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**Heart rate and RPE differences with 8" and 10" step heights
and low versus high intensity ALL OUT StepTM choreography in
a female population**

Wexted, Teresa Lynne, M.A.

San Jose State University, 1993

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HEART RATE AND RPE DIFFERENCES WITH 8" AND 10" STEP HEIGHTS
AND LOW VERSUS HIGH INTENSITY ALL OUT STEP™ CHOREOGRAPHY
IN A FEMALE POPULATION

A Thesis

Presented to

The Faculty of the Department of Human Performance

San Jose State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

By

Teresa Lynne Wexted

May, 1993

APPROVED FOR THE DEPARTMENT OF HUMAN PERFORMANCE

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ABSTRACT

HEART RATE AND RPE DIFFERENCES WITH 8" AND 10" STEP HEIGHTS AND LOW VERSUS HIGH INTENSITY ALL OUT STEP™ CHOREOGRAPHY IN A FEMALE POPULATION

by Teresa Lynne Wexted

This study determined differences in heart rate (HR) and ratings of perceived exertion (RPE) levels of nineteen female fitness club participants and instructors (mean age = 30.1 yrs), using 8" and 10" step heights, during two identical twenty minute step workouts, at minutes 3:20, 7:40, 9:40, 13:20, 16:40, and 19:40. Data were analyzed with ANOVA for repeated measures and Scheffe' post hoc tests. These findings demonstrated that: (a) there were significantly higher ($p < .01$) HR and RPE values on the 10" step height than on the 8" step height; (b) there were significantly higher ($p < .01$) HR & RPE values during high intensity ALL OUT Step™ choreography than during low intensity choreography; and (c) traveling movements, lunges, and arm use elicit HR and RPE values associated with high intensity choreography.

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CHAPTER ONE

INTRODUCTION

Step exercise is quickly becoming one of the most popular aerobic trends of the 1990's. It is an intense, primarily low-impact aerobic exercise activity, accompanied by music, that involves taking controlled steps up and down on a raised platform. The focus of this activity is to increase cardiovascular endurance, while developing muscular endurance and strength of the major muscle groups throughout the entire body, with special emphasis on the legs and gluteals. It is a new and beneficial alternative to other cardiovascular endurance exercise activities (Fisher, 1991; La Forge, 1991; Olson, Williford, Blessing & Greathouse, 1991b).

According to Lorna Francis, PhD, and Peter Francis, PhD, "when performed correctly, stepping can give the participant the aerobic benefits of running seven miles per hour, with no more foot impact than the forces exerted during walking at three miles per hour" (Price, 1990, p. 57). Four advantages of step training are: 1) it provides a high intensity, low-impact, balanced and complete workout; 2) it can be performed by men and women of all ages and fitness levels; 3) it improves muscular strength and endurance; and 4) it is a simple, yet challenging workout to execute.

Due to the growing popularity of step exercise, a number of studies have been done to increase the knowledge and understanding of this cardiovascular endurance activity. Much of this research has been presented at two conferences, the American College of Sports Medicine (ACSM) Conferences in 1991 and 1992, and the International Dance and Exercise Association (IDEA)/American Council on Exercise (ACE) International Convention and Educational Conferences in 1991 and 1992. Further studies in this area may prove to be important by increasing the knowledge base and understanding of the effectiveness of step exercise as an alternative to many other cardiovascular endurance exercise activities.

Statement of the Purpose

The primary purpose of this study was to determine if a difference existed between exercise heart rate and ratings of perceived exertion levels of female fitness club participants and instructors during two identical twenty minute step exercise workouts, one using an 8" (20.3cm) height step and another using a 10" (25.4cm) step. In addition, this study determined the effects of low and high intensity ALL OUT Step™ Choreography on exercise heart rate and ratings of perceived exertion (choreography by Teri Wexted/ALL OUT Fitness Productions, Inc.trademark).

Null Hypotheses

The following are null hypotheses that were tested in this study.

1. There will be no significant differences in exercise heart rate and ratings of perceived exertion (RPE) levels for subjects at selected times (3:20, 7:40, 9:40, 13:20, 16:40, and 19:40 minutes) during two identical twenty minute step exercise workouts, one using an 8" (20.3cm) step and the other using a 10" (25.4cm) step.
2. There will be no significant difference in exercise heart rate and RPE from subjects between the low (minutes 3:20, 7:40, 9:40) and high (minutes 13:20, 16:40, and 19:40) intensity ALL OUT Step™ Choreography, using an 8" (20.3cm) and 10" (25.4cm) step.

Assumptions

The following eight assumptions were made for this study.

1. It was assumed that all subjects reported truthfully to the health questionnaire regarding their health history. They were carefully screened for any previously significant musculoskeletal injuries, physical abnormalities, and other contraindications for exercise.

2. It was assumed that all subjects were physiologically capable of completing each of the two twenty minute step exercise workouts at the designated step heights of 8" (20.3cm) and 10" (25.4cm).
3. It was assumed that all subjects correctly and honestly answered the step exercise experience questionnaire form.
4. It was assumed that all subjects refrained from any additional or unfamiliar exercise on, or prior to, testing days, and within twenty-four hours of testing.
5. It was assumed that all subjects performed and completed the pretesting protocol and both twenty minute workouts to the best of their ability.
6. It was assumed that all subjects were able to effectively follow and execute the videotaped step exercise workout during both sessions.
7. It was assumed that all subjects performed the two twenty minute workouts without any distractions to alter or compromise their performance results.
8. It was assumed that all subjects would minimally reach their individual exercise training zone during the low intensity phase (first 10 minutes) of both workouts.

Limitations

The results of this study were limited by the parameters listed below.

1. The study included a small sample size and limited selection of subjects.
2. The subjects were volunteers from local fitness clubs, and therefore, not a random group sample.
3. The specifically selected step choreography that was used to design the twenty minute workout incorporated both low and high intensity step movements.
4. The abilities of each subject to accurately understand, interpret, and perform all tasks requested of them for this study.
5. The subjects' attitudes, motivations, and willingness to cooperate fully in completing the required tasks.

6. The various personal habits of all subjects such as: diet, exercise, rest, and stress management.
7. The accuracy of testing equipment used to obtain data pertinent to this study.
8. The variations in execution of each step exercise workout at the two designated step heights of both 8" (20.3cm) and 10" (25.4cm).

Delimitations

The six delimitations of this study were as follows.

1. The study was limited to nineteen healthy female participants and instructors, ages 22-39, volunteering from fitness clubs within Santa Clara County, California.
2. Subjects were selected on the basis of having a minimum of three months step exercise experience at a fitness club, and having met a minimum of two times per week for one hour at 60 to 90% maxHR workload intensity during the three month time period.
3. Each of the twenty minute workouts were completed no more than two weeks apart from one another.
4. Only two step heights were utilized: 8" (20.3cm) and 10" (25.4cm).
5. Subjects who exceeded 90% of their maximum heart rate during either test were monitored closely, and when additional exhaustion or overexertion signs were present, the subject was asked to either decrease intensity, or stop immediately if necessary. This procedure may have altered results in heart rate and/or RPE levels.

Definitions of Terms

Basic Step Movements

Step movements used for choreography selection including: Basic Step (BS), Alternating Lead (AL), Over the Top (OT), Knee Lift (KL), Basic Lunge (BL), V-Step

(VS), Change Directions (CD), Step Kick (SK), ALL OUT™ Pattern #1 (AP1), ALL OUT™ Pattern #2 (AP2), (See Appendix A for detailed descriptions of these movements and actual step patterns found in the twenty minute video workout.).

Choreography (Step Exercise)

The creation, selection, and ordering of step exercise movements and/or patterns of movement which make up a complete step exercise workout.

Heart -Rate Reserve

The difference between the resting heart rate (RHR) and the maximal heart rate (maxHR). Formula: Heart Rate Reserve (HRR) = maxHR - RHR

High-Impact Aerobics

Aerobic exercise movements which include bringing both feet off the ground at the same time, and therefore, increasing the stress on impact. Such movements may include: jogging, jumping, hopping, and leaping (ACSM, 1990; Francis, Francis, & Wilshons-Smith, 1985).

High-Intensity Movement

Aerobic exercise movements which include “using vigorous arm movements above the shoulder level, and kicking above the hip level and with a straight leg” (Williford et al., 1989, p. 95).

Injury/Illness

Any change in physical health that limits, impairs, or removes the participant from continued participation in the study.

Intensity

The physiological stress on the body, during exercise, that reflects the degree or extent to which the body is working.

Karvonen Formula

A formula used to calculate target heart rate (THR), which is a percentage of the heart rate reserve, plus the resting heart rate (IDEA, 1987).

Formula: $THR = (220 - \text{age} - \text{resting HR}) \times \% \text{ intensity} + \text{resting HR}$

Low-Impact Aerobics

Aerobic exercise movements that include maintaining at least one foot in contact with the floor at all times, and therefore, reducing the amount of stress on the body during impact (Williford, Blessing, Olson, & Smith, 1989).

Low-Intensity Movement

Aerobic exercise movements that include limited arm movement below the shoulder level, and leg movement below the hip level (Williford et al., 1989).

Maximal Exercise Test

A test that continues until a person has reached a maximal level of oxygen consumption or voluntary exhaustion.

Maximal Heart Rate (maxHR)

The highest heart rate a person can attain during heavy exercise (Howley & Franks, 1992). Formula for Predicted maxHR is $220 - \text{age}$ (ACSM, 1991).

Maximal Oxygen Consumption (maxVO₂)

The maximal rate at which oxygen can be consumed per minute (Fox, Bowers & Foss, 1989).

Range of Motion

The flexibility of a joint, muscle, tendon, or ligament in the determination of mobility.

Static Stretching

A nonmoving stretch that is low-force and long in duration, and is recommended for optimal results in gained flexibility (IDEA, 1987).

Steady State

The point at which oxygen consumption reaches a constant level (Fox, et. al., 1989).

Step Cueing

A verbal technique that refers to the name of the step in an aerobic dance-exercise routine (IDEA, 1987).

Step Exercise

Aerobic exercise movement utilizing a step or raised platform.

Target Heart Rate Range (Exercise Training Zone- 60% to 90% maxHR)

The exercise intensity that represents the minimum and maximum heart rate intensity recommended for a safe and effective aerobic exercise workout (ACSM, 1990).

“The Step”

A step product licensed by Reebok which includes a platform with height options for use in a step exercise workout.

Significance of the Study

Step exercise has been determined to be an effective mode of aerobic exercise for those striving to improve cardiovascular endurance and increase fat metabolism (LaForge, 1991; Olsen et al., 1991b; Price, 1990). Several possible factors, including the height of the step and the intensity of the movements, may effect the workload as related to exercise heart rate levels. American College of Sports Medicine (1991) recommends an exercise intensity range of 60% to 90% for optimal cardiovascular training benefits. The results of this study may help in identifying any significant differences in heart rate levels at two designated heights, 8” (20.3cm) and 10” (25.4cm), and the changes in heart rate levels, while performing both low and high intensity ALL OUT Step™ Choreography.

CHAPTER TWO

REVIEW OF LITERATURE

Introduction

This chapter will present a review of literature, and will focus on the following topics: 1) aerobic dance, as a popular mode of cardiorespiratory activity for improved fitness, 2) heart rate, as it relates to aerobic endurance activities, and 3) step exercise, as a popular new alternative to traditional aerobic dance activity.

Aerobic Dance

During the past decade, an overwhelming interest in improving fitness has led to the popularity of many new forms of aerobic exercise activity. One of the most popular and fastest growing exercise activities is aerobic dance, which has been recommended for those preferring a mode of activity to improve cardiorespiratory fitness and performance (Cearly, Moffatt & Kruitzen, 1984; Dowdy, Cureton & Du Val, 1985; Johnson, Berg & Latin, 1984; Milburn & Butts, 1983; Williford et al., 1989).

Garrick, Gillien and Whiteside (1986) reported that aerobic dance has grown into the largest organized fitness activity for women in the United States. Garrick et al. further reported that in a recent survey of aerobic dance facilities in San Francisco, approximately 68,000 people participate in these facilities out of a population of more than 700,000.

A typical aerobic dance class is led by an aerobic dance instructor, and is performed to selected rhythmical music. The primary goal of these classes is to improve cardiovascular fitness. Typically, each class includes: (a) an active warm-up followed by static stretching, incorporating movements to increase heart rate, body temperature, circulation, and range of

motion; (b) an aerobic exercise period to obtain peak aerobic levels for a specified time period; and (c) a cool-down period to gradually decrease heart rate and body temperature, and to help in the prevention of injuries (Richie, Kelso & Bellucci, 1985).

Due to the growing popularity of aerobic dance, several researchers have investigated the appropriateness of this mode of exercise in helping to facilitate improved physical fitness and performance. Smith, Williford, Olson and Blessing (1991) studied fuel utilization while performing four different intensities and styles of aerobic dance. Ten female subjects were asked to perform 25 minute choreographed routines to high-impact high intensity (HMHI), high-impact low intensity (HMLI), low-impact high intensity (LMHI), and low-impact low intensity (LMLI). Findings showed no significant differences between the types of fuel being utilized. However, significant differences in caloric expenditures ($p < .05$) were reported, showing: $HMHI > HMLI > LMHI > LMLI$. It was concluded that for weight loss, appropriate forms and styles of aerobic dance should be selected based on total caloric expenditure and not on fuel utilization.

Another study investigated the energy cost of different intensities of high and low-impact aerobic dance. Williford, Blessing and Scharff (1988) concluded, after having found higher intensity levels in both high and low intensity high-impact aerobic dance, that low-impact aerobic dance should be performed at higher intensity levels in order to create an energy expenditure of an intensity level similar to that obtained in both high and low intensity high-impact aerobic dance.

Low-impact aerobic exercise, determined to be the preferred method of reducing the incidence of injury associated with training, should be performed at higher intensity levels to receive maximum training benefits (Williford et al., 1989). High-impact aerobic dance has been determined to elicit foot impact during forefoot strike which can exceed three times the body weight of the dancer (Francis et al., 1985). Harnischfeger et al. (1988) report similar findings describing low-impact aerobics to be a safer form of exercise as compared to high-impact aerobics.

Olson et al. (1991b) suggested that exercise modalities such as walking and low-

impact aerobic dance have recently been emphasized as appropriate activities for promoting cardiovascular fitness in adults. They further reported that high-impact aerobic dance is an activity which produces greater vertical ground reaction forces, which may potentially increase the risk of sustaining lower extremity injuries.

American College of Sports Medicine (1990) determined that “endurance activities that require running and jumping are considered high-impact type of activities, and generally cause significantly more debilitating injuries to beginning as well as long-term exercisers than do low-impact and non-weight bearing type activities” (p. 267). Powell, Kohl, Caspersen and Blair (1986) reported similar findings.

Williford et al. (1989) identified low-impact aerobic dance as an exercise activity that can strengthen the heart. For maximum benefits they further suggested that participants work at high intensity “using vigorous arm movements above the shoulder level, and kicking above the hip level and with a straight leg” (p. 95).

