relation to oxygen consumption.

Little research has been done on the effect of aerobics, specifically step aerobics, on energy cost. The available research would support the assumption of aerobic dance as a training alternative. Metabolic loads reported by investigators from aerobic dance sessions are comparable to metabolic loads of running.

The lack of research on step aerobics specifically indicates a need for more studies on this relatively new aerobic dance phenomenon. As step aerobics becomes commonplace at fitness clubs and in the videotape markets there is a need to investigate the physiological effects of this type of activity.

CHAPTER III

METHODOLOGY

The problem of the study was to determine the effects of step height and arm movement on oxygen consumption and energy expenditure during step aerobics. The oxygen consumption achieved during each of the test conditions will be compared with the range recommended by the ACSM for an aerobic activity. R and VO2 were measured during six experimental conditions involving three step heights, 4, 6, and 8 in., and two arm conditions, with arms and without. In addition, two VO2max tests were completed in order to calculate the percentage of VO2 achieved by subjects during each experimental condition. This chapter includes the following procedural steps: (a) selection of subjects, (b) instrumentation, (c) testing procedures, (d) design of the study, and (e) treatment of data.

Selection of Subjects

The subjects were 12 "apparently healthy" (ACSM, 1995) college-age male and female volunteers, ages 18 to 25 years. The subjects were screened for any cardiovascular disease risk factors or orthopedic problems that would limit participation in the study (see Screening Form, Appendix A). Individuals with cardiovascular disease, those with known symptoms of cardiovascular disease, or those possessing two or more known major risk factors for cardiovascular disease were eliminated from the study. Individuals with orthopedic injuries that required medical treatment during the past year or that were chronic enough to warrant exclusion were eliminated. In addition, female volunteers who indicated that they were pregnant were eliminated from the study. The subjects gave written informed consent prior to participation in the study (see Informed Consent Form, Appendix B). Approval to conduct this study was given by Western Michigan University's Human Subjects Institutional Review Board (see Approval Letter, Appendix C).

Each individual had at least 1 year of experience in step aerobics and was comfortable with each of the three step heights, 4, 6, and 8 in. Each subject was instructed to keep physical activity prior to the tests at a minimum. In addition, the subjects were asked to refrain from consuming a heavy meal and drinks containing alcohol or caffeine for 2 hours preceding each test. They were asked not to smoke for 2 hours preceding each test. The subjects were recruited from Health, Physical Education, and Recreation classes at Western Michigan University (see Recruitment Script, Appendix D).

Instrumentation

The equipment for the VO2max tests consisted of a Quinton metabolic cart, model Q-plex 1, Quinton Instrument Company, Seattle, WA; a Polar Heart Rate monitor, model 61210, Country Technology Inc., Gays Mills, WI; and a modified lead EKG with an oscilloscope, Bosch 501A and ECS 502, Germany, respectively. Borg's Rating of Perceived Exertion (RPE) with a scale of 6 to 20 was used as an indicator of subjects' tolerance to exercise and exhaustion level (ACSM, 1995). A treadmill, Quinton Instruments model 643, Seattle, WA, was used for the VO2max test. The step aerobic sessions were conducted using a Reebok step with 2-in. risers, and subjects were monitored using the Polar Heart Rate monitor. A Quinton Q-plex 1 metabolic cart was used to measure VO2, VO2max, and R.

Testing Procedures

Initial Procedure

All testing was completed in the Exercise Physiology Laboratory in the University Recreation Center at Western Michigan University, Kalamazoo. Prior to the study, a consent form was signed and dated by each of the subjects. Within the consent form, the testing procedures and possible risks of the study were explained. Subjects were asked to wear clothing and footwear that were functional and appropriate for walking or jogging on the treadmill and for step aerobics. Subjects were allowed time to become comfortable with the treadmill and metabolic cart before the testing began.

VO2max Test

Subjects performed a VO2max test, each on 2 different days, on the treadmill using the Bruce protocol (ACSM, 1995). This protocol was predominantly an uphill walking test. Following a 3-min warm-up, speed and grade were increased every 3 min (see Bruce protocol, Appendix E). Maximal heart rate (MHR) was calculated using the age predicted maximal heart rate formula (220 - age). During the test, the subject's VO2, heart rate, and electrocardiogram were monitored continuously. An RPE value was determined near the end of each stage. The test was terminated when there was no increase in heart rate or oxygen consumption with a subsequent increase in workload, or when the subject reached volitional exhaustion. Two maximal tests were completed to insure a value reflective of the subject's true VO2max. The higher value from the two tests was treated as the subject's VO2max. The VO2max test was completed so that the VO2 achieved during each experimental condition could be represented as a percentage of VO2max.