Based on these findings, and on the findings of other similar studies, it is suggested that high intensity low-impact aerobic dance appears to be a mode of activity which offers participants the potential for fitness enhancement and enjoyment, with a minimal risk of injury, provided recommended aerobic dance training principals are met (Garrick et al., 1986; Vetter, Helfet, Spear & Matthews, 1985).

Heart Rate

Heart rate during aerobic exercise has been the interest of many studies (Hornsby, Dixon, Anderson & East, 1991; Makalous, Araujo & Thomas, 1988; Milburn & Butts, 1983; Olson et al., 1991a, 1991b; Parker, Hurley, Hanlon & Vaccaro, 1989; Richie et al., 1985; Ryschon, Kemp & Johnson, 1991; Stanforth, Hamman & Senechal, 1988; Thomas & Londeree, 1989; Williford et al., 1989). Parker et al. (1989) cite that “target heart rate has been used extensively to monitor exercise intensity for both running and aerobic dance training” (p. 230). In two other studies it was also reported that heart rate is often used to measure exercise intensity (Richie et al., 1985; Williford et al., 1989).

American College of Sports Medicine (1990) determined that heart rate may be used as a standard for estimating training intensity and recommend that the training heart rate be kept between 60% and 90% of maximum heart rate. These guidelines also recommend the use of Borg's Rating of Perceived Exertion (RPE) as a valid instrument in monitoring exercise intensity. The Borg scale, as a measure of RPE, is recognized and used as a subjective method to evaluate exercise intensity (Williford et al., 1989).

Specific studies have looked at heart rate, as related to aerobic exercise energy expenditure, and have reported a number of different findings. One study by Thomas and Londeree (1989) investigated energy cost during prolonged walking and jogging. Nine men were asked to walk and jog at 65% of their maximum heart rate for 60 minutes, and then at 75% of their maximum heart rate for 45 minutes. During exercise, heart rate was monitored continuously and recorded every five minutes. Ratings of perceived exertion (RPE) were also recorded after 10, 30, and 50 minutes in the 60 minute test, and after 10, 30, and 40 minutes in the 45 minute test. Results of this study indicated that exercise at equivalent heart rates produced significantly higher VO₂ during jogging than during walking. Also, RPE was reported as significantly lower during jogging than during walking. Although reported results appeared to be contradictory, conclusions made from these findings suggested that if walking can elicit a heart rate comparable to that of jogging, the calorie expenditure may be of similar levels.

When comparing heart rate levels and energy expenditure in aerobic dance exercise, studies have suggested that although high-impact high intensity aerobic dance elicits greater heart rate and energy expenditure values, low-impact aerobic dance can attain similar values if high intensity movements are performed (Otto, Yoke, Wygand & Larsen, 1988; Williford et al., 1989; Williford et al., 1988). One example of such findings was reported by Williford et al. (1989) who investigated whether low-impact aerobic dance was an effective cardiovascular workout. Ten women were asked to perform four different aerobic dance routines in a randomized crossover study to evaluate energy expenditure. The four

different routines included: low intensity, low-impact (LILM); high intensity, low-impact (HILM); low intensity, high-impact (LIHM), and high intensity, high-impact (HIHM). For both high-impact routines, significantly greater energy expenditure was found, regardless of heart rate. The movements used for both high intensity routines included straight leg kicks above hip level and vigorous arm movements above shoulder and head level. Movements used for both low intensity routines included modifications of the high intensity movements, with arms remaining at or below shoulder level, and kicking at or below hip level. Values for VO₂ and heart rate were determined from values obtained during the last minute of the five minute warm-up and at 5, 10, 15, and 20 minutes during the aerobic exercise. Results demonstrated a significantly higher ($p < .05$) mean heart rate for HIHM (175 bpm) as compared to heart rate values for HILM (163 bpm) and for LIHM (164 bpm). No significant differences were found in heart rates between HILM and LIHM. The mean heart rate of LILM was 130 beats per minute (bpm), which was significantly lower than for the other three routines. It was concluded that energy expenditure of various forms of aerobic dance can vary greatly, depending on the form, intensity, type of music, selection of movement, type of impact, presence or absence of a warm-up and/or cool-down, and fitness level of the participant. Therefore, "persons performing low-impact aerobic dance should maintain a fairly high level of intensity to expend an amount of energy similar to that associated with traditional, high-impact aerobics" (Williford et al., 1989, p. 109). Similar conclusions of differences in energy expenditure and VO₂ in different types of dance exercises performed were reported by Hornsby et al. (1991).

Cline, Berry, Berry and Davis (1991) stated that previous studies have reported that aerobic dance has been shown to produce disproportionately higher heart rates than running at similar VO₂ levels, and that extensive use of arms during aerobic dance has been the possible explanation for this discrepancy. After comparison between two forms of aerobic dance (with and without arm use) and running, their findings described a similar relationship between HR, %VO₂, and cardiovascular responses during aerobic dance and

running. Therefore, this study does not support the conclusions of other studies. More research is being conducted to expand these studies to include step exercise, in terms of energy expenditure and heart rate levels.

Step Exercise

Step exercise, also referred to as bench aerobics, bench stepping, step training, bench step aerobic dance, or step aerobics, is quickly growing into one of the most popular forms of aerobic exercise activities in the 1990's. Olson et al. (1991b) identified bench stepping, in addition to walking and low-impact aerobic dance, as an activity that is widely participated in by the female population, and may be a highly viable group exercise alternative for those who may not have the skill to effectively perform vigorously-paced aerobic dance exercise choreography.

The modality of step exercise dates back to the earlier part of the century with the clinical use of stairclimbing and step testing. Holland, Hoffmann, Vincent, Mayer and Caston (1990) cite human-powered step treadmills as being used in prisons for exercise, and then popularized by the development of the Master's step test. Although research indicates the use of step tests as a tool for testing submaximal exercise levels, more recent research has been identifying step exercise as an exercise modality that provides sufficient cardiorespiratory demands necessary for enhancing aerobic fitness and weight management (Ahlquist et al., 1991; Kravitz, Cisar, Christensen & Setterlund, 1991; Olson, et. al., 1991a, 1991b; Samuels et al., 1991).

Calarco et al. (1991) investigated the metabolic cost of six common movement patterns of bench step aerobic dance, and described bench step aerobic dance choreography as a limited number of repeated movement patterns arranged in a variety of sequences. Twenty-two subjects were randomly assigned to perform six-minute video sequences, at a cadence of 120(bpm) on a six inch step. The six common movement patterns incorporated included: (a) the basic step (S); (b) traveling with alternating lead (T); (c) lateral across the

top (LAT); (d) knee up (K); (e) lunge (L); and (f) repeater (R). Results indicated significant differences in oxygen consumption, ventilation and heart rate between trials L, R, and T, as compared to trials S, K, and LAT. Trials R versus S also showed significant differences, and the only significant difference in RPE was between trials L and S. They concluded that by selecting less vigorous movement patterns, even moderately fit participants can use bench step aerobics safely.

Stanforth, Velasquez, and Stanforth (1991) studied the effect of bench height and rate of stepping on the metabolic cost of bench stepping. Twenty-nine subjects were randomly assigned to bench stepping sessions with hands on hips at 30 and 32 step cycles/minute and at 120 and 128 bpm, respectively. Each session consisted of 4 consecutive 5-minute bouts at heights of 15.2, 20.3, 25.4, and 30.5 centimeters. Results showed a significant difference ($p < .01$) in VO_2 between bench height (BH) and rate of stepping (RS), with no significant ($p > .05$) interaction between BH and RS.

Olson et al. (1991b) reported on the cardiovascular and metabolic effects of bench stepping exercise in females, while performing 20-minute continuous bouts of choreographed bench stepping. Four heights were used for this study (6", 8", 10", and 12"). Oxygen consumption (VO_2) responses showed a direct relationship to step height: 12" > 10" > 8" > 6" ($p < .05$). No significant differences were found in heart rate and the respiratory exchange ratio between 12" and 10" heights. The researchers concluded that aerobic bench stepping provides sufficient cardiorespiratory demands necessary for enhancing aerobic fitness and promoting weight loss in females.

Another study examined the physiological effects of step training. Twenty-four females performed three 30-minute training sessions per week over an 8 week testing period. The first three weeks of training began on a 6" step and progressed to an 8" step during the last five weeks. Propulsion steps (high-impact movement) progressed throughout the 8 week study. Results indicated that the 8 week step training program significantly ($p < .05$) improved many of the physiological variables including aerobic work indices, body composition, bodybuild characteristics, and muscle strength (Kravitz et al., 1991).

Summary

Step exercise is becoming a popular new mode of aerobic activity. However, much research must be conducted to better understand the potential benefits attained through participation in this activity. Research is limited in this area. Conclusions based on the findings cited in this review of literature suggest that step exercise may possibly be a new and beneficial alternative mode of low-impact aerobic exercise activity, with the potential for eliciting enhanced cardiorespiratory fitness and weight loss.

CHAPTER THREE

METHODS AND PROCEDURES

Introduction

This chapter presents the methods and procedures that were used in this study. More specifically, this chapter discusses the following topics: subjects, measurements, equipment, design of study, preliminary testing, instrumentation, and statistical analysis.

Subjects

Nineteen subjects were recruited from twelve fitness clubs located within Santa Clara County, California. An additional two subjects volunteered and completed the pretesting, however, voluntarily terminated the testing for personal reasons. Subjects included female fitness club participants and instructors, 22 to 39 years old, in good overall health, and with no history of any significant musculoskeletal injuries or contraindications for exercise.

Subjects for this study had participated in a fitness club step class program for a minimum of three months, having met at least two times per week during that three month time period. All subjects were asked to read and sign an informed consent form (Appendix B) approved by the San Jose State University Institutional Review Board: Human Subjects. Procedures were explained, both verbally and in writing, by the principal investigator. Subjects were fully advised of the risks and/or discomforts that they might expect as a result of their participation, and of their rights as subjects in this study. The description of procedures were also described on the informed consent form. The principal investigator made no attempt to bias the subjects in any way throughout the testing procedures. Subjects were also asked to complete a health history and step exercise experience questionnaire prior to pretesting day (Appendix C). Any subject not meeting the

preliminary criteria as stated above was not included in this study.

Measurements

The subjects were randomly assigned to either Group A or B, as determined by the flip of a coin. Step workouts were assigned as follows: Group A (Subject #'s 4, 6, 10, 11, 12, 13, 15, 17) performed the 8" (20.3cm) step workout then 10" (25.4cm) step workout and Group B (Subject #'s 1, 2, 3, 5, 7, 8, 9, 14, 16, 18, 19) performed the 10" step workout then the 8" step workout. Each subject completed pretests no more than two weeks prior to the first workout day. At that time maximum oxygen consumption (maxVO₂) and maximum heart rate (maxHR) were determined. In addition, height, weight, resting heart rate, skinfold measurements and body fat %, and resting blood pressure were assessed. Any subject found to be 20% above or below the desired weight, as determined by the Metropolitan Life Insurance Company Height/Weight Table (Neiman, 1986), was to be excluded from this study.

Design of Study

Written invitations to participate as a volunteer for this study (Appendix D) were sent out to ten major fitness clubs within Santa Clara County, California. Subjects from two additional clubs volunteered, for a total representation of 12 clubs (Appendix E). The first twenty-one females who responded, and who met the criteria described earlier, were chosen to participate in this study.

Upon having been selected, all subjects received a phone call and a Subject's Acceptance Notification Packet which included: (a) a Subject Confirmation Cover Letter (Appendix H); (b) an Informed Consent (Appendix B); and (c) a Health History and Step Exercise Questionnaire (Appendix C). Detailed information regarding subject's participation was also included in the cover letter.

Subjects were asked to wear comfortable exercise clothing, including a half top, shorts, cotton socks, and appropriate rubber-soled exercise shoes during the pretest and for both workout days. Additionally, all subjects were asked to bring a towel and water bottle. Subjects were requested to refrain from engaging in any additional (beyond normal activity level) or unfamiliar exercise twenty-four hours prior to pretesting or workout days.

Pretesting

Subjects were called for scheduling and asked to report to the San Jose State University Human Performance Exercise Physiology/Biomechanics Laboratory for pretesting. Upon arriving, each subject was welcomed and given a brief verbal explanation of all events that would take place during pretesting and during both workouts. All nineteen subjects participated in the pretesting procedure that included completion of: (a) an informed consent (Appendix B) prior to pretesting day; (b) a health history and step exercise experience questionnaire (Appendix C); (c) a physical activity readiness questionnaire used for each testing day (Appendix F); (d) height and weight measurements; (e) skinfold measurements; (f) blood pressure and resting heart rate assessments; (g) reading RPE instructions to be used for all testing days; and (h) maximum VO₂, maximum heart rate, and RPE assessments. For safety purposes, a monitored cool-down period followed the maximum VO₂ pretest until the subject's heart rate returned to at least 120 beats per minute. Subjects were asked to view the videotaped step workout instructions (10 minutes) to become familiar with the step movements that would be found in both workouts. Upon completion of pretesting, the exercise training zone was determined for each subject (ACSM, 1990). Each subject was requested to be available for a scheduled two hour period for pretesting and both workout days in order to complete all procedures designed for this study. A testing confirmation slip was given highlighting details for the two workouts days.

Workouts

All subjects were given a reminder call prior to each workout, and were asked to report to San Jose State University within two weeks after completion of the pretest. Upon arrival, subjects were welcomed and asked to complete the physical activity readiness questionnaire. Subjects flipped a coin to determine their randomly assigned step height workout order. Additionally, they were weighed, had electrodes appropriately placed, and were asked to sit quietly while resting heart rate was taken. They were then instructed to begin the workout.

All subjects received workout instructions from the workout videotape during both workout sessions. Although subjects had already viewed the initial 10 minute introduction to the workout on pretesting day, they were given an opportunity to view it again on both workout days. All subjects elected to begin both workouts without viewing the introduction again. “ALL OUT Step™ Choreography” was a selection of the movements described in Appendix A. Step cadence of 126 bpm was paced to the music included on the videotaped workout during both workouts, and was set at 126 beats per minute for all step warm ups, as defined through the use of a metronome.

Subjects were tested individually. During these workouts, heart rate was monitored throughout the entire 20 minute test, and recorded each minute, and additionally at minutes 3:20, 7:40, 9:40, 13:20, 16:40, and 19:40 (these times corresponded with the final 10 seconds of each routine). RPE data was also collected during minute 4 of both step warm-ups, and at minutes 3:20, 7:40, 9:40, 13:20, 16:40, and 19:40 during both workouts, and at minute 25 during the cool-down. Within two weeks following the first exercise workout, subjects were asked to return for the second twenty-minute videotaped step exercise workout. This second and final workout was identical to the first step workout, and was performed on the height not previously used. Once again, heart rate was monitored throughout the entire test, and heart rate and RPE data were recorded during the minutes mentioned above.

Subjects who exceeded 90% of their maximum heart rate during either test were monitored closely, and when additional exhaustion or overexertion signs were present, the subject was asked to either decrease intensity, or stop immediately if necessary. It is important to note that this procedure may have altered results in heart rate and/or RPE levels as related to all out effort and workload intensity levels.