Step Aerobics Tests

A videotaped routine was used to ensure that the step aerobic routine was the same for all subjects. An effort was made to incorporate moves and choreography into the videotaped routine that would most often be found in a basic step aerobics class. Moves such as a basic right and left step up, high knees, traveling along the length of the step, tap-ups, and repeater movements were incorporated into the routine.

The subject, performing individually, was asked to follow the recording as he or she would follow the movements and verbal cues of a class instructor. The movement cadence ranged from 122 to 128 bpm, in accordance with the safety standards set forth by Reebok (Olson & Williford, 1996). This cadence allowed the participant to maintain proper stepping techniques with little risk of injury.

The routine was choreographed using simple repetitive movements repeated in groups of 8 and 16 counts. The video included a 2-min warmup and a 15-min workout. The 15-min workout consisted of a 5-min cycle of movements that was repeated three times. The following step heights were used: 4, 6, and 8 in. Two conditions were completed at each step height, one with and one without arm movement. Arm involvement was determined by the shoulder range of motion and position relative to heart level. Arm movements included biceps curls at shoulder height, shoulder press upward, arm press forward, arm pull-down, and combinations of these movements. Subjects were assured a full range of arm movement as well as freedom to move forward, backward and laterally. The hose for collecting the expired gases was placed over the subject's shoulder and was secured to the subject's clothing.

The six conditions, 4 in. no arms (4NA), 4 in. with arms (4A), 6 in. no arms (6NA), 6 in. with arms (6A), 8 in. no arms (8NA), and 8 in. with arms (8A), were each completed on separate days in a random order. VO2 and heart rate were monitored continuously during the tests. Exercise heart rate was monitored in order to verify that subjects responded similiarly in the second and third cycle of the step routine. R values and VO2 measurements were collected every 20 s during the second and third cycles of the routine. An event marker was initiated on the data sheet at 5 min and 10 min into the routine and at the completion of the routine. Mean VO2 values and mean R values for each condition were determined by averaging the sample VO2 and R values collected during the second and third 5-min cycles of the step aerobic routine.

Design of the Study

The order of participation in each of the experimental conditions was randomly assigned for each subject. Three dependent variables were analyzed: (1) VO2, (2) VO2 as a percentage of VO2max, and (3) energy cost. The subjects participated in six experimental conditions, including three step heights and two arm conditions, 4NA, 4A, 6NA, 6A, 8NA, and 8A.

Treatment of Data

VO2 and R were sampled every 20 s during the second and third 5-min cycles in the 15-min step aerobics routine. Means for both VO2 and R were established by averaging the samples in both the second and the third cycle in each step aerobic routine. VO2 as a percentage of VO2max was calculated by dividing the mean VO2 for each condition by the VO2max for each subject. Energy cost in kilocalories was calculated by determining the mean R value for each cycle. A non-protein R table was consulted to determine the kilocalorie equivalent value per liter of oxygen consumed (McArdle et al., 1991). The value for kilocalorie per liter oxygen consumed was multiplied by the mean VO2 value in liters per minute for each cycle to calculate kilocalories per minute for each step height and arm condition.

Randomized block factorial ANOVAs were calculated to determine if the VO2, VO2 as a percentage of VO2max, and energy cost were significantly different in the second and third 5-min cycles of the routine. If the results indicated a significant difference in the means then the two cycles were included in each ANOVA. If no significant difference existed, the grand mean of the two 5-min cycles was used in the subsequent ANOVAs.

Randomized block factorial ANOVAs were used to determine if significant differences in VO2, and VO2 as a percentage of VO2max, and energy cost occurred among the three step heights and between the two arm conditions. Chi-square tests for goodness of fit were also calculated to determine if all experimental conditions provided sufficient workloads to place performers in the VO2 range recommended by ACSM (1995). The obtained frequency was the number of subjects for whom the VO2 fell within the ACSM guidelines of 50% to 85% of VO2max.

CHAPTER IV

RESULTS AND DISCUSSION

In this study the researcher investigated the effects of step height and arm involvement on VO2, VO2 as a percentage of VO2max, and energy expenditure during a step aerobic exercise routine. The routine consisted of a warm-up followed by three repeating 5-min cycles of step aerobic movements performed consecutively. Data were collected during the second and third cycle in the routine. Results were discussed under the following subheadings: (a) subject demographics, (b) internal consistency, (c) VO2, (d) VO2 as a percentage of VO2max, (e) energy cost, and (f) Chi-square goodness of fit. A separate randomized block factorial ANOVA was used to determine the internal consistency of the three dependent measures across the second and third cycles in the step routine. Separate ANOVAs were also calculated to determine the effects of step height (4, 6, and 8 in.) and arm involvement (A and NA) for each of the 3 dependent variables. A Chi-square goodness of fit test was conducted to determine whether the work intensities of the various conditions fell within the recommended range of 50% to 85% of VO2max.