Preliminary Testing

A preliminary test was administered to three volunteer subjects to ensure that all testing procedures worked efficiently and successfully. All modifications were made prior to actual testing days.

Instrumentation and Protocols

Pretesting: Physical characteristics were determined by obtaining the following measurements of all subjects in the following sequence: (a) height was measured in centimeters using a stadiometer; (b) body weight was measured in kilograms using a platform balance scale; and (c) Lange calipers were used to measure skinfold thickness at the thigh, suprailium, and triceps, as determined sites for females (ACSM, 1991). The average of three repeated trials, within 0.5 millimeters of each other, was used for skinfold measurements (Howley & Franks, 1992). Skinfold assessments were calculated first using the equations found in the Guidelines for Exercise Testing and Prescription (ACSM, 1991) for body density, and then the Siri equation was used to calculate body fat percentage.

Prior to maximum V_{O2} testing, all subjects were asked to sit and relax for five minutes, while blood pressure was taken using a mercury sphygmomanometer. Electrodes were then placed on the subjects using the single ECG CM5 lead (Howley & Franks, 1992).

Pre-exercise resting heart rate was taken, using a Transkinetic Heart Rate Monitor and NarcoTrace 40 chart recorder. Final instructions were given for the treadmill test, including an explanation of the testing protocol, RPE determination, and hand signals to be used during the test. The headgear, mouthpiece, and nose clip were then placed on the subject, and adjusted as necessary. The subject was given a demonstration and practice walk for proper positioning and walking on the treadmill. The subject was instructed to walk (not run) at a comfortable stride. The gas analyzing hoses were then placed over the mouthpiece, in preparation for the five minute warm-up.

All subjects performed a five minute warm-up on an 8" step; heart rate and oxygen consumption (VO_2) were taken during the last 10 seconds of each minute during this warm-up period. Maximum VO_2 and maximum heart rate were determined using a modified Balke Treadmill protocol. The original protocol maintains a constant speed of 3.3 miles per hour, with one percent grade increases per minute until the subject reaches the point of voluntary exhaustion (Balke & Ware, 1959). In the modified Balke Treadmill protocol, there was a constant speed of 3.5 miles per hour, with a two percent grade increase per minute in order to help elicit voluntary exhaustion within 8 to 15 minutes (Buchfuhrer et al., 1983). This treadmill test used a Quinton treadmill, model #1860. Ratings of perceived exertion (RPE) were taken just prior to changes in grade during the treadmill test. The Borg 6-20 point scale was used for RPE as described in Appendix G (ACSM, 1991; Borg, 1982).

For oxygen consumption measurements, subjects were fitted with headgear which was attached to a Hans-Rudolph respiratory valve and mouth piece. Inhaled volume of air was measured by a Parkinson-Cowan Dry Test Meter, model # CD-4, and exhaled air was sent through the respiratory valve to a mixing chamber. A Wilmore-Costill Spinner Valve was used to collect samples of expired air from the mixing chamber, a dessicant in the line removed water. A Beckman Medical Gas Analyzer, model # LB-2, was used to determine percent of carbon dioxide in expired air. An Applied Electrochemical Analyzer, model # S-3A was used to measure percent of oxygen in expired air. Heart rate was continuously

monitored during the test, using a Transkinetic Heart Rate Monitor and NarcoTrace 40 chart recorder. Finally, expired ventilation (VE), oxygen uptake, and carbon dioxide production (VCO₂) rates were calculated using an Apple II+ computer interfaced with the gas analysis equipment.

The subjects began the treadmill test by walking at 3.5 miles per hour and at 0% grade. The workload was increased with a 2% grade increase each minute (Buchfuhrer et al., 1983). Maximal oxygen consumption was determined as the highest VO₂ value obtained when: (a) heart rate was within 10 beats per minute of age-predicted maximal heart rate; (b) respiratory quotient was above 1.15; and/or (c) VO₂ value reached a steady state in relation to workload increases with less than 2.1 ml/(kg • min) (Howley & Franks, 1992).

Criteria for terminating the treadmill test were as follows: (a) voluntary exhaustion and termination by the subject; (b) failure of heart rate to increase with increasing workload; (c) discomfort or fatigue experienced as demonstrated by decreasing coordination or balance; (d) abnormal ECG readings; or (e) equipment failure (ACSM, 1990). Subjects who did not reach their estimated maximum heart rates were included in this study, provided they did not have abnormal ECG readings, and had met preliminary criteria necessary to participate as a subject in this study.

A cool-down period followed the test to help ensure a safe heart rate recovery, and to help prevent delayed onset muscle soreness. The subject's heart rate was monitored until it decreased to at least 120 beats per minute.

Room temperature and barometric pressure readings were obtained prior to the maximal treadmill test. All testing procedures were supervised by ACSM and cardiopulmonary resuscitation (CPR) certified personnel.

Workouts: Prior to both workout sessions, subjects were asked to sit and relax for at least five minutes, then pre-exercise resting heart rate was taken, using an electrocardiogram (ECG) monitoring system described earlier. Heart rate was continuously monitored and recorded during the final 10 seconds of each minute of both 20 minute workouts, and additionally at 3:20, 7:40, 9:40, 13:20, 16:40, and 19:40 minutes. Ratings

of perceived exertion were reported and recorded during both workout sessions, at minutes 3:20, 7:40, 9:40, 13:20, 16:40, and 19:40. Subjects viewed each twenty-minute videotape ALL OUT Step™ workout, using a television screen with a VHS video monitor, during each exercise session.

During both workouts the criteria for termination of exercise included: (a) voluntary exhaustion and termination by the subject; (b) discomfort or fatigue experienced as demonstrated by decreasing coordination or balance; (c) heart rate within 10 beats per minute of age-predicted maximal heart rate (or the subject was asked to decrease intensity); and/or (d) equipment failure.

A cool-down period followed each workout, as with the pretesting, to help ensure a safe heart rate recovery, and to help prevent delayed onset muscle soreness. The cool-down for each twenty minute workout was a videotaped five minute step exercise movement sequence of decreased work intensity. All subjects were asked to sit and relax for a minimum of five additional minutes. Nineteen subjects completed all tests, with two subjects voluntarily terminating participation in the study.

Equipment

The equipment that was used in the exercise routine portion of this study was “The STEP™”, owned by San Jose State University’s Human Performance Department, and licensed by Reebok International Inc.

Statistical Analysis

Descriptive statistics (M, SD, and range) were used to describe the physiological characteristics of all nineteen subjects. Results were calculated only from data of those subjects who completed all tests, including the pretest and both workouts. Two two-way ANOVAs (within-subjects) with repeated measures were calculated to compare heart rates

and RPE's over time, using two different step heights, and while incorporating both low and high intensity choreography. Three Scheffe' post-hoc tests were also calculated to determine where differences occurred when the ANOVA tests were significant. ANOVA and Scheffe' statistical results were initially hand calculated, and then verified by the use of the computer program Microsoft Excel (v4.0) for the Apple Mac IICI (system 7.0.1). The computer program was additionally used for all statistical analysis of data, graphs, tables, and figures for this study. Four statistical books were used extensively for reference and analysis of statistical results for both the ANOVAs and Scheffe' results (Glass & Stanley, 1970; Keppel, 1991; Keppel et al., 1992; Rothstein, 1985). An alpha level of $p < .01$ determined statistical significance.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter presents the results of data analysis and discussion for this study. Data from this study were analyzed to determine heart rate (HR) and ratings of perceived exertion (RPE) changes with the 8" (20.3cm) and 10" (25.4cm) step heights, and low versus high intensity ALL OUT Step™ Choreography.

Results of Data Analysis

The mean baseline descriptive characteristics for all 19 subjects are summarized in Table 1. The mean ($\pm$ SD) age was 30.1 years (± 5.33), mean body fat was 18.0% (± 3.97), and mean maxVO₂ was 46.15 ml/(kg·min) (± 5.72). Additionally, the mean weight was 55.0 kg (± 4.06), mean height was 161.5 cm (± 3.76), and mean resting blood pressure was 109.3/71.9 mmHg ($\pm 9.04/8.48$ respectively). The pre-exercise resting heart rate mean was 73.8 bpm (± 11.73), and mean maximum heart rate was 188.6 bpm (± 9.91). Similar data was determined with Olson et al. (1991b) where the mean age was 30.4 years (± 8.2), mean maxVO₂ was 47.5 ml/(kg·min) (± 5.2), mean weight was 55.4 kg (± 9.3), mean resting heart rate was 67.7 bpm (± 8.1), and mean maxHR was 182.7 bpm (± 7.6).

Table 2 summarizes heart rate results of the two-way analysis of variance (ANOVA) with repeated measures, while Figure 1 summarizes mean heart rate data. ANOVA results for this study showed significant differences in heart rate (Table 2) between the 8" and 10" step heights (heights or H), [$F(1, 18) = 39.09, p < .01$], and between the six choreography intensity levels (choreography or C), [$F(5, 90) = 140.94, p < .01$]. Additionally, there was a significant interaction for heart rate between height and choreography, [$F(5, 90) =$

TABLE 1. DESCRIPTIVE CHARACTERISTICS

n = 19 females	MEAN	RANGE		± (SD)
		min	max	
AGE (yrs)	30.1	22.0	39.0	± (5.33)
HEIGHT (cm)	161.5	152.5	168.6	± (3.76)
WEIGHT (kg)	55.0	48.5	61.7	± (4.06)
BODY FAT (%)	18.0	12.1	29.1	± (3.97)
RESTING BLOOD PRESSURE (BP)				
SYSTOLIC BP (mmHg)	109.3	90.0	120.0	± (9.04)
DIASTOLIC BP (mmHg)	71.9	60.0	90.0	± (8.48)
RESTING HEART RATE (bpm)	73.8	59.0	95.0	± (11.73)
TREADMILL WORKOUT (min)				
MAX VO₂ (ml/(kg·min))	46.15	37.60	56.91	± (5.72)
MAX HEART RATE (bpm) (maxHR)	188.6	169.0	205.0	± (9.91)
CALCULATED maxHR (bpm)	189.9	181.0	198.0	± (5.33)

TABLE 2. ANOVA: HEART RATE TWO-FACTOR (REPEATED) WITHIN-SUBJECTS DESIGN (2R x 6)

SOURCE	df	SS	MS	F	F (crit)	df	p
Subjects (S)	18	88158.23	4897.68				
Height (H)	1	5740.07	5740.07	39.09	8.29	(1, 18)	(< .01)
Choreography (C)	5	31239.67	6247.93	140.94	3.26	(5, 90)	(< .01)
Choreography x Height	5	303.77	60.75	4.80	3.26	(5, 90)	(< .01)
Error Height	18	2642.93	146.83				
Error Choreography	90	3989.67	44.33				
Error Height x Choreography	90	1140.23	12.67				
TOTAL	227	133214.56

FIGURE 1. HEART RATE DATA

4.80, $p < .01$]. Scheffe' correction formulas were calculated to further analyze the main effects for heart rate between height and choreography intensity levels (Table 3). Initial Scheffe' results showed no significant main effects interaction between the 8" and 10" step heights within the six choreography intensity levels, and therefore, did not distinguish where significant differences occurred.

Further Scheffe' analyses of heart rate (after combining the mean heart rate values for the 8" and 10" step heights for each intensity level), showed that significant differences occurred within the six choreography intensity levels for the 8" and 10" step heights (Table 4) between the first choreography intensity level at minute 3:20 and all five other choreography intensity levels at minutes 7:40, 9:40, 13:20, 16:40, and 19:40, with Scheffe' values of 16.0, 17.8, 37.2, 39.3, and 36.2 respectively. Significant differences also occurred between the second choreography intensity level at minute 7:40 and at minutes 13:20, 16:40, and 19:40, with Scheffe' values of 21.2, 23.3, and 20.2 respectively. Significant differences were also found between the third choreography intensity level at minute 9:40 and at minutes 13:20, 16:40, and 19:40, with Scheffe' values of 19.4, 21.5, and 18.4 respectively. No significant differences were found between the second and third choreography intensity levels at minutes 7:40 and 9:40, with a Scheffe' value of 1.8. Additionally, no significant differences were found between minutes 13:20 and 16:40, and 19:40, with Scheffe' values of 2.1 and 1.0 respectively, and between minutes 16:40 and 19:40, with a Scheffe' value of 3.1.

It was also found that all six intensity heart rate means at the 10" step height were consistently higher than the six intensity heart rate means at the 8" step height (Figure 1), with the average 10" low intensity mean of 153.8 bpm and the high intensity mean of 173.2 bpm (Table 5). The average 8" low intensity mean was 141.8 bpm and the high intensity mean was 165.2 bpm (Table 6).

The familywise error rate for this study was set at .06, and the critical value of 4.03 was used to determine all heart rate levels of significance ($p < .01$). Results of the ANOVA and Scheffe' tests for heart rate showed that significant differences existed

TABLE 3. SCHEFFE' RESULTS FOR HEART RATE

8" STEP vs 10" STEP (Interaction)	
TIME COMPARISON	VALUE
3:20 - 7:40	1.6
3:20 - 9:40	0.5
3:20 - 13:20	2.1
3:20 - 16:40	1.9
3:20 - 19:40	2.2
7:40 - 9:40	2.1
7:40 - 13:20	3.7
7:40 - 16:40	3.6
7:40 - 19:40	3.8
9:40 - 13:20	1.6
9:40 - 16:40	1.4
9:40 - 19:40	1.7
13:20 - 16:40	0.1
13:20 - 19:40	0.1
16:40 - 19:40	0.2
significant ($p < .01$) if ≥ 4.03	

TABLE 4. SCHEFFE' RESULTS FOR HEART RATE

8" STEP and 10" STEP (Main Effects)	
TIME COMPARISON	VALUE
3:20 - 7:40	16.0
3:20 - 9:40	17.8
3:20 - 13:20	37.2
3:20 - 16:40	39.3
3:20 - 19:40	36.2
7:40 - 9:40	1.8
7:40 - 13:20	21.2
7:40 - 16:40	23.3
7:40 - 19:40	20.2
9:40 - 13:20	19.4
9:40 - 16:40	21.5
9:40 - 19:40	18.4
13:20 - 16:40	2.1
13:20 - 19:40	1.0
16:40 - 19:40	3.1
significant ($p < .01$) if ≥ 4.03	

TABLE 5. SUMMARY OF LOW/HIGH INTENSITY POINTS/HR'S FOR 10" STEP

SUBJECT	LOW INTENSITY				HIGH INTENSITY				90% maxHR	
	3:20	7:40	9:40		13:20	16:40	19:40		Age Pr	Actual
1	150	176	171		198	191	195		176	176
2	164	175	171		188	184	182		173	174
3	139	153	153		165	164	152		168	158
4	120	130	140		159	159	155		177	166
5	127	141	148		157	154	157		168	169
6	122	131	139		144	147	144		163	174
7	142	162	159		182	188	177		169	164
8	133	150	147		169	174	168		176	171
9	163	183	181		188	194	192		171	185
10	93	99	109		115	111	115		163	152
11	158	181	179		195	188	195		174	183
12	167	172	171		185	183	179		165	171
13	130	143	152		158	164	161		172	159
14	161	174	171		183	185	188		171	173
15	156	171	165		181	183	185		163	171
16	143	160	158		174	174	171		178	171
17	185	192	185		197	200	197		168	183
18	133	152	147		167	188	172		166	161
19	155	169	163		180	188	183		176	177
MEAN	144.3	158.6	158.4		172.9	174.7	172.0		170.4	170.4
Avg of 3		153.8				173.2				

NOTES: 1) Shaded Subjects did 10" Step first. 2) BOLD data > 90% maxHR column where both AGE Predicted and Actual are shown

TABLE 6. SUMMARY OF LOW/HIGH INTENSITY POINTS/HR'S FOR 8" STEP

SUBJECT	LOW INTENSITY				HIGH INTENSITY				90% maxHR	
	3:20	7:40	9:40	HR (bpm)	13:20	16:40	19:40	HR (bpm)	Age Pr	Actual
1	131	149	149		171	171	174		176	176
2	155	169	172		177	185	182		173	174
3	116	131	134		146	160	151		168	158
4	124	134	142		154	161	154		177	166
5	113	122	135		141	136	144		168	169
6	113	120	120		132	132	131		163	174
7	125	128	130		171	157	170		169	164
8	123	134	136		161	163	166		176	171
9	143	163	165		179	183	183		171	185
10	90	96	110		113	107	110		163	152
11	155	171	174		195	195	190		174	183
12	150	155	155		177	179	174		165	171
13	120	124	142		155	155	149		172	159
14	146	156	153		167	171	169		171	173
15	152	163	160		181	183	179		163	171
16	115	135	142		165	167	160		178	171
17	174	190	190		197	195	195		168	183
18	125	144	141		170	180	167		166	161
19	153	160	160		181	183	181		176	177
MEAN	132.9	144.6	147.8		164.9	166.5	164.2		170.4	170.4
Avg of 3		141.8				165.2				

NOTES: 1) Shaded Subjects did 10" Step first. 2) BOLD data > 90% maxHR column where both AGE Predicted and Actual are shown

between step heights and choreography intensity levels as described above, and supported rejection of both null hypotheses for heart rate.