Results

Subject Demographics

Twelve subjects completed the study. The mean age of the subjects was 22.4 years with a standard deviation of 1.9 years. The mean weight of the subjects was 65.3 kg with a standard deviation of 6.6 kg. The mean height of the subjects was 67.0 in. with a standard deviation of 2.0 in. The mean VO2max estimate for the subjects was 51.8 $ml \cdot kg^{-1} \cdot min^{-1}$ with a standard deviation 3.7 $ml \cdot kg^{-1} \cdot min^{-1}$.

Internal Consistency

The mean performances of the subjects on the dependent variables, VO2, VO2 as a percentage of VO2max, and energy cost for the second and third cycles of the step aerobic routine were analyzed to determine the internal consistency of the subjects' performance across these movement cycles in the routine. Separate ANOVAs were calculated for each dependent variable to determine if significant main effects for the cycle time existed. A summary for the main effects for cycle time are presented in Table 1. No significant differences were found for cycle time for the dependent variables, VO2, VO2 as a percentage of VO2max, and energy cost, $F(1, 121) = 2.69$, $p > .05$; $F(1, 121) = 2.72$, $p > .05$; and $F(1, 121) = 2.59$, $p > .05$, respectively. Therefore, cycle time was removed from the subsequent

ANOVAs to determine whether significant main effects for step height and use of arms existed. The grand mean performances of subjects across the second and third cycles of the step aerobic routine on the dependent variables were used in these ANOVAs.

Table 1

Internal Consistency Based on the ANOVA Main Effect for Cycle Time

Variable	M_2	M_3	F
VO2 (ml·kg^{-1}·min^{-1})	28.58	29.21	2.69
VO2 as a % of VO2max	55.19	47.42	2.72
Energy cost (kcal/min)	9.20	9.40	2.59

Note. M_2 represents the mean for the second cycle, whereas M_3 represents the mean for the third cycle.

VO2

Means and standard deviations for VO2 are displayed in Table 2. The values for VO2 ranged from 17.5 to 26.5, 22.9 to 36.5, 23.6 to 28.2, 25.0 to 37.2, 28.1 to 34.6, and 30.4 to 39.9 ml·kg^{-1}·min^{-1} for 4NA, 4A, 6NA, 6A, 8NA, and 8A, respectively. The mean for A was greater than the mean for NA for each step height. The means increased as the step height increased for both A and NA. The mean for the step height of 4A was greater than 6NA, likewise for 6A and 8NA. The condition 8A elicited the greatest VO2.

Table 2

Means and Standard Deviations for VO2 ($ml \cdot kg^{-1} \cdot min^{-1}$)

Step Height (in.)	Condition	M	SD
4	NA	22.67	2.55
	A	27.98	3.49
6	NA	26.26	1.52
	A	31.09	3.42
8	NA	30.82	2.26
	A	34.56	2.89

A randomized block factorial ANOVA was calculated to analyze the VO2. The ANOVA summary table is presented in Table 3. There was no significant interaction effect between arm involvement and step height, $F(2, 55) = 0.70$, $p > .05$. The ANOVA revealed significant differences for arm involvement, $F(1, 55) = 69.63$, $p < .05$. Therefore, significant differences in VO2 existed between arms and no arms in the step aerobic routine across all step heights tested. The ANOVA also revealed significant differences for step height, $F(2, 55) = 58.87$, $p < .05$. A Tukey HSD (Honestly Significant Difference) post-hoc test was performed in order to determine where the significant differences were between step heights. The results are displayed in Table 4. Significant differences existed between 4 and 6 in., 4 and 8 in., and 6 and 8 in., respectively.

Table 3

ANOVA Summary Table for VO2

Source	SS	df	MS	F
Arms (A)	385.73	1	385.73	69.63*
Step (S)	652.25	2	326.13	58.87*
A x S	7.80	2	3.90	0.70
Error	304.60	55	5.54	

*Significant at the .05 level.

VO2 as a Percentage of VO2max

Means and standard deviations for VO2 as a percentage of VO2max are presented in Table 5. The ranges of values for VO2 as a percentage of VO2max were 36.5 to 53.0, 42.0 to 71.0, 44.0 to 56.0, 52.5 to 65.5, 52.5 to 69.5, and 61.0 to 73.5% for 4NA, 4A, 6NA, 6A, 8NA, and 8A, respectively. The means for each condition increased as the step height increased, and the means for arm involvement were all greater than their respective means for the no-arm-involvement condition.

Table 4

The Tukey HSD Test on Step Height for VO2 (ml·kg^{-1}·min^{-1})

		Step Height (in.)		
Step Height (in.)		4	6	8
	M	25.33	28.67	32.69
4	25.33	0	3.34*	7.36*
6	28.67		0	4.02*
8	32.69			0

*Significant at the .05 level.

Table 5

Means and Standard Deviations for VO2 as a Percentage of VO2max

Step Height (in.)	Condition	M	SD
4	NA	43.71	4.38
	A	52.79	7.39
6	NA	50.88	4.47
	A	59.96	4.48
8	NA	59.71	5.14
	A	66.79	4.06

A randomized block factorial ANOVA design was used to analyze the dependent variable, VO2 as a percentage of VO2max. The ANOVA summary table is presented in Table 6. There was no significant interaction effect between arm involvement and step height, $F(2, 55) = 0.68$, $p > .05$. The ANOVA revealed significant differences for arm involvement, $F(1, 55) = 66.58$, $p < .05$. The ANOVA also revealed significant differences for step height, $F(2, 55) = 61.07$, $p < .05$. A Tukey HSD post-hoc test revealed significant differences existed between 4 and 6 in., 4 and 8 in., and 6 and 8 in. The results are displayed in Table 7.

Table 6

ANOVA Summary Table for VO2 as a Percentage of VO2max

Source	SS	df	MS	F
Arms (A)	1378.13	1	1378.13	66.58*
Step (S)	2528.44	2	1264.22	61.07*
A x S	28.00	2	14.00	0.68
Error	1138.77	55	20.70	

*Significant at the .05 level.

Energy Cost

The means and standard deviations for energy cost are displayed in

Table 8. The ranges of values for energy cost were 5.65 to 8.75, 7.25 to 11.55, 6.5 to 10.1, 7.4 to 13.25, 8.4 to 12.3, and 8.3 to 13.3 kcal/min for 4NA, 4A, 6NA, 6A, 8NA, and 8A, respectively. The means for arms increased with the increase in step height as did the means for no arms. The mean for A was greater than the mean for NA at each respective step height. The greatest energy cost was in the condition 8A.

Table 7

The Tukey HSD Test on Step Height for VO2 as a Percentage of VO2max

		Step Height (in.)		
Step Height (in.)		4	6	8
	_M_	48.75	55.42	63.25
4	48.75	0	6.67*	14.50*
6	55.42		0	7.83*
8	63.25			0

*Significant at the .05 level.

A randomized block factorial ANOVA design was used to analyze the dependent variable, energy cost. The ANOVA summary table is presented in Table 9. There was no significant interaction effect between arm involvement and step height, $\underline{F}(2, 55) = 0.57$, $\underline{p} > .05$. The ANOVA revealed significant differences for arm involvement, $F(1, 55) = 68.25$, $p < .05$. The ANOVA also revealed significant differences for step height, $F(2, 55) = 57.38$, $p < .05$. A Tukey HSD post-hoc test revealed significant differences existed between 4- and 6-in., 4- and 8-in., and 6- and 8-in. step. The results are displayed in Table 10.

Table 8

Means and Standard Deviations for Energy Cost (kcal/min)

Step Height (in.)	Condition	M	SD
4	NA	7.29	1.02
	A	8.98	1.53
6	NA	8.41	1.01
	A	10.01	1.76
8	NA	9.94	1.18
	A	11.18	1.54

Table 9

ANOVA Summary Table for Energy Cost

Source	SS	df	MS	F
Arms (A)	40.95	1	40.95	68.25*

Table 9—Continued

Source	SS	df	MS	F
Step (S)	70.86	2	34.43	57.38*
A x S	0.68	2	0.34	0.57
Error	33.03	55	0.60	

*Significant at the .05 level.

Table 10

The Tukey HSD Test on Step Height for Energy Cost (kcal/min)

		Step Height (in.)		
Step Height (in.)		4	6	8
	M	8.14	9.21	10.56
4	8.14	0	1.07*	2.42*
6	9.21		0	1.35*
8	10.56			0

*Significant at the .05 level.

Chi-Square Test for Goodness of Fit

A Chi-Square test for goodness of fit was calculated to determine if all experimental conditions provided sufficient workloads to place performers in the recommended VO2 range for aerobic improvement. The obtained frequency was the number of subjects for whom the VO2 was within the ACSM guidelines of 50% to 85% of VO2max. The chi-square values are displayed in Table 11. Only four conditions were significant at the .05 level, 4NA, 6A, 8NA, and 8A.

Table 11

Chi-Square Test for Goodness of Fit

Step Height (in.)	Condition	Chi-Square	p
4	NA	8.33	.004
4	A	3.00	.083
6	NA	1.33	.248
6	A	12.00	.000
8	NA	12.00	.000
8	A	12.00	.000

Table 12 displays the percentage of subjects in the recommended range for each of the experimental conditions. Only condition 4NA had a significant number of subjects outside of the range, with only 8% of the subjects within the recommended range of 50% to 85% of VO2max. The conditions 6A, 8NA, and 8A, were all significant in that all of the subjects VO2 were within the recommended range.