Table 7 summarizes the RPE results of the two-way analysis of variance (ANOVA) with repeated measures, and Figure 2 summarizes RPE mean data. ANOVA results of this study showed significant differences in RPE (Table 7) between the 8" and 10" step heights, $[F(1, 18) = 21.45, p < .01]$. Significant differences were also noted between choreography intensity levels, $[F(5, 90) = 159.31, p < .01]$. There was, however, no significant interaction for RPE step height and choreography, $[F(5, 90) = 1.50, p > .05]$. Scheffe' correction formulas were calculated to further analyze where significant differences occurred within the six choreography intensity levels for the 8" and 10" step heights (Table 8). After combining the mean RPE values for the 8" and 10" step heights, it was found that RPE values increased with time. RPE at minute 3:20 was significantly lower than the remaining five other intensity levels at minutes 7:40, 9:40, 13:20, 16:40, and 19:40, with Scheffe' values of 4.7, 7.3, 12.3, 15.5, and 15.9 respectively. Significantly lower RPE values were also noted at minute 7:40 when compared to all three high intensity level minutes of 13:20, 16:40, and 19:40, with Scheffe' values of 7.6, 10.6, and 11.2 respectively for minute 7:40, and 4.9, 8.0, and 8.6 respectively (Table 8). Additionally, a significant difference was found between the third choreography intensity level at minute 9:40 when compared to all three high intensity level minutes of 13:20, 16:40, and 19:40, with Scheffe' values of 5.0, 8.0, and 8.6 respectively. No significant differences were found for RPE between minutes 7:40 and 9:40, with a Scheffe' value of 2.6, between minutes 13:20 and 16:40, with a Scheffe' value of 3.0, between minutes 13:20 and 19:40, with a Scheffe' value of 3.6, and between minutes 16:40 and 19:40, with a Scheffe' value of 0.6. Additionally, and as with the heart rate mean values, it was found that all six RPE intensity 10" means were consistently higher than the six intensity 8" means (Figure 2), with the average 10" low intensity mean at 11.7 and the high intensity mean at 15.1 (Table 9), and the average 8" low intensity mean at 10.4 and the high intensity mean at 14.2 (Table 10). Results of the ANOVA and Scheffe' tests for RPE showed that significant differences

TABLE 7. ANOVA: RATE of PERCEIVED EXERTION (RPE)
TWO-FACTOR (REPEATED) WITHIN-SUBJECTS DESIGN (2R x 6)

SOURCE	df	SS	MS	F	F (crit)	df	p
Subjects (S)	18	455.32	25.30				
Height (H)	1	74.12	74.12	21.45	8.29	(1,18)	(< .01)
Choreography (C)	5	921.84	184.37	159.31	3.26	(5,90)	(< .01)
Choreography x Height	5	2.67	0.53	1.50	2.33	(5,90)	(> .05)
Error Height	18	62.21	3.46				
Error Choreography	90	104.16	1.16				
Error Height x Choreography	90	32.00	0.36				
TOTAL	227	1652.32

FIGURE 2. RATE of PERCEIVED EXERTION (RPE) DATA

**TABLE 8. SCHEFFE' RESULTS FOR
RATE of PERCEIVED EXERTION (RPE)**

8" STEP and 10" STEP (Main Effects)	
TIME COMPARISON	VALUE
3:20 - 7:40	4.7
3:20 - 9:40	7.3
3:20 - 13:20	12.3
3:20 - 16:40	15.3
3:20 - 19:40	15.9
7:40 - 9:40	2.6
7:40 - 13:20	7.6
7:40 - 16:40	10.6
7:40 - 19:40	11.2
9:40 - 13:20	5.0
9:40 - 16:40	8.0
9:40 - 19:40	8.6
13:20 - 16:40	3.0
13:20 - 19:40	3.6
16:40 - 19:40	0.6
significant ($p < .01$) if ≥ 4.03	

TABLE 9. SUMMARY OF LOW/HIGH INTENSITY POINTS/RPE'S FOR 10" STEP

SUBJECT	LOW INTENSITY			HIGH INTENSITY		
	3:20	7:40	9:40	13:20	16:40	19:40
1	11	12	13	15	16	16
2	9	10	11	14	14	14
3	10	12	12	13	14	15
4	7	9	10	12	14	14
5	12	13	14	15	15	16
6	11	12	14	15	16	16
7	11	14	14	15	17	17
8	11	11	12	13	13	13
9	9	12	13	14	16	17
10	8	9	11	11	12	12
11	11	12	13	14	14	15
12	8	12	12	14	15	15
13	11	13	13	15	16	16
14	8	11	12	13	16	16
15	12	13	13	15	16	16
16	11	12	13	14	15	15
17	13	15	19	20	20	20
18	12	14	15	18	19	19
19	9	11	11	12	15	16
MEAN	10.2	11.9	12.9	14.3	15.4	15.7
Avg of 3		11.7			15.1	

NOTE: 1) Shaded Subjects performed the 10" Step first.

TABLE 10. SUMMARY OF LOW/HIGH INTENSITY POINTS/RPE'S FOR 8" STEP

SUBJECT	LOW INTENSITY				HIGH INTENSITY			
	3:20	7:40	9:40	RPE	13:20	16:40	19:40	RPE
1	10	12	12	12	13	14	15	
2	7	8	8	8	12	13	13	
3	8	10	12	12	13	14	14	
4	6	6	9	9	12	13	14	
5	12	12	13	13	14	15	15	
6	11	11	12	12	13	13	13	
7	10	12	13	13	15	16	16	
8	10	11	11	11	13	12	12	
9	9	10	11	11	13	15	15	
10	8	10	11	11	12	12	13	
11	10	11	12	12	13	15	15	
12	9	11	11	11	13	14	15	
13	9	12	13	13	15	15	17	
14	8	11	11	11	13	15	15	
15	7	8	8	8	12	13	13	
16	9	11	12	12	13	14	13	
17	11	14	15	15	18	19	17	
18	9	11	11	11	15	17	17	
19	8	11	12	12	14	16	16	
MEAN	9.0	10.6	11.4		13.5	14.5	14.6	
Avg of 3		10.4				14.2		

NOTE: 1) Shaded Subjects performed the 10" Step first.

existed between step heights and choreography intensity levels as described above, and supported rejection of both null hypotheses for RPE at a significance level of $p < .01$. The critical value of 4.03 was used to determine levels of significance.

Results of the ANOVA and Scheffe' tests for RPE showed that significant differences existed between step heights and choreography intensity levels as described above, and supported rejection of both null hypotheses for RPE. Additionally, results of this study suggested that step exercise elicits higher heart rate levels and RPE values on the 10" step height as compared to the 8" step height, and higher heart rate levels and RPE values with higher intensity movements, than with lower intensity movements.

Figures 1 and 2 (means of raw data are shown in Appendices M and individual descriptive data are found in Appendix N) offer an overall observation of heart rate and RPE means respectively for all 19 subjects at the six intensity points during both ALL OUT Step™ workouts (8" and 10" step heights). Minute ten of each 20 minute workout was initially determined as the point of separation between the low and high intensity choreography levels.

Discussion

In discussing the results of this study, it is important to note that studies of heart rate and RPE values for step exercise were difficult to compare because of the limited number of studies done on this relatively new aerobic dance form of exercise, and because assessment procedures and testing protocols have not yet been completely standardized. Although there were very few step exercise studies which reported heart rate and RPE results for specific step choreography movements, Olson et al. (1991b) and Calarco et al. (1991) did report heart rate and RPE results. Unfortunately, the choreography used by Olson et al. (1991b) was an undefined combination of the Basic Step, Lunge, Step Kick, and repeater variation movements (most of which were defined and used for this study). It was, therefore, difficult to fully assess why heart rate or RPE differences occurred as related to step height for this study.

Heart Rate

Results of this study showed that 15 of the 19 subjects exceeded 90% of their actual maximum heart rate (maxHR) on the 10" step height, with 12 of those 15 subjects exceeding 90% of their actual maxHR level on both the 8" and 10" step heights over 25% of both workout times (see Tables 5 and 6). This study also reported that eleven subjects exceeded 90% of their actual maxHR on the 8" step height, with 8 of those 11 subjects exceeding 90% of their actual maxHR over 25% of the time. The mean totals during the six intensity points for all 19 subjects of this study demonstrated that subjects went beyond 90% of both age-predicted and/or actual maxHR levels 47% of the time on the 10" step height and 26% of the time on the 8" step height.

Eight out of 19 subjects were beyond 90% of their actual maxHR levels on both the 8" and 10" from 42% to 79% of the total workout time. This data suggests that this particular step workout produced intensity levels that exceeded the ACSM recommended upper limits on the 8" and 10" for several subjects in this study (Tables 5 and 6). Further, this data reported that the mean heart rates during the high intensity levels for all 19 subjects (173.2 bpm) exceeded the ACSM recommendations of 90% maxHR average for this study (170.4 bpm), suggesting that subjects in this study were exercising beyond recommended maxHR levels during the "high intensity" portion of both step workouts. It is important to note that, as was previously mentioned in the delimitations for this study (Chapter 1, p.4), subjects who exceeded 90% of their maximum heart rate during either test were monitored closely, and when additional exhaustion or overexertion signs were present, the subject was asked to decrease intensity. No subject terminated any test. This procedure may have altered results in heart rate and/or RPE levels, and as is reported, heart rates for many still continued at or beyond 90% maxHR during portions of both step workouts.

Only four subjects did not conform to the average subject for this study, and did not go beyond 90% maxHR during either step workout. Of these four, one subject was below the ACSM recommended lower exercise heart rate level of 60% maxHR at only one time interval, and one other subject worked out below 60% of maxHR 40% of the time during both workouts combined. Interestingly, this latter subject was the only one who started each warm-up with a heart rate below 60% of maxHR. Olson et al. (1991b) also reported 10" step heights heart rate responses at or above 90% of the subjects' maxHR during the latter part of their 20 minute step workout. Average pretest resting heart rates (see also Table 1) and warm-up heart rates for the current study are summarized in Table 11, with total pre-exercise resting heart rate means for pretest (73.8 bpm), 10" (69.5 bpm), and 8" (71.1 bpm). A mean resting heart rate of 67.7 bpm (± 8.1) was reported from Olson et al. (1991b).

Heart rate intensity level differences for aerobic dance were similar to that found in this step study (step exercise having been determined to be a primarily a low-impact activity),

TABLE 11. MEAN HEART RATE (bpm) DURING WARM-UP

MINUTE	PRE-TEST	10"	8"
Pre-exercise	73.8	69.5	71.1
1	130.9	132.4	125.5
2	133.8	138.0	124.5
3	136.1	137.6	127.8
4	137.5	139.3	124.3
5	139.0	140.6	129.3
MEAN	135.4	137.6	126.3
± (SD)	3.2	3.1	2.2

by Williford et al., (1989), who reported higher mean heart rates of 175 bpm for high intensity, high-impact, 163 bpm for high intensity, low-impact, and 164 bpm for low intensity, high-impact, than the mean heart rate of 130 bpm for low intensity, low-impact. They further reported significant differences, showing $HIHM > HILM$ and $LIHM > LILM$. Olson et al., (1991b) also reported similar findings in step exercise with mean heart rates of 161.6 bpm (± 11.3) and 154.1 bpm (± 12.8) for the 10" and 8" respectively.

The higher mean heart rates found on the 10" step height and lower mean heart rates found on the 8" step height associated with this study could have been related to one or more of the following factors including: (a) participants' stress level associated with working out on a step height that was not a preferred training height; (b) choreography of arm movements used in conjunction with a challenging step height; (c) participant being unaware of workload and/or overexertion; and/or (d) greater workload demands with the higher step height.

For choreography (low and high intensity levels), significant differences in heart rate were found between the 8" and 10" step heights. Specifically, significant differences in heart rate were found between all intensity minutes except between minutes 7:40 and 9:40 (Scheffe' value = 1.8), minutes 13:20 and 16:40 (Scheffe' value = 2.1), minutes 13:20 and 19:40 (Scheffe' value = 1.0), and at minutes 16:40 and 19:40 (Scheffe' value = 3.1). While the second intensity level was initially considered low intensity choreography, results of this study suggested that heart rate values reached heavy workload conditions (10" step height in particular) with approximately 80-89% maxHR according to ACSM guidelines (ACSM, 1990). When analyzing the actual ALL OUT Step™ choreography, increases in workload may have been the result of: (a) additional and progressive use of traveling steps and "Change Directions" steps, which required the participant to cover more area with the entire body; (b) the "V-Step," a larger range of motion and variation of the basic step; (c) the use of lunges; and (d) the additional use of legs at or above the hip. Although literature reported conflicting opinions of whether the additional use of arm movement may in fact contribute to significant increases in workload and/or elicit disproportionately higher heart

rates (Cline et al., 1991; Parker et al., 1989), the results of this study suggested that due to the significantly greater increases in heart rate at minute 7:40 for both the 8" and 10" step heights, the additional use of arms may have at least contributed to heart rate increases and overall increases in workload.

The latter three intensity levels (13:20, 16:40, and 19:40), were defined as "high intensity choreography." Minute 13:20 included Knee Lifts and Step Kick combinations with arms, minute 16:40 included the AOP1-Alternating Knee Lifts and Step Kick pattern, and minute 19:40 included the AOP2-Knee Lift, Step Kick, and Alternating Step Kick pattern. All of these individual "high intensity" movements included vigorously raising the arms above the shoulders and/or head, and knees or legs lifting to approximately waist height. Heart rate values significantly increased from minute 3:20 to 7:40, decreased slightly from minute 7:40 to 9:40 (10" only), again significantly increased from minute 9:40 to 13:20, and then decreased slightly from minute 16:40 to 19:40 (Figure 1) on both the 8" and 10" step workouts. This data suggested that either the choreography selections were, on an average, progressively more difficult to execute, and thus demanding increased workloads on the participants, and/or fatigue played a part in overall workload increases on the heart with each additional intensity level and minute within the workout, thus creating increases and decreases in intensities. Slight decreases in heart rate that were found during the last intensity minute of the low and high intensity choreography segments may have been due to the subjects' feelings of exhaustion and fatigue, thus voluntarily or involuntarily decreasing the intensity level of the workouts.

While it was the intention of the principal investigator to select and categorize individual step movement (based on current step choreography standards), and choreograph the 20 minute ALL OUT Step™ workout to include 10 minutes of low intensity and 10 minutes of high intensity step choreography, total mean and many individual heart rate levels for this study indicated that not all previously defined "low intensity" step movements actually elicited heart rate values generally accepted as low intensity. In fact, considering a moderate level of exercise workload to equal approximately 60-79% maxHR, a heavy

exercise workload to equal approximately 80-89% maxHR, and a very heavy exercise workload to equal approximately 90% and above, mean heart rate levels for this study were elevated to the higher intensity levels as of minute 7:40 for both step heights (ACSM, 1990).

Minute 3:20 showed moderate heart rate values (Figure 1) which might be appropriate for “low intensity” choreography, including the Basic Step and Alternating Basic Step with no arms used. Minute 7:40 (significant increase with Scheffe’ value of 16.0) showed heart rate increases which would be associated with heavy workloads, and thus possibly considered to be “high intensity” choreography. Choreography for this level included the use of arms, with the V-Step, Alternating V-Step, and Change Directions. Minute 9:40, being significantly different from minute 3:20, also showed heart rate increases which would be associated with heavy workloads, and thus possibly considered to be “high intensity” choreography. The Step Touch, Over-The-Top and Basic Lunge were step movements used for this intensity level. Both of these intensity levels included either traveling with the entire body, or a more active effort of the entire body with arms below the shoulders and legs below the waist. Lack of significant differences in workload between these two minutes may have suggested that either the subjects’ did not respond to changes in choreography intensities, and/ or workload intensities were similar between step choreography. Finally, minutes 13:20, 16:40, and 19:40 showed very heavy workloads, with heart rate values at or above 90% HRmax. Choreography for these levels, as previously mentioned, included vigorous arm movements with knee lifts, step kick combinations, and repeating patterns. Calarco et al. (1991) also found higher mean heart rate values with the “travel with alternating lead (167 bpm), lunge (162 bpm), and the repeater (157 bpm).” These steps were similar with the step choreography for this study as follows: (a) Travel with Alternating Lead and Change Directions (144.4 bpm); (b) Lunge (147.9 bpm); and (c) Repeater and AOP1 or AOP2 (164.9 bpm). It is important to note that the study by Calarco et al. (1991) used the 6” step height, and it was reported that “by choosing less vigorous movement patterns, even moderately fit participants can use bench

step aerobics safely” (p. S140).

Although it is difficult to explain precisely why differences occurred for heart rate, suggested causes may have been due to a number of factors including: (a) selection and/or order of specific choreography patterns and movements due to intensity level differences; (b) brief transitional marches (approximately 10 seconds between intervals to prepare the body for a new direction and/or movement pattern) taken between intensity minutes, possibly eliciting increases or decreases in heart rate; (c) initial pre-exercise heart rate levels upon beginning each 20 minute workout; (d) selection of step height as related to personal skill, training level, or body frame size (all but three subjects did not regularly use the 10” step height in their training program); and/or (e) fatigue. Astrand and Rodahl (1986) stated that it is still unknown and a debate among physiologists as to the exact causes of muscular fatigue. They further stated that mechanical design and fiber type composition of the various muscle groups involved may respond differently, and thus elicit limits in performance. Additionally, they stressed that “mood-motivation can highly affect the performance” (p.118).

RPE

Significant RPE differences were found between the 8” and 10” step heights, with RPE values having reached or exceeded “somewhat heavy-13” workload conditions by minute 9:40 during both step heights. Proportionally higher RPE mean values were found on the 10” step height with lower RPE mean values found on the 8” step height, and progressively greater RPE values with longer workout time were reported. The four intensity points between minutes 7:40 and 9:40 (Scheffe’ value = 2.6), minutes 13:20 and 16:40 (Scheffe’ value = 3.0), minutes 13:20 and 19:40 (Scheffe’ value = 3.6), and minutes 16:40 and 19:40 (Scheffe’ value = 0.6) showed no significant differences for RPE values. Individual analysis of RPE values indicated that eleven of the nineteen participants worked at levels that were either approaching or at “heavy workload” RPE values (based on the

Borg scale). The subjects, however, were either not aware of their extremely high exertion level (as evidenced by high heart rates), or were not unusually exhausted or uncomfortable enough to voluntarily terminate either testing.

Based on the classification system of workload intensity (ACSM, 1990), minute 3:20 showed “very light” mean RPE value of 9.0 for the 8” step and “light” 10.2 for 10” step (Figure 2), and “light” mean RPE values for minute 7:40 of 10.6 for the 8” step and 11.9 for the 10” step, which choreography for those intensity minutes might be appropriate for “low intensity” choreography, including the Basic Step, Alternating Basic Step with no arms, V-Step and Change Directions with arms. Minutes 9:40 showed an RPE value of 11.4 for the 8” step which would still be classified as a “light” workout, however, a value of 12.9 was determined on the 10” step which would be associated with moderate workloads, and included Step Touches, Over-The-Top, and Lunges. A mean RPE value of 13.5 was shown at minute 13:20 for the 8” step, however, the 10” RPE value shown was 14.3, which is considered a “heavy” workload. All other mean RPE values for the 8” and 10” step at minutes 16:40 and 19:40 were ≥ 14.5 and < 16 which would classify workload intensities to be “heavy.”

Calarco et al. (1991) found higher mean RPE values with the “travel with alternating lead (12.1), lunge (11.9), and the repeater (11.9). These steps are similar with 8” steps of this study as follows: (a) Travel with Alternating Lead and Change Directions (10.6); (b) Lunge (11.4); and (c) Repeater and AOP1 or AOP2 (13.5). Olson et al. (1991b) reported similar perceptual findings to those of this study. They reported higher mean ($\pm$ SD) RPE’s for the 10” step heights and lower mean RPE’s for the 8” step heights at 13.1 (± 3.1) and 11.9 (± 3.7) respectively, as compared to 15.1 for the 10” step height and 11.7 for the 8” step height for this study. Williford et al. (1989) also reported similar findings for aerobic dance with mean RPE’s of 13.93 (± 2.52) for high intensity, high-impact, 12.00 (± 1.96) for high intensity, low-impact, and 12.53 (± 1.99) for low intensity, high-impact, than the mean RPE of 9.48 (± 2.06) for low intensity, low-impact movement.

In an effort to explain why differences were found between heart rate and RPE values,

it is important to note that perceived exertion (RPE) is based on one's subjective rating of workload intensity, while heart rate has been acknowledged and studied as one of many physiological variables to determine workload intensities. Additionally, it is important to note that subjects within this current step study were intermediate to advanced level step exercisers, with mean descriptive statistics having suggested that they were a physically trained group of subjects. Significant differences found may have been due to a number of possibilities including: (a) the participants' subjective perception of workload increases with increased time of workout and/or step height; (b) the "perceived" starting RPE value and the consistently gradual increase associated with perceived workload feelings; (c) the participants' preconceived assumption that a workout on a higher step height or a longer time period may elicit a higher RPE value; (d) the possible competitive spirit experienced by any or all of the subjects; and/or (e) muscle fatigue experienced. Again, it is important to note that as mentioned with heart rate, it is still unknown as to the exact causes of muscle fatigue experienced, and how the body responds to various workload intensities.

Acosta (1989) and Bar-Or, Skinner, Buskirk, and Borg (1972) reported that highly fit individuals' perception of effort were lower than less fit individuals at a given absolute workload. Additionally, Acosta reported that there is conflicting literature with regards to perceptions of workload, as related to fitness level, and that some literature suggests that less physiological strain may be experienced by a trained individual when compared to a less-trained individual if both are exercising at the same absolute workload. Plato (1981) suggested that individuals of differing fitness levels may perceive and report workload effort similarly. Although differences in individual descriptive data (Appendix N) suggested varying fitness levels among the nineteen subjects, many reported mean RPE values increased with time, regardless of reported heart rate values. This suggested that individuals' perception of workload increases were similar, regardless of the physiological strain experienced by both the more-trained individual and the less-trained individual.

Plato (1981) stated that "the RPE scale has been the most widely used as it gives values that grow linearly with workload and heart rate" (pg. 11). The discrepancy that not all

heart rate values progressively increased as compared to all RPE values which did progressively increase may be explained by the fact that, while measures such as heart rate indicate the physiological workload experienced, heart rate alone is not an adequate measure for determining the individual's total response to stresses experienced. An individual's perception of workload stresses may be another excellent means of determining total workload responses. Plato (1981) also reported that what one is experiencing physiologically, may not be as important as what one is perceiving. Many researchers have agreed that RPE may be used as a valid indicator of physiological stress.

With regards to this current step exercise study, the progressive increases in reported RPE values may have been due to the subjects' perceptions of workload intensities as compared to perceptions of other workout intensity levels normally experienced. For some subjects, heart rate values suggested much greater physiological stresses at the same workload than perceived exertion values. On the other hand, progressively higher RPE values reported may have been the subjects' subjective determination of workload intensity increases. Although their perceived determination of workload increased over time, physiological responses in those who were reaching or had passed near maximal heart rate levels may have decreased intensity levels to meet energy needs and abilities at that time. The instructions informing each subject that the "low-intensity" level was terminating and the "high-intensity" level was beginning for each workout may have affected their perceptions of the total workload stresses. Therefore, significant differences in heart rate at minutes 7:40 and 16:40, and then a nonsignificant decrease at minutes 9:40 and 19:40 may have demonstrated the subjects' responses to getting ready to begin the following (higher intensity) portion of the workout.

Summary of Findings

Results of this study (ANOVA and Scheffe' analyses) for heart rate and RPE showed that:

- 1) Significant differences existed between the 8" and 10" step heights and choreography intensity levels, and supported rejection of both null hypotheses for heart rate and RPE at a significance level of $p < .01$.
- 2) Although originally defined as either low or high intensity choreography, heart rate and RPE values obtained in this study determined that the choreography at minutes 7:40 and 9:40, originally classified as "low intensity" for both the 8" and 10" step heights, elicited higher heart rate and RPE values than were expected, and despite some step choreography standards, might have more accurately been classified as moderate to high intensity step choreography. Movements during these two intensity points included: Change Direction, Over-The-Top, V-Step, Lunges, variations of these steps, and the use of arms.
- 3) Results of this study suggested that step exercise elicits higher heart rate levels and RPE values on the 10" step height as compared with the 8" step height, and higher heart rate levels and RPE values with higher intensity movements, and lower heart rate levels and RPE values with lower intensity movements.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This chapter presents a summary, the conclusions, and the recommendations for this study.

Summary

The primary purpose of this study was to determine if differences existed in heart rate and RPE of female fitness club participants and instructors during two identical twenty minute step exercise workouts, one using an 8" (20.3cm) height step, and another using a 10" (25.4cm) step. A second purpose of this study was to determine if differences existed in heart rate and RPE of low versus high intensity ALL OUT Step™ Choreography.

Nineteen subjects were recruited from twelve fitness clubs located within Santa Clara County, California. Subjects included female fitness club participants and instructors, 22 to 39 years of age, in good overall health, and with no history of any significant musculoskeletal injuries, physical abnormalities or contraindications for exercise. All subjects completed the pretesting, including the treadmill test using a modified Balke test to assess maximum heart rate and maximum VO2 levels. Subjects were randomly assigned to either group A (8" then 10" step workout order) or group B (10" then 8" step workout order) by the subjects' flip of a coin. Subjects completed the twenty minute workout on both the 8" and 10" step heights at a cadence of 126 beats per minute on two separate days that were no more than two weeks apart.

Heart rate (HR) was monitored continuously and measured during the last 10 seconds of each minute during the pretest and both step workouts. Ratings of perceived exertion (RPE) were taken during the pretesting, and were reported at six interval points (minutes 3:20, 7:40, 9:40, 13:20, 16:40, and 19:40) during both step workouts. Each interval corresponded to the end of a choreography intensity level.

Differences in mean heart rate and RPE, as related to step height and intensity of choreography, were analyzed by 2 two-way ANOVA's with repeated measures, and Scheffe' post hoc tests. Statistical results indicated significant ANOVA differences ($p < .01$) in heart rate between step heights, choreography, and an interaction between both step heights and choreography. Results for the ANOVA test indicated significant differences ($p < .01$) in RPE between step heights and choreography, however, there was no interaction between parameters. Scheffe' results indicated where significant differences ($p < .01$) in heart rate and RPE occurred across all six intensity points, at a significance level of 4.03. A familywise error rate was determined at .06.

Conclusions

On the basis of the results and within the limitations of this study, the following conclusions were reached:

- 1) The 10" step height elicits significantly higher heart rate and RPE values than the 8" step height.
- 2) High intensity step choreography elicits significantly higher heart rate and RPE values than low intensity step choreography.
- 3) Although originally defined as either low or high intensity choreography, heart rate and RPE values obtained in this study determined that the choreography at minutes

7:40 and 9:40, originally classified as “low intensity” for both the 8” and 10” step heights, elicited higher heart rate and RPE values than expected, and despite some step choreography standards, might have more accurately been classified as moderate to high intensity step choreography. Movements during these two intensity points included: Change Direction, Over-The Top, V-Step, Lunges, variations of these steps, and the use of arms.

- 4) The choreography selection and order of this particular 20 minute ALL OUT Step™ Workout may have elicited too high of an intensity level for the represented female fitness club participant population.

Recommendations

Based on the results presented in this study, the following recommendations are suggested for this and/or future studies and research.

1. Future research should investigate heart rate and RPE as related to: other step heights, intensity differences with specific choreography movements, special populations and varying ability and/or skill levels, changes in bpm, propulsion steps as related to high-intensity choreography, high and low intensity with and without the use of arms, with and without music, live instruction versus videotaped step instructions, weights versus no weights, warm-up variations and intensity levels, instructors versus participants, male versus female, step aerobic competitors and intensity levels, changes in times of day to work out, styles of choreography on intensity levels such as funk versus traditional movements, caloric expenditure and fuel utilization using the step.
2. Despite the recommendations of Williford et al. (1989) to work at high intensity

levels for maximum benefits, results of this study support the recommendation that not all participants should work out at high intensity levels, as this may not be a safe range for their individual fitness level. Exercising at lower intensity levels may, in fact, provide some participants with more optimal benefits, depending on a number of factors including, but not limited to, the fitness level of the subject, specificity of training, and energy expended during the workout.