Table 12

Percentage of Subjects Within Recommended Range

Step Height (in.)	Condition	Cycle	Percent in Range
4	NA	2, 3	8
4	A	2, 3	75
6	NA	2, 3	68
6	A	2, 3	100
8	NA	2, 3	100
8	A	2, 3	100

Discussion

The results demonstrated a number of significant findings. For each of the three dependent variables, VO2, VO2 as a percentage of VO2max, and energy cost, step height and arm involvement had significant effects. For VO2, oxygen consumption increased as bench height increased. This was in agreement with a number of studies (Scharff-Olson, Williford, Blessing, & Greathouse, 1991; Stanforth, Stanforth, & Velasquez, 1993).

Scharff-Olson et al. (1991) used four step heights, 6, 8, 10, and 12 in. The investigators found that the oxygen requirement for each step height increased significantly from the lowest bench height to the highest, ranging from 28.4 to 37.3 $ml \cdot kg^{-1} \cdot min^{-1}$. Stanforth et al. (1993) also found a significant increase in oxygen uptake between bench heights (6, 8, 10, and 12 in.) and between two stepping rates of 120 bpm and 128 bpm. The present study used a stepping cadence that ranged from 122 bpm to 128 bpm, and the VO2 means ranged from 22.67 to 34.56 $ml \cdot kg^{-1} \cdot min^{-1}$.

Arm involvement also significantly increased VO2 for each step height. Arm involvement increased the intensity of exercise and consequently increased the oxygen cost. It is important to note that mean VO2 for 4A was greater than the mean VO2 for 6NA, and the mean for 6A was greater than the mean for 8NA. This would indicate that the inclusion of arm movements increased VO2 more than raising the step height by 2 in. A study by Williford, Blessing, and Scharff-Olson (1988) investigated the effect of intensity in high- and low-impact aerobics. The following conditions were studied: high intensity and high impact, high intensity and low impact, low intensity and high impact, and low intensity and low impact. The researchers found a VO2 of 29.4 $ml \cdot kg^{-1} \cdot min^{-1}$ for a high-intensity, low-impact aerobic routine. This condition was similar to the intensity and the impact level of the step aerobic routine used in the present study, which had a VO2 range of 27.98 to 34.96 $ml \cdot kg^{-1} \cdot min^{-1}$ for the conditions, 4A, 6A, and 8A.

For the variable VO2 as a percentage of VO2max, only 4NA was not within the recommended range of 50% to 85% of VO2max. However, the mean VO2 did not exceed 70% of VO2max for any of the step heights or conditions. Scharff-Olson et al. (1991) found a VO2 as a percentage of VO2max value of 59.8% for the 6-in. step and 65.9% for the 8-in. step. The tendency for VO2 as a percentage of VO2max to be low was also indicated in a study completed by Scharff-Olson and Williford (1996). The study used five basic step aerobic movements that varied in intensity, a forward and backward step, a straddling step, a knee raise, an alternate lead step, and a lunge step. The study found VO2 as a percentage of VO2max values ranging from 62.6% for a basic forward and backward step to 75.6% for a lunge step. The movements were all performed using an 8-in. step. The present study, which consisted of a combination of the movements studied by Scharff-Olson and Williford (1996), found a similar VO2 as a percentage of VO2max of 66.79% for 8A. VO2 as a percentage of VO2 increased with the addition of arm movements and with the increase in step height, in a pattern similar to the VO2 results. Francis, Poliner, Buono, and Francis (1992) found for a 20.3-cm (8-in.) step the VO2 as a percentage of VO2max for stepping with arms was significantly greater than stepping without arms, 57.9% and 51.9%, respectively. It should be noted that the participants in the present study were well conditioned, as indicated by their VO2max performances ($\underline{M}$ = 51.8 ml·kg·min^{-1}). It is likely that the VO2 as a percentage of VO2max would be higher for less well-conditioned individuals.

In the variable energy cost, there was an increase in energy cost with an increase in step height. In addition, there was an increase in energy cost with the inclusion of arm movements. The mean energy cost for 4A was greater than the mean energy cost for 6NA, and the mean energy cost for 6A was greater than the mean energy cost for 8NA, the same pattern as found for both VO2 and VO2 as a percent of VO2max. Francis et al. (1992) found that the addition of arm movements created approximately the same increase in energy cost as an increase of 5.1 cm (2 in.) in step height. The 15-min bout of step aerobics used in this study required approximately 109, 135, 126, 150, 149, and 168 kcal for 4NA, 4A, 6NA, 6A, 8NA, and 8A, respectively. These values, when extrapolated to 20 min, are similar to values found by Scharff-Olson et al. (1991) with 6-in. (150 kcal) and 8-in. (170 kcal) step. Wang, Scharff-Olson, and Williford (1993) had 9 subjects perform a videotaped step aerobics routine on 6-, 8-, and 10-in. step. They found energy cost values of 6.7, 7.7, and 8.7 kcal/min for 6-, 8-, and 10-in. step, respectively. Every 2-in. increment in step height was related to a 1 kcal/min increase in energy cost. In the present study, slightly higher mean energy cost values of 8.41, 10.01, 9.94, and 11.18 kcal/min for 6NA, 6A, 8NA, and 8A, respectively, were found.