3. Step instructors should be sensitive to the varying needs and ability levels of the populations that they instruct. It is recommended to select the appropriate intensity level of movement (low and/or high intensity) based on the specific design of each class, with modifications offered to help accommodate varying individual fitness levels. Modification options are essential, as most classes are designed to meet the average fitness level of the class, and not each individual participant.
4. A re-evaluation of specific step exercise choreography should be conducted to better assess the intensity level of movements used in the step exercise industry.

For thesis students:

5. Select a dedicated thesis committee having strengths in the topic of the study and in statistical analysis, and select reliable subjects and technicians for timely data collection.
6. Be organized, having check lists, reminder notices, posted time schedules, outlines, etc. for everyone involved in the data collection.
7. NEVER GIVE UP!

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APPENDICES

APPENDIX A

BASIC STEP MOVEMENTS

The following steps will be demonstrated and performed during the videotaped introduction of each twenty minute video workout, however, a brief written description of each step movement used for choreography selection is included. For purposes of this written description, the right foot will lead, and the X refers to the number of repetitions for that particular movement.

Basic Step (BS):

Facing forward, lead with either the right or left foot (e.g., right) and step forward onto The Step™ with the right on count one, step up with the left on count two, step down with the right on count three, and finish by stepping down with the left on count four. Repeat with the right foot lead.

Alternating Lead (AL):

Similar to the basic step, face forward and lead with either the right or left foot (e.g., right) and step forward onto The Step™ with the right on count one, step up with the left on count two, step down with the right on count three, and finish by touching down with the left on count four. Repeat with the left foot lead.

V-Step (VS):

Similar to the Basic Step or the Alternating Lead, select either the same or alternating lead foot (e.g., right) to complete each count of four. When stepping up, rather than stepping up to the center of The Step, place the lead foot up and to the side of The Step™ on count one, place the left foot up and to the other side on count two, right down center on count three, and left down as a step or touch center on count four. Variations of this step include stepping to the side or to the center on any of the four counts.

Change Directions (CD):

Similar to the Alternating Lead, lead with either the right or left foot (e.g., right), while facing sideways to The Step™. Step up sideways with the right on count one, face forward while stepping up with the left on count two, face the other side while stepping down with the right on count three, and finish by touching down with the left on count four. Repeat with the left lead.

Step Touch (ST):

Facing either forward, sideways, or diagonally, lead with either the right or left foot (e.g., right) and step up with the right on count one, touch the left foot (either toe or heel) in the designated direction on count two, step down with the left on count three, and either step or touch with the right on count four. Variations of this may include kicks or step touches to one side for up to four times, with a touch down prior to changing to the other foot.

Knee Lift (KL):

Facing forward, diagonal, or sideways, step up with the right on count one, lift the left knee up on count two, step down with the left on count three, and finish by either stepping or touching down with the right on count four. Repeat with either the same lead foot or alternate, depending on the selection of either the step or touch on count four.

Basic Lunge (BL):

Begin while on top of The Step™ with both feet, facing either sideways or forward, and step down on either the right or left (e.g., right) in a lunge on count one, step up to the original position on count two, step down on the left in a lunge on count three, and finish by stepping up to the original position on count four. Variations of this may include lunges to one side for up to four times, with a touch on top, prior to changing to the other foot.

Step Kick (SK):

Facing either forward, sideways, or diagonally, lead with either the right or left foot (e.g., right) and step up with the right on count one, lift and kick the left leg in the designated direction on count two, step down with the left on count three, and either step or touch with the right on count four. Variations of this may include kicks or step touches to one side for up to four times, with a touch down prior to changing to the other foot.

Over The Top (OT):

Facing sideways to The Step™ (e.g., right), step up sideways with the right on count one, step up sideways with the left on count two, step down sideways with the right on count three, and finish by stepping down sideways with the left on count four. Repeat with the left foot lead.

ALL OUT Step™ Pattern #1 (AP1): (12 counts of 8 total to complete one pattern)

Part I - Legs: Facing forward, lead with either the right or left foot (e.g., right) and step up with the right on count one, lift the left knee turned out on count two, step down on the left on count three, step side with the right on count four, step up with the left on count five, lift the right knee turned out on count six, step down on the right on count seven, step side with the left on count eight. Repeat 2X's. Then vary the knees with leg kicks out to the side for 2X's. Arms: As you execute foot pattern, arms are bent at elbows and parallel to the floor on the odd counts, and out horizontally on the even counts. (4 counts of 8 total)

Part II - Legs: Facing either diagonal (e.g., left diagonal), step up with the right on count one, lift the left knee parallel to body on count two, step down on the left on count three, toe touch back with right on count four, step up with right on count five, lift the left knee parallel to body and up to the waist on count six, step down on the left on count seven, toe touch back with right on count eight. Step up with the right on count one, lift the left knee parallel to body and up to the waist on count two, step down on the left on count three, toe touch back with right on count four, step up with right on count five, kick

diagonal with left on count six, step down on the left on count seven, and step side with right on count eight. Repeat on each side 2X's. Arms: Extend arms up overhead on count one, lat pull down on count two, up overhead on count three, lat pull down on count four, up overhead on count five, lat pull down on count six, up overhead on count seven, lat pull down on count eight. Bend elbows and parallel to floor on odd counts 1,3,5,7, and extend out horizontal on even counts 2,4,6,8. (4 counts of 8 total on each side)

ALL OUT Step™ Pattern #2 (AP2): (counts of 8 total to complete one pattern)

Part I - Legs: Facing either right or left side (e.g., right foot close to step, facing left), Step Touch (ST) 3X's and then Over The Top (OT) 1X. Repeat to left, and 2X's total to each side. Vary touch with step Knee Lift (KL) 3X's and then Over The Top 1X. Repeat to left, and 2X's total to each side. Vary step Knee Lift with Step Kick (SK) 3X's and then Over the Top 1X. Repeat to left, and 2X's total to each side. Arms: Lateral arm swings horizontal on odd counts and cross down at wrists on even counts during 3X leg movements. During Over The Top arms swing horizontal on count five, up overhead on count six, out horizontal on count seven, and down on count eight. Repeat with all leg variations.

Part II - Legs: Facing over the end of the platform lengthwise, lead with either the right or left foot (e.g., right), step up with the right on count one, left back leg lift on count two, step down with left on count three, step with right on count four, step up with the left on count five, right back leg lift on count six, step down with right on count seven, step with left on count eight. Repeat 4X's on each side. Arms: Arms swing or push up on counts 1,2,5,6, and swing down on counts 3,4,7,8. Repeat with leg pattern.

ALL OUT STEP™ CHOREOGRAPHY MOVEMENTS AND PATTERNS

Movements:

Low-Intensity Movements: (First 10 minutes/patterns 1 through 3)

Basic Step, Alternating Lead, Over The Top, Lunge, V-Step, Change Direction, Step Touch, no arms or arms below shoulder level.

High-Intensity Movements: (Second 10 minutes/patterns 4 through 6)

Knee Lift, Step Kick, Variations of Over the Top Movement, arms at or above shoulder level.

Patterns: (1 through 6)-X refers to number of repetitions

1. Basic Step R-4X, L-4X, R-4X, L-4X, R-2X, L-2X, R-2X, L-2X,
Alternating Lead R-1X, L-1X, R-1X, L-1X
Repeat 2X (No arms used for this first pattern.)
2. V-Step R-4X, L-4X, R-4X, L-4X, R-2X, L-2X, R-2X, L-2X,
Alternating V-Step R-1X, L-1X, R-1X, L-1X
Change Directions 8X
Repeat 2X adding arms below shoulders
3. Step Touch R-3X, Over The Top R-1X, Repeat L side
Repeat 4X
Basic Lunge (Alternating Lead) 4X
Repeat Step Touch/Over The Top combo 4X
4. Knee Lift (Alternating Lead) 16X, Step Kick (Alternating Lead) 16X
Repeat 4X
5. ALL OUT Step™ Pattern #1: Part I-Alternating Knee Lift 4X, Alternating Step Kick 4X
Part II-Knee Lift 3X and Step Kick 1X L, Repeat R
Repeat 2X each side
Repeat Part I and II 4X
6. ALL OUT Step™ Pattern #2: Part I-Step Touch R-3X, Over The Top R-1X,
Repeat L
Repeat with Knee Lift, and then with step kick 4X each type
Part II-Alternating Step Kick Back 16X
Repeat Part I and II 4X

APPENDIX B
INFORMED CONSENT FORM

Agreement to Participate in Research

Responsible Investigator(s): Teri Wexted (principle investigator)

Title of Protocol: Heart Rate Changes With Varying Step Height And Intensity of Choreography

1. I have been asked to participate in a research study to examine heart rate changes with two step heights (8" and 10"), and two intensities of choreography (low and high) during two 20-minute videotaped step exercise workouts.
2. I will be asked to complete a health history and step exercise experience questionnaire, an agreement to participate in the research, a VO₂max treadmill pretest, two step exercise workouts, and have the following measurements taken: height, weight, skinfold measurements, resting blood pressure, and resting heart rate at San Jose State University, during Spring 1992.
3. **Possible Risks and/or Discomforts:** You may experience some discomfort and/or dryness in the mouth, throat, and chest during the pretest or workouts. You may feel lightheaded, fatigued, and slightly nauseous for a short time following these procedures. Also, you may experience other discomforts commonly associated with exercise such as: sweating, increased heart rate or breathing rate, elevated body temperature, cramps. Discomfort may also be experienced by the restricted breathing thru apparatus or electrocardiogram electrodes during treadmill testing. During pretesting, upon reaching or getting near maximal exercise levels, you may experience abnormal blood pressure, fainting, and/or dizziness, muscle fatigue or cramps, and/or abnormalities in heart beat. If abnormalities are detected in pulmonary function or electrocardiographic recordings, the test will be stopped, and you will not be included as a subject in this study. Additionally, there may be some bruising or pinching from skinfold measurements.
4. I will benefit from participation in this study by receiving information regarding body composition, physical characteristics (height, weight, resting blood pressure), and cardiorespiratory endurance (maximal oxygen uptake, maximum heart rate, resting heart rate, and exercise training zone). I will also receive information regarding heart rate changes during workout sessions. Results from this research study may improve current step exercise training methods, and improve the quality of instruction for this mode of activity.
5. All data collected from this research study may be used for medical and/or scientific purposes, including publication and presentation at professional conventions and events. Your identity for individual test results will not be revealed in published or presented papers without your written consent.
6. I understand that I will not be compensated for my participation in this study.
7. Any questions about the research may be addressed to Teri Wexted (principal investigator), at (408) 446-9599. Complaints about the research may be presented to Dr. James Bryant, Chairman of Department of Human Performance, at (408) 924-3010. Questions or complaints about research, subjects' rights, or research-related injury may be presented to Serena Stanford, Ph.D., Associate Vice President of Graduate Studies and Research, at (408) 924-2480.

8. No service of any kind, to which I am otherwise entitled, will be lost or jeopardized if I choose to “not participate” in the study.

9. Having read the above, I agree that my consent is given voluntarily without being coerced. I understand that I may withdraw from this study at any time (including during testing), without prejudice to my relations with the Department of Human Performance, San Jose State University, the principal investigator, or their associates.

10. I understand that I have received a signed and dated copy of the consent form. The returned copy of this consent form indicates agreement and confirmation of my being included as a participant in this study, and that I agree that I have been fully informed of my rights.

* * * * *

My signature indicates that I have agreed to participate in this study.

Subject's Signature Date

Investigator's Signature Date

APPENDIX C

HEALTH HISTORY AND STEP EXERCISE QUESTIONNAIRE

(ALL INFORMATION IS PRIVATE AND CONFIDENTIAL)

Please print and fill in all questions.

GENERAL INFORMATION

Today' Date _____ Participant / Instructor (Circle One)
Club Affiliation _____
Name: Last _____ First _____ MI _____
Address _____ Apt _____
City _____ State _____ Zip _____
Phone: Day () _____ Evening () _____ ext. _____
Date of Birth: M/D/Y _____ Age _____ Ht: ft./in. _____ Wt: lbs. _____
Family Physician: Dr. _____
City _____ State _____ Zip _____
Phone _____ Clinic Name _____
Person to be notified in case of emergency:
Name _____ Relationship _____ Phone () _____
List any drug allergies: _____

HEALTH HISTORY STATUS

(Check if you previously or currently experience any of the following conditions.)

() High Blood Pressure	() Anemia
() Heart Disease or Dysfunction	() Hernia
() Peripheral Circulatory Disorder	() Thyroid Dysfunction
() Lung Disease or Dysfunction	() Pancreas Dysfunction
() Arthritis or Gout	() Liver Dysfunction
() Edema	() Kidney Dysfunction
() Epilepsy	() Neural Dysfunction
() Multiple Sclerosis	() Acute Infection
() High Blood Cholesterol or Triglyceride Levels	() Others: _____
() Diabetes or Blood Sugar Level Abnormality	_____

FAMILY HISTORY

(Check if any of your blood relatives have or had any of the following conditions.)

- () Heart Disease
() Heart Attacks or Strokes prior to age 50
() Elevated Blood Cholesterol or Triglyceride Levels
() Diabetes
() Others: _____

JOINT/MUSCLE STATUS

(Check areas which you currently experience any problems or discomforts.)

Joint Areas

- () Wrists
- () Elbows
- () Shoulders
- () Upper Spine and Neck
- () Lower Spine
- () Hips
- () Knees
- () Ankles
- () Feet
- () Others: _____

Muscle Areas

- () Arms
- () Shoulders
- () Chest
- () Upper Back and Neck
- () Abdominal Region
- () Lower Back
- () Buttocks
- () Thighs
- () Lower Leg
- () Feet
- () Others: _____

PHYSICAL EXAMINATION HISTORY

(Answer the following questions as accurately and honestly as possible. Please print.)

When was your last physical exam? _____

Any physical problems detected at that time? Yes/ No (circle one) If yes, please explain: _____

When was your last resting electrocardiogram evaluated? _____

Was it normal? Yes/ No (circle one) If no, please explain: _____

When was your last electrocardiogram evaluated during an exercise stress test? _____

Was it normal? Yes/ No (circle one) If no, please explain: _____

What heart rate did you reach during this exercise? _____

Has a physician ever made any recommendations relative to limiting your levels of physical exertion? Yes/ No (circle one) If yes, please explain: _____

PHYSICAL DIFFICULTIES OR LIMITATIONS

(Check if you have had or currently experience any of the following during rest or physically active periods.)