Table 13

The Estimated Number of Minutes Necessary to
Expend 200, 300, and 500 kcal

Step Height (in.)	Condition	200 kcal	300 kcal	500 kcal
4	NA	27	41	69
	A	22	33	55
6	NA	24	36	59
	A	20	30	50
8	NA	20	30	50
	A	18	27	45

For weight loss and fat reduction, Scharff-Olson et al. (1991) stated that an exercise bout should elicit an expenditure of 300 to 500 kcal and be performed a minimum of 3 days per week. An expenditure of 200 kcal is recommended if the frequency is 4 days per week. ACSM (1995) guidelines are in agreement, stating a minimum threshold of 300 kcal for exercise performed 3 days per week and 200 kcal for exercise performed 4 days per week. Table 13 indicates the estimated number of minutes necessary to expend 200, 300, and 500 kcal for each step height and condition. Based on this study it would require at least 30 min to expend 300 kcal and 50 min to expend 500 kcal for all conditions except 8A. Also, it would take at least 20 min to expend 200 kcal for all conditions except 8A.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to determine the effects of step height and arm involvement on oxygen consumption and energy expenditure during step aerobics. The research was discussed under the following chapter headings: (a) summary, (b) findings, (c) conclusions, and (d) recommendations.

Summary

The effects of step height and arm involvement on VO2, VO2 as a percentage of VO2max, and energy expenditure during a step aerobic exercise routine were studied. The oxygen consumption achieved during each of the test conditions was compared with the range of 50% to 85% recommended by the ACSM for an aerobic activity. The 12 subjects completed the following 6 experimental conditions in a random order: 4NA, 4A, 6NA, 6A, 8NA, and 8A.

VO2 and R values were measured during each of the 6 experimental conditions using a Quinton Q-plex 1 metabolic cart. The subjects were instructed to follow the step aerobics exercise video and either mimic the arm movements or place their hands on their waist. R values and VO2 measurements were collected every 20 s during the second and third cycles of the routine. Mean values for VO2 and R were calculated by averaging the samples in the second and third cycle of the routine. VO2 as a percentage of VO2max was calculated by dividing the mean VO2 for each condition by the subject's VO2max. Energy cost was calculated by consulting a non-protein R table to determine the kcal equivalent value per liter of oxygen and multiplying that value by the mean VO2 in liters per minute for the second and third cycle in the step aerobics routine.

Three randomized block factorial ANOVAs were calculated for each of the dependent variables, VO2, VO2 as a percentage of VO2max, and energy cost. A chi-square test for goodness of fit was calculated to determine if all experimental conditions provided sufficient workloads to place performers in the ACSM recommended range of 50% to 85% of their VO2max. All statistical hypotheses were tested at the .05 level of significance.

Findings

With the exception of the hypothesis stating all of the experimental conditions would have a VO2 as a percentage of VO2max value within the recommended range, the research hypotheses were supported. The ANOVA for the dependent variable VO2 revealed significant differences for step height, $F(2, 55) = 58.87$, $p < .05$. There were also significant differences in VO2 for arm involvement, $F(1, 55) = 69.63$, $p < .05$. There was no significant interaction effect between step height and arm involvement, $F(2, 55) = 0.70$, $p > .05$. The ANOVA for the dependent variable VO2 as a percentage of VO2max revealed significant differences for step height, $F(2, 55) = 61.07$, $p < .05$. Arm involvement was also significant for VO2 as a percent of VO2max, $F(1, 55) = 66.58$, $p < .05$. There was no significant interaction effect between step height and arm involvement, $F(2, 55) = 0.68$, $p > .05$. The ANOVA for the dependent variable energy cost revealed significant differences for step height, $F(2, 55) = 57.38$, $p < .05$. Arm involvement was also significant for energy cost, $F(1, 55) = 68.25$, $p < .05$. There was no significant interaction effect between step height and arm involvement, $F(2, 55) = 0.57$, $p > .05$. The Chi-Square goodness of fit test revealed that conditions 4NA, 6A, 8NA, and 8A were significant. The experimental condition 4NA had a significant number of subjects outside the recommended range.

Conclusions

Based on the results of this study, it was concluded that an increase in step height will result in increased VO2, VO2 as a percentage of VO2max, and energy expenditure. The addition of arm movement will also result in increased VO2, VO2 as a percentage of VO2max, and energy expenditure. Step aerobics, for all conditions except 4NA, was found to produce an exercise intensity within the range recommended by ACSM, 50% to 85% of VO2max.