Rest

- () Chest Pain
- () Heart Palpations
- () Unusually Rapid Breathing
- () Overheating
- () Muscle Cramping
- () Joint Pain
- () Nausea
- () Light Headedness
- () Loss of Balance
- () Loss of Condition
- () Extreme Weakness
- () Numbness
- () Mental Confusion
- () Other: _____

Physically Active

- () Chest Pain
- () Heart Palpations
- () Unusually Rapid Breathing
- () Overheating
- () Muscle Cramping
- () Joint Pain
- () Nausea
- () Light Headedness
- () Loss of Balance
- () Loss of Condition
- () Extreme Weakness
- () Numbness
- () Mental Confusion
- () Other: _____

CURRENT STATUS/HABITS

(Answer the following questions as accurately and honestly as possible. Please print.)

Do you smoke? Yes / No (circle one) If yes, how many per day? _____

Do you drink alcohol? Yes / No (circle one) If yes, how often? _____
If yes, how much? _____

Do you drink coffee, tea, or soda with caffeine? Yes / No (circle one) If yes, explain which ones and how many cups per day. _____

Describe your eating habits: Excellent _____, Good _____, Fair _____, Poor _____, Bad _____

Describe your fitness level: Excellent _____, Good _____, Fair _____, Poor _____, Bad _____

Describe your daily stress level: Never _____, Rarely _____, Occasionally _____, Always _____

List any prescribed medications you are currently taking _____

List any self-prescribed medications or dietary supplements you are currently taking:
These may include vitamins, pain relievers, antacids, etc. _____

STEP EXERCISE EXPERIENCE AND CURRENT FITNESS LEVEL

(Answer the following questions as accurately and honestly as possible. Print or check off.)

Typical Exercise Participation: Heavy _____, Moderate _____, Light _____, Infrequent _____

Exercise Frequency: 6 - 7 d/w _____, 4 - 5 d/w _____, 2 - 3 ds/w _____, 1 d/w _____, None _____

Step Exercise Frequency: 6 - 7 d/w _____, 4 - 5 d/w _____, 2 - 3 ds/w _____, 1 d/w _____, None _____

Amount of time that your heart rate is elevated and/or you are "out of breath" during exercise:
Less than 15 min. _____, 15 to 30 min. _____, 30 to 45 min. _____, 45 to 60 min. _____, 60+ _____

Preferred time of exercise: Before 8am _____, Mornings (8-12) _____, Lunch Time (12-1) _____,
Afternoons (1-5) _____, Evenings (after 5pm) _____, Weekdays _____, Weekends _____

Which of the following do you participate in? (how many times per week-frequency):

Step Exercise _____ Frequency _____	Aerobic Dance _____ Frequency _____
Conditioning _____ Frequency _____	Walking _____ Frequency _____
Jogging _____ Frequency _____	Cycling _____ Frequency _____
Dance _____ Frequency _____	Swimming _____ Frequency _____
Rope Skipping _____ Frequency _____	Rowing _____ Frequency _____
Weight Lifting _____ Frequency _____	Other: _____ Frequency _____

If you are a fitness club instructor, how many classes do you teach daily, and per week? _____

Do you teach step exercise? Yes / No (circle one) If yes, how many classes per week? _____

ADDITIONAL COMMENTS: (Please use back if necessary.)

THANK YOU FOR YOUR COOPERATION IN FILLING OUT THIS SURVEY!

APPENDIX D

WRITTEN INVITATION TO PARTICIPATE IN STUDY

VOLUNTEER SUBJECTS NEEDED FOR STEP EXERCISE STUDY

Teri Wexted, candidate for a Master of Arts, specializing in Exercise Physiology at San Jose State University, will be conducting a Master's Thesis research study on step exercise. Specifically, the purpose of this research study is to determine heart rate changes with two step heights and two intensities of choreography during a videotaped twenty minute step exercise workout.

* * * * *

Invitation to Participate

In order to complete this study, twenty females will be selected from fitness clubs located within Santa Clara County, California. Volunteers must be 22 to 39 years old, in good overall health, and have no history of coronary heart disease, significant musculoskeletal injuries or contraindications for exercise. In addition they must have participated in a fitness club step class program for a minimum of three months, having met at least two times per week during that three month time period. This study is tentatively set for Spring '92.

If you are interested in participating in this study, or have additional questions please call Teri Wexted at (408) 446-9599.

INVITATION COVER LETTER

Date

Name of Club

Address

City, State Zip

Phone

Attn: _____, Aerobic Director

I am happy to announce that _____ Club of _____ has been selected as one of ten fitness / athletic clubs within Santa Clara County to participate in a master's thesis study to be held at San Jose State University.

Currently, I am a candidate for a Master of Arts, specializing in Dance Exercise Physiology at San Jose State University, and will be conducting a Master's Thesis research study on step exercise. Specifically, the purpose of this research study is to determine heart rate changes with two step heights and two intensities of choreography during a videotaped twenty minute step exercise workout.

In order to complete this study, twenty females will be selected from fitness clubs located within Santa Clara County, California. Volunteers may either be instructors and / or participants of your fitness club, must be 25 to 39 years old, in good overall health, and have no history of coronary heart disease, significant musculoskeletal injuries or contraindications for exercise. In addition, they must have participated in your fitness club step class program for a minimum of three months, having met at least two times per week during that three month time period.

As the aerobic director / fitness coordinator, I am asking for your help by 1) having your instructors announce this in all classes as soon as possible, and 2) posting the enclosed neon flyers for your instructors and step class participants to read. Suggested locations for these flyers include: bulletin boards, information center boards, front desk handout slots, etc. I have also enclosed a white flyer for you to make additional copies as needed. This study is scheduled for Spring '92, with the actual testing to take place in March / April. The first twenty females to respond from all ten clubs combined, and who meet the preliminary testing criteria, will be chosen to participate in this study. With the study just right around the corner, time is of the essence. Please post this information as soon as possible.

I am looking forward to hearing from all interested participants representing your club, and in the results of this study. Hopefully, this study will be one of the first to specifically target the fitness club population, and add to the limited knowledge base that we currently have on Step Exercise. Upon completion of this study and thesis, I will submit an abstract and article highlighting the details of the study for potential publication. At that time, I will be happy to share my results with you, as one of the ten participating fitness / athletic clubs in this study.

Once again, congratulations on your club being selected to participate in this study. I appreciate your help in delivering this information to your instructors and step participants in a timely manner. Should you or any interested participant have any questions please feel free to call me at (408) 446-9599.

Sincerely yours,

Teri Wexted, SJSU Master of Arts Candidate

APPENDIX E

FITNESS CLUBS INVITED AND/OR REPRESENTED IN STUDY

<u>NAME OF FITNESS CLUB</u>	<u>LOCATION: CITY, STATE</u>
1. Almaden Valley Athletic Club*	San Jose, California
2. Apple Health & Fitness*	Cupertino, California
3. Decathlon Club*	Santa Clara, California
4. Los Gatos Athletic Club	Los Gatos, California
5. Move-It*	Los Gatos, California
6. NASA Fitness Center*	Mountain View, California
7. Reach	Mountain View, California
8. Ronnie Lott's Club Fitness	San Jose, California
9. Royal Courts Athletic Club*	San Jose, California
10. San Jose Athletic Club*	San Jose, California
11. Schoeber's Athletic Club*	San Jose, California
12. Supreme Court*	Sunnyvale, California

* = represented fitness club

APPENDIX F

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE

(All information is private and will remain confidential.)

I. GENERAL INFORMATION

Today's Date _____ Participant / Instructor (Circle One)
Club Affiliation _____
Name: Last _____ First _____ MI _____
Address _____ Apt. _____
City _____ State _____ Zip _____
Phone: Day () _____ Evening () _____ ext. _____
Date of Birth: M/D/Y _____ Age _____ Ht: ft./in. _____ Wt: lbs. _____
Family Physician: Dr. _____
City _____ State _____ Zip _____
Phone _____ Clinic Name _____

Person to be notified in case of emergency:
Name _____ Relationship _____ Phone () _____
List any drug allergies: _____

II. HEALTH HISTORY

Please answer the following questions as accurately and honestly as possible. (Circle yes or no)

1. Has your doctor ever said you have heart trouble? Yes No
2. Do you frequently suffer from pains in your chest? Yes No
3. Do you often feel faint or have spells of severe dizziness? Yes No
4. Has a doctor ever said your blood pressure was too high? Yes No
5. Has your doctor ever told you that you have a bone or joint problem such as arthritis that has been aggravated by exercise, or might be made worse with exercise? Yes No
6. Is there a good physical reason not mentioned here why you should not follow an activity program even if you wanted to? Yes No

*Reference: ACSM's Guidelines for Exercise Testing and Prescription, 1991, 37 "PAR-Q Validation Report", British Columbia Dept. of Health, June 1975 (Modified Version).

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (Cont.)

III. 24 -HOUR TESTING STATUS

Have you had or consumed any of the following within the past 24 hours?

1. Smoked? Yes/No (circle one) If yes, how many? _____
2. Alcoholic drink? Yes/No (circle one) If yes, how many drinks? _____
3. Coffee, tea, or soda with caffeine? Yes/No (circle one) If yes, explain which ones and how many cups. _____
4. Drugs or Medication? Yes / No (circle one) If yes, explain: _____

5. Describe what you have eaten within the past 24 hours and the times of consumption.

Breakfast: _____
Snack: _____
Lunch: _____
Snack: _____
Dinner: _____
Snack: _____
6. Describe any and all physical activity you have done within the past 24 hours and the length of time for each.
7. Describe today's stress level: None____ , Low____, Average ____ , High____, Excessive ____
8. List any prescribed medications you have taken within the past 24 hours.
9. List any self-prescribed medications or dietary supplements you have taken within the past 24 hours. These may include vitamins, pain relievers, antacids, etc.
10. Please list any additional considerations you feel may influence your performance or alter the outcome of today's test.

Additional Comments: (Please use back if necessary.)

'92-TW

THANK YOU FOR YOUR COOPERATION IN FILLING OUT THIS SURVEY!

APPENDIX G

Rating of Perceived Exertion (RPE) Instructions

"Maximal heart rate varies greatly among individuals during exercise testing. Therefore, it is helpful to be able to evaluate ratings of perceived exertion to assess whether or not a test is truly maximal and to assess when maximum exercise is being approached. The perceived exertion scale provides a method to quantify subjective exercise intensity.

During the graded exercise test we want you to pay close attention to how hard you *feel* the work rate is. This feeling should be your total amount of exertion and fatigue, combining all sensations and feelings of physical stress, effort, and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath or exercise intensity, but try to concentrate on your *total, inner* feeling of exertion. Don't underestimate or overestimate, just be as accurate as you can." *

When asked your RPE (how you feel) during the graded exercise test and the step workouts, please indicate by pointing to the number that most accurately describes how you feel at that moment. (Ex. If you are feeling like the workout is "somewhat hard" point to #13. If you are between "somewhat hard" and "hard" point to #14.) Remember, this is only a rating of perceived exertion.

(*Taken from ACSM's Guidelines for Exercise Testing and Prescription, 4th edition, 1991, 69-71.)

* * * * *

BORG'S RATE OF PERCEIVED EXERTION SCALE (Category RPE Scale)

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	

APPENDIX H
SUBJECT CONFIRMATION COVER LETTER

Date:

Attn: _____, Volunteer Subject

I would like to thank you for your interest in volunteering as a subject to participate in a master's thesis study to be held at San Jose State University.

Currently, I am a candidate for a Master of Arts, specializing in Dance Exercise Physiology at San Jose State University, and will be conducting a Master's Thesis research study on step exercise. Specifically, the purpose of this research study is to determine heart rate changes with two step heights and two intensities of choreography during a videotaped twenty minute step exercise workout.

In order to complete this study, twenty females will be selected from ten fitness clubs located within Santa Clara County, California. Volunteers may either be instructors and/or participants, must be 25 to 39 years old, in good overall health, and have no history of coronary heart disease, significant musculoskeletal injuries or contraindications for exercise. In addition, they must have participated in their affiliated fitness club step class program for a minimum of three months, having met at least two times per week during that three month time period.

You have been selected as one of the first twenty volunteers for the preliminary testing of this study. Enclosed in this packet is the 1) Agreement to Participate in Research form (2 pages), and 2) Health History and Step Exercise Questionnaire (3 pages). Please read over all information, answering each question carefully and truthfully. Your information packet will remain confidential as is mentioned in the agreement to participate, and you are able to terminate participation from this study at any time.

Upon review of your packet and acceptance as a subject for the next phase of this study, you will be notified by phone and asked to sign up for your testing dates. Provided there are no unforeseen problems in collection of data or testing procedures, testing dates will include three-two hour periods of time either on a Friday, Saturday, or Sunday during the month of May. Full explanation of all testing procedures and times will be given to you upon confirmation as one of the primary volunteer subjects.

Hopefully, this study will be one of the first to specifically target the fitness club population, and add to the limited knowledge base that we currently have on Step Exercise. Upon completion of this study and thesis, I will submit an abstract and article highlighting the details of the study for potential publication. At that time, I will be happy to share my results with you, as one of the volunteer subjects for this study.

Once again, congratulations on being selected to participate in the first phase of this study. I appreciate your time in filling out this information and sending it completed in the preaddressed stamped envelope no later than **Friday, April 24th**. Should you have any further questions please feel free to call me at (408) 446-9599.

Sincerely yours,

Teri Wexted, SJSU Master of Arts Candidate

APPENDIX I. HEART RATE STATISTICS PER MINUTE FOR 8" STEP

MINUTE	aMEAN	STD ERROR	MEDIAN	MODE	STD DEV	VARIANCE	KURTOSIS	SKWENESS	RANGE	MIN	MAX	SUM	COUNT
1	130.4	3.8	125.0	118.0	16.7	278.2	1.0	0.4	75	96	171	2477	19
2	134.3	4.4	133.0	149.0	19.0	361.2	0.4	0.1	83	94	177	2552	19
3	134.9	4.4	130.0	121.0	19.4	375.7	-0.2	0.0	80	94	174	2563	19
3:20	132.8	4.7	125.0	155.0	20.7	428.4	-0.3	0.0	84	90	174	2623	19
4	130.8	4.8	125.0	122.0	20.9	435.0	-0.4	0.0	83	89	172	2486	19
5	138.5	4.7	136.0	130.0	20.6	425.9	-0.2	-0.2	81	97	178	2631	19
6	145.9	4.9	141.0	135.0	21.3	454.7	0.1	-0.2	89	99	188	2772	19
7	144.3	4.9	139.0	123.0	21.3	453.0	0.2	-0.1	91	97	188	2741	19
7:40	144.4	5.2	144.0	134.0	21.5	511.4	0.0	-0.1	94	96	190	2744	19
8	145.4	5.1	142.0	134.0	22.4	503.1	0.2	0.0	95	97	192	2783	19
9	138.9	4.9	138.0	160.0	21.3	452.3	-0.2	0.3	85	100	185	2640	19
9:40	147.9	4.5	142.0	142.0	19.5	382.5	0.1	0.2	80	110	190	2810	19
10	149.0	4.6	142.0	165.0	19.9	395.6	-0.2	0.1	80	110	190	2831	19
11	141.7	5.0	144.0	118.0	22.0	483.0	-0.2	-0.1	89	96	185	2693	19
12	157.2	4.8	161.0	#N/A	20.7	430.3	0.6	-0.5	88	107	195	2987	19
13	164.4	4.5	167.0	167.0	19.8	390.9	0.7	-0.7	81	116	197	3123	19
13:20	164.9	4.8	170.0	171.0	21.1	443.8	0.8	-0.8	84	113	197	3133	19
14	162.5	4.9	164.0	183.0	21.5	460.2	0.7	-0.8	87	110	197	3087	19
15	158.5	5.1	163.0	177.0	22.3	499.0	0.2	-0.5	90	107	197	3011	19
16	165.2	4.8	168.0	152.0	21.1	445.5	1.2	-1.0	85	110	195	3138	19
16:40	166.5	5.2	171.0	183.0	22.5	507.3	1.4	-1.1	88	107	195	3183	19
17	166.4	5.2	171.0	183.0	22.8	519.4	1.1	-1.2	84	108	192	3161	19
18	154.0	5.5	161.0	149.0	23.9	571.6	0.2	-0.7	90	98	188	2926	19
19	160.5	5.1	165.0	177.0	22.3	495.4	0.7	-0.9	87	105	192	3049	19
19:40	164.2	4.9	169.0	174.0	21.2	448.1	1.0	-0.9	85	110	195	3119	19
20	162.8	5.0	167.0	167.0	21.7	472.8	1.2	-1.1	86	107	195	3093	19
MINUTE	aMEAN	STD ERROR	MEDIAN	MODE	STD DEV	VARIANCE	KURTOSIS	SKWENESS	RANGE	MIN	MAX	SUM	COUNT
AVG	150.2	4.8	150.1	#N/A	21.1	447.1	0.4	-0.4	85.6	102.4	188.0	2854.5	19.0

NOTE: The "COUNT" column verifies the number of subjects (19) used for data calculations per minute.
The "SUM" column totals data for all subjects per minute.

APPENDIX J. HEART RATE STATISTICS PER MINUTE FOR 10" STEP

MINUTE	aMEAN	STD ERROR	MEDIAN	MODE	STD DEV	VARIANCE	KURTOSIS	SKWENESS	RANGE	MIN	MAX	SUM	COUNT
1	137.8	4.0	135.0	#N/A	17.5	306.3	0.4	-0.2	75	97	172	2619	19
2	143.6	4.4	140.0	130.0	19.0	361.7	0.8	-0.3	84	97	181	2729	19
3	145.7	4.7	147.0	135.0	20.3	411.6	0.3	-0.5	85	98	183	2769	19
3:20	144.3	4.9	143.0	133.0	21.3	454.1	0.6	-0.4	92	93	185	2741	19
4	142.7	5.0	141.0	126.0	21.8	476.6	-0.4	-0.4	85	94	179	2711	19
5	152.1	4.8	153.0	169.0	20.8	431.8	0.8	-0.8	88	99	185	2889	19
6	156.4	4.9	159.0	172.0	21.8	464.7	1.2	-0.9	90	100	190	2971	19
7	157.1	5.1	160.0	169.0	22.3	498.8	0.3	-0.7	89	103	192	2985	19
7:40	158.6	5.2	162.0	#N/A	22.7	517.2	1.1	-1.0	83	99	192	3014	19
8	157.6	5.1	160.0	140.0	22.4	501.1	0.6	-0.9	90	102	192	2995	19
9	151.8	4.7	157.0	165.0	20.3	413.3	0.4	-0.7	81	102	183	2885	19
9:40	158.4	4.2	159.0	171.0	18.2	329.8	1.6	-0.9	78	109	185	3009	19
10	158.3	4.6	159.0	150.0	19.9	397.4	0.8	-0.8	78	107	185	3007	19
11	152.0	4.8	158.0	167.0	20.9	434.9	0.1	-0.6	83	102	185	2888	19
12	169.2	4.4	174.0	161.0	19.3	374.1	1.5	-1.1	76	116	192	3196	19
13	171.3	4.4	177.0	157.0	19.1	363.2	2.0	-1.2	81	119	200	3254	19
13:20	172.9	4.7	180.0	188.0	20.5	420.7	2.2	-1.3	83	115	198	3288	19
14	171.4	4.5	175.0	184.0	19.4	377.9	2.7	-1.4	82	115	197	3256	19
15	166.5	4.8	174.0	181.0	20.8	432.5	2.1	-1.3	84	108	192	3163	19
16	173.8	4.8	183.0	183.0	20.9	437.7	3.8	-1.7	87	110	197	3303	19
16:40	174.7	4.9	183.0	188.0	21.1	447.0	3.4	-1.7	89	111	200	3310	19
17	178.4	5.2	179.0	174.0	22.5	505.8	1.9	-1.4	88	112	200	3295	19
18	164.4	5.2	172.0	188.0	22.8	519.4	1.4	-1.2	85	103	188	3124	19
19	168.2	4.8	177.0	177.0	20.9	435.0	2.9	-1.5	85	107	192	3196	19
19:40	172.0	4.8	177.0	195.0	20.9	438.2	1.6	-1.1	82	115	197	3288	19
20	169.9	4.9	174.0	188.0	21.2	447.4	2.6	-1.4	86	109	195	3229	19
MINUTE	aMEAN	STD ERROR	MEDIAN	MODE	STD DEV	VARIANCE	KURTOSIS	SKWENESS	RANGE	MIN	MAX	SUM	COUNT
AVG	160.1	4.8	163.8	#N/A	20.7	430.6	1.4	-1.0	84.4	105.5	189.9	3042.3	19.0

NOTE: The "COUNT" column verifies the number of subjects (19) used for data calculations per minute.
The "SUM" column totals data for all subjects per minute.

APPENDIX K. HEART RATE RAW DATA FOR 8" STEP

MINUTE	SUBJECTS vs HEART RATES																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
8" STEP	124	145	119	128	118	117	125	117	139	96	139	147	118	136	150	125	171	121	142
1	134	150	117	133	119	113	125	121	146	94	149	147	122	149	153	128	177	126	149
2	131	151	121	127	117	115	130	123	149	94	156	153	121	147	152	124	174	125	153
3	131	155	116	121	113	113	123	123	143	96	155	150	120	146	152	115	174	125	153
5:20	132	152	115	122	116	109	125	116	142	89	150	147	106	143	153	122	172	122	153
4	140	164	133	129	119	106	136	130	153	97	153	150	115	148	160	130	178	134	158
5	153	165	135	141	122	124	141	135	160	99	169	156	122	155	169	136	188	139	163
6	151	168	132	138	125	123	128	133	155	97	167	158	123	156	160	139	188	139	161
7	140	165	131	134	122	120	124	134	163	98	171	155	124	156	163	135	183	144	160
7:40	146	170	134	134	121	121	141	135	161	97	169	155	124	156	167	135	192	142	163
8	139	160	117	125	125	115	138	126	160	100	167	153	119	144	155	128	185	132	152
9	149	172	124	142	135	120	130	135	165	110	174	155	142	153	169	142	190	141	160
9:40	150	175	130	136	138	122	141	139	165	110	172	158	139	156	165	138	190	142	165
10	144	165	132	127	118	118	148	130	161	96	169	152	115	146	156	136	185	135	160
11	162	175	144	145	141	131	165	152	171	107	181	167	147	161	177	156	195	136	174
12	167	179	146	154	144	134	172	161	177	116	190	174	153	169	179	163	197	167	181
13	171	177	146	154	144	132	171	161	179	113	185	177	155	167	181	165	197	170	181
13:20	163	177	140	155	142	130	168	163	179	110	180	174	147	167	177	161	197	164	183
14	164	175	144	141	136	125	165	150	177	107	188	172	143	161	174	152	197	163	177
15	175	181	152	156	139	134	168	161	183	110	192	177	152	167	179	165	195	173	179
16	171	185	160	161	134	132	157	163	183	107	185	179	155	171	183	167	195	180	183
16:40	170	183	150	167	132	130	171	163	181	108	182	179	153	171	181	167	192	188	183
17	164	173	140	133	129	115	153	149	171	98	188	172	138	161	167	149	188	167	171
18	177	177	144	150	142	124	168	154	177	105	188	172	142	165	177	153	192	165	177
19	174	182	151	154	144	131	170	164	183	110	180	174	149	169	179	163	195	187	181
19:40	171	180	148	173	142	125	167	155	180	107	188	172	147	167	174	156	195	187	179
20	196	193	175	184	188	181	182	190	205	169	203	190	177	192	190	203	179	197	197
maxHR	118	116	105	110	113	109	109	114	123	101	122	114	106	115	114	114	122	107	118
(50% maxHR)	176.4	173.7	157.5	165.6	169.2	162.9	163.8	171	184.5	152.1	182.7	171	159.3	172.8	171	171	182.7	161.1	177.3
(90% maxHR)	196	192	187	197	187	193	188	195	190	181	193	183	191	190	181	198	187	184	195
exerciseHR	176	173	168	177	168	174	169	176	171	163	174	165	172	171	163	178	168	166	176
220 - AGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
90%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SUBJECT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
#HR values >90% maxHR at 10"	12	13	10	0	0	0	12	3	12	0	12	16	6	14	12	6	21	12	11
#HR values >90% maxHR at 8"	1	12	1	2	0	0	10	0	0	0	11	11	0	0	11	0	20	11	11
Total	53	25	11	2	0	0	22	3	12	0	23	27	8	14	23	6	41	23	22

APPENDIX L. HEART RATE RAW DATA FOR 10" STEP

MINUTE	SUBJECTS vs HEART RATES																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
10" STEP																			
1	135	147	128	125	119	123	129	132	150	97	152	155	133	156	158	140	172	124	144
2	140	159	125	130	132	130	136	132	163	97	158	161	135	161	160	144	181	135	150
3	150	162	134	119	128	126	145	135	163	98	161	167	135	165	160	147	183	138	153
4	154	164	139	120	127	122	142	133	163	83	154	167	130	161	158	139	179	129	165
5	153	161	133	118	125	120	141	126	163	94	156	160	126	167	156	139	179	129	165
6	162	169	148	125	140	131	153	140	172	99	172	167	138	169	169	150	185	140	160
7	170	172	152	127	142	135	159	144	181	100	174	169	140	172	171	158	190	150	165
8	172	169	154	129	139	130	159	146	183	103	179	172	136	174	169	160	192	150	169
9	176	175	153	130	141	131	162	150	183	95	181	172	143	174	171	160	192	152	169
10	176	173	154	124	140	133	160	147	181	102	177	172	140	172	171	160	192	152	169
11	167	165	157	127	137	130	154	139	174	102	174	165	133	169	161	150	183	140	158
12	171	171	153	140	148	139	159	147	181	109	179	171	152	171	165	158	185	147	163
13	176	178	150	133	150	139	159	146	183	107	177	172	147	171	165	156	185	144	169
14	175	167	146	130	135	129	159	140	172	102	174	169	138	167	158	144	185	138	160
15	191	176	161	150	160	141	177	161	188	116	190	181	152	174	179	165	192	177	165
16	183	182	162	157	157	141	180	169	190	119	190	185	161	181	181	172	200	167	177
17	198	181	165	159	157	144	182	169	194	115	194	185	154	183	181	174	197	167	180
18	184	184	163	156	155	144	175	171	192	115	188	181	160	183	179	174	197	170	185
19	180	178	161	147	150	138	174	160	190	108	185	177	152	181	181	163	192	167	179
20	190	188	167	158	154	147	178	172	194	110	192	183	164	183	183	172	197	188	183
maxHR	191	184	164	159	154	147	188	174	194	111	193	183	164	185	183	174	200	188	188
exerciseHR	193	179	174	152	136	146	179	174	192	112	196	183	165	185	183	174	200	188	184
220 - AGE	181	174	157	136	142	135	169	160	188	103	188	172	152	179	177	160	188	188	175
90%	184	178	163	148	152	140	171	165	190	107	190	177	156	181	181	167	192	177	177
	195	183	162	155	157	144	177	168	192	115	195	179	161	185	185	171	197	172	183
	193	188	164	146	156	144	177	168	188	109	192	174	158	183	181	169	195	167	177
	196	193	175	184	188	181	182	190	205	169	203	190	177	192	190	203	179	197	
(60% maxHR)	118	116	105	110	113	109	109	114	123	101	122	114	106	115	114	122	107	118	
(90% maxHR)	176.4	173.7	157.5	165.6	169.2	162.9	163.8	171	184.5	152.1	182.7	171	159.3	172.8	171	171	182.7	161.1	177.3
	196	192	167	197	187	193	188	195	190	181	193	183	191	190	181	188	187	184	196
	176	173	168	177	168	174	169	176	171	163	174	165	172	171	163	178	168	166	176
SUBJECT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
#HR values >90% maxHR at 10"	12	13	10	0	0	0	12	3	12	0	12	16	6	14	12	6	21	12	11
#HR values >90% maxHR at 8"	1	12	1	0	0	0	10	0	0	0	11	11	0	0	11	0	20	11	11
Total	13	25	11	2	0	0	22	3	12	0	23	27	6	14	23	6	41	23	22

MEANS ($\pm$ SD)

BPM: 10" = 160.1 ($\pm$ 20.7)
RPE: 10" = 13.4 ($\pm$ 2.1)

BPM: 8" = 150.4 ($\pm$ 21.1)
RPE: 8" = 12.3 ($\pm$ 2.3)

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APPENDIX O. PRETEST WARM-UP VO2 DATA

SUBJECT MINUTE	1	2	3	4	5	6	7	8	9	10	
1	12.77	14.20	9.81	17.13	16.79	13.84	14.73	20.53	20.07	19.56	Can't Below
2	16.53	28.97	26.35	21.17	24.66	17.78	22.13	27.25	24.93	24.89	
3	17.15	27.30	26.72	22.45	23.32	20.76	22.80	25.77	24.63	22.62	
4	19.49	28.63	25.69	20.83	23.04	23.09	22.14	26.62	24.27	22.09	
5	22.39	27.95	28.57	22.52	23.08	25.84	21.76	25.53	24.31	22.60	
TOTAL	88.33	127.05	117.14	104.10	110.89	101.31	103.56	125.70	118.21	111.76	
AVERAGE	17.67	25.41	23.43	20.82	22.18	20.26	20.71	25.14	23.64	22.35	
SUBJECT MINUTE	11	12	13	14	15	16	17	18	19	AVERAGES	STDEV
1	20.82	15.91	20.23	19.58	24.60	19.23	16.51	15.23	18.17	17.35	3.49
2	24.00	24.76	24.10	24.81	25.91	22.32	25.49	21.52	25.80	23.86	3.05
3	22.32	26.41	23.88	25.06	28.55	10.04	24.09	25.62	24.47	23.37	4.12
4	23.45	26.57	23.86	25.56	26.45	13.95	25.79	26.48	31.45	24.18	3.73
5	24.24	26.64	24.79	23.46	26.66	14.02	25.94	24.79	24.90	24.21	3.11
TOTAL	114.83	120.29	116.86	118.47	132.17	79.56	117.82	113.64	124.79	112.97	
AVERAGE	22.97	24.06	23.37	23.69	26.43	15.91	23.56	22.73	24.96	22.59	

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