Recommendations

Several ideas warrant mention in regard to recommendations for further research. None of the 6 conditions studied produced a work intensity greater than 70% of VO2max. Further studies of step aerobics should investigate whether an increase in step height would increase the rate of injury. In addition, further studies could be completed concerning the effect of propulsion steps on VO2 as a percentage of VO2max. The addition of propulsion steps could increase the VO2 as a percentage of VO2max, however impact forces could also increase. Additional suggestions include (a) investigations of smaller cycles of time to determine the effect of each movement within a step aerobics routine, and (b) comparing the responses of conditioned and nonconditioned subjects to step aerobic routines of varying intensities.

Appendix A

Subject Screening Form

SUBJECT SCREENING FORM

Code number:______________

Please answer 'yes' or 'no' to the following questions regarding your current health status:

_____ 1. Do you smoke?
_____ 2. Do you have diabetes?
_____ 3. Have you been told that you have high blood pressure or do you take blood pressure medication?
_____ 4. Has a member of your immediate family (parent or sibling) suffered from coronary or other atherosclerotic disease before age 55?
_____ 5. Have you been told that you have a high blood cholesterol level?
_____ 6. Are you taking any medication, prescribed or over the counter?
_____ 7. Is there any possibility that you are pregnant (women only)?
_____ 8. Are you taking any of the following drugs?
Beta Blockers, Alpha Blockers, Amphetamines, Antiadrenergic Agents, Nitrates and Nitroglycerin, Calcium Channel Blockers, Cocaine, Digitalis, Diuretics, Peripheral Vasodilators, Marijuana, Angiotensin-Converting Enzyme, Antiarrhythmic Agents, Sympathomimetic, or Antihyperlipidemic Agents?
_____ 9. Have you experienced chest pains, shortness of breath, tightness in the chest, or fainting spells?
_____ 10. Do your ankles swell?
_____ 11. Do you have varicose veins?
_____ 12. Do you currently have a systemic infection?
_____ 13. Do you have mononucleosis?
_____ 14. Are you or have you been recently ill?
_____ 15. Do you have an injury that may be aggravated by exercise?
_____ 16. Do you have arthritis?
_____ 17. Do you experience extreme shortness of breath, especially with exercise?

Failure to answer any of these questions will result in elimination from the study. If a potential subject answers 'yes' to two or more items, 1-5, he or she does not qualify as apparently healthly according to the American College of Sports Medicine (ACSM, 1995). Only 'apparently healthy' subjects will be eligible to participate in the study. An individual judgment will be made concerning participation of potential subjects answering 'yes' to items 6-17. The judgment will be based on the potential impact of exercise on that particular individual. Individuals with cardiovascular disease, or those possessing two or more known major factors or orthopedic injuries that require medical treatment during the past year or that in view of the investigator would limit participation will be eliminated. Individuals who answer 'yes' to item 7 will also be eliminated.

Appendix B

Informed Consent Form

Western Michigan University
Department of Health, Physical Education, and Recreation

Principal Investigator: Dr. Roger Zabik

Research Associate: Heidi A. Riker

I have been invited to participate in a research project entitled "The effect of step height and upper body involvement on oxygen consumption and energy expenditure in step aerobics." I understand that this research is intended to determine at what percentage of maximal capacity an individual is working for three different step heights. I further understand that this project is Heidi Riker's master's thesis in the Department of Health, Physical Education, and Recreation at Western Michigan University.

My consent to participate in this project indicates that I will participate in eight 30-min sessions. These sessions will take place in the Exercise Physiology Laboratory, room 1055, in the Student Recreation Center. These sessions will involve two Bruce treadmill maximal oxygen consumption tests, and two step aerobic tests at each of the three step heights, one with arm involvement and one without, for a total of six step aerobic tests. The step heights are 4, 6, and 8 in. In the first session, I will be familiarized with Borg's rating of perceived exertion (RPE) scale and all testing procedures, and I will participate in the first of two maximal oxygen consumption tests. There will be at least 48 hours between the maximal oxygen consumption tests and at least 24 hours between consecutive step aerobic tests. I will be asked to breath through an apparatus that collects and analyzes my expired air and I will be monitored by an electrocardiogram during the maximal oxygen consumption tests.

As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to me except as otherwise specified in this consent form. I understand that there may be some potential risk of injury, such as muscle soreness or possible heart attack. However, appropriate measures will be taken to minimize these risks. The investigators and assistants in the data collection are all CPR and First Aid trained. Emergency response procedures are also posted in the Exercise Physiology Laboratory, where all the testing will take place. I also understand that I may terminate my involvement with this research for any reason at any time without prejudice or without affecting my academic evaluation in any way.

I may benefit from my participation by knowing my maximal oxygen consumption (VO2 max) on the treadmill. I may gain insight as to the time and equipment involved for taking a maximal graded exercise test. I may also gain knowledge as to the step height and arm condition which elicits the greatest VO2 value.

I understand that all the information collected from me is confidential. My name will only appear on this form and on a list of identification codes, and no individual names will be printed on any papers or reports other than this form, which will be seen only the investigators and those helping to test. All data will be retained for a period of 3 years in a locked file controlled by the principal investigator. At the conclusion of the study, I will be able to receive a copy of my results upon request.

If I have any questions or concerns about this study I may contact Heidi Riker at 427-7325 or Dr. Zabik at 387-2720. I may also contact the chair of the Human Subjects Institutional Review Board at 387-8293 or the Vice President for Research at 387-5926. I affirm that I am between the ages of 18 and 25 years old and free of any known cardiorespiratory disease. My signature below indicates that I understand the purpose and requirements of the study and that I agree to participate.

____________________________ ______________

Signature Date

Appendix C

Human Subjects Institutional Review Board Approval Letter

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-3899
616 387-8293

WESTERN MICHIGAN UNIVERSITY

To: Dr. Roger Zabik
Heidi Riker

From: Richard A. Wright, Chair
Human Subjects Institutional Review Board

Richard A. Wright

Subject: HSIRB Project # 96-09-12

Date: October 11, 1996

This is to inform you that the modifications to your project entitled "Effect of Step Height and Upper Body Involvement on Oxygen Consumption and Energy Expenditure," have been received and approved. Therefore, your project has been approved under the full board category of research. This approval is based upon your proposal as presented to the HSIRB, and you may utilize human subjects only in accord with this approved proposal.

Your project is approved for a period of one year from the above date. If you should revise any procedures relative to human subjects or materials, you must resubmit those changes for review in order to retain approval. Should any untoward incidents or unanticipated adverse reactions occur with the subjects in the process of this study, you must suspend the study and notify me immediately. The HSIRB will then determine whether or not the study may continue.

Please be reminded that all research involving human subjects must be accomplished in full accord with the policies and procedures of Western Michigan University, as well as all applicable local, state, and federal laws and regulations. Any deviation from those policies, procedures, laws or regulations may cause immediate termination of approval for this project.

Thank you for your cooperation. If you have any questions, please do not hesitate to contact me.

Project Expiration Date: October 11, 1997

Appendix D

Recruitment Script

Western Michigan University
Department of Health, Physical Education, and Recreation
Recruitment Script

Graduate assistant Heidi Riker is looking for volunteers to participate in her master's thesis research. The study is titled, "The effects of step height and upper body involvement on oxygen consumption and energy expenditure in step aerobics." The study requires 12 volunteers between the ages of 18 and 25 years. As a volunteer, you will be required to participate in eight testing sessions. Two of the sessions will be tests to determine maximal oxygen consumption and six of the sessions will be step aerobic exercise sessions, utilizing three step heights. The step aerobic tests will have two conditions on each height, with arms and without arms. A random selection process will be established to determine which height and arm condition you will participate in first and the order of successive tests.

Prospective participants will be asked to complete a questionnaire on their current health history to determine if they will be able to participate. Reasons for exclusion could be pregnancy or coronary disease in the immediate family. If you are accepted as a subject you must read and sign an informed consent form before participating. Your commitment would involve eight 30-min sessions. Each subject will be given at least 48 hours rest between tests. All sessions will take place in the Exercise Physiology Laboratory, room 1055 at the Student Recreation Center.

All of the sessions will involve breathing through an apparatus that will collect and analyze your expired air. The maximal oxygen consumption tests will involve walking/jogging on a treadmill. The tests will involve increasing workloads according to the pre-established test protocol. During the VO2max tests, heart rate, VO2, electrocardiogram, and perceived level of exertion (RPE) will be recorded. The step aerobic tests involve following a videotaped routine. For the step aerobic tests, VO2 and Respiratory Exchange Ratio will be monitored and recorded.

You have the option to voluntarily terminate your involvement in the study for any reason. Your participation or performance during the study will not have any effect on your academic evaluation in any way. All test information will be kept confidential, and you will be able to receive a copy of your test results upon request. If you are between 18 and 25 years old and are interested in getting more information or volunteering for the study, please fill out the information below or contact Heidi Riker by phone at 387- 2689 or 427- 7325. Thank you.

Name Phone number

____

____

Appendix E

Bruce Protocol

The Bruce Treadmill Graded Exercise Test Protocol

	Time (min)					
% Grade	3	6	9	12	15	18
10	1.7 mph					
12		2.5 mph				
14			3.4 mph			
16				4.2 mph		
18					5.0 mph	
20						5.5 mph

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