THE EFFECT OF HAND-HELD WEIGHTS AND EXAGGERATED ARM SWING ON HEART RATE, BLOOD PRESSURE, AND RATINGS OF PERCEIVED EXERTION DURING SUBMAXIMAL WALKING

DISSERTATION

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements For the Degree of

DOCTOR OF PHILOSOPHY

By

Karen Christine Austen, B.S., M.Ed.

Denton, Texas

December, 1994
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The purpose of this study was to investigate the effect of hand-weights and exaggerated arm swing on heart rate, blood pressure, and ratings of perceived exertion during submaximal walking. Twenty middle-aged (40-59 years) female volunteers were given four submaximal treadmill tests at 3.0 mph and 0 grade. The four treatment conditions were as follows: 1) walking with unexaggerated arm swing (AS); 2) walking with unexaggerated arm swing with hand-held weights (ASHW); 3) walking with exaggerated arm swing (EAS), and 4) walking with exaggerated arm swing with hand-held weights (EASHW). The testing sequence was randomized and a minimum of 48 hr was given between tests.

The data were treated statistically with a three-way analysis of variance with repeated measures for each of the four dependent variables. The alpha level was set at $p<0.0125$ to acknowledge the four separate analyses. Significant differences were found between AS and EAS ($F=12.89$, $p=0.002$) and ASHW and EASHW ($F=9.77$, $p=0.006$) regarding heart rate. The same treatment differences were found ($F=24.45$, $p=0.000$, $F=11.60$, $p=0.003$, respectively) for ratings of perceived exertion. RPE was also significantly different across time ($F=1.57$, $p=0.000$). No significant differences were found regarding either systolic or diastolic blood pressure.

Significant $F$ values were examined with the $t$-test and a manova command with a repeated measures analysis. A conclusion was drawn that the use of exaggerated arm swing with 0.45 kg hand weights is effective in increasing heart rate while fitness walking for middle-aged, sedentary women. The results also indicate that exaggerated arm swing
walking with hand weights (EASHW) is perceived to be more difficult than unexaggerated arm swing walking with weights (ASHW). Thus, the use of EASHW, generally, is not recommended for middle-aged sedentary women since it is easier to increase walking speed to increase training intensity. EASHW may, however, be recommended for persons who cannot or do not wish to increase walking speed.
ACKNOWLEDGMENTS

This dissertation is dedicated to my grandmother Aletha M. Kayaloff who has shown me, by example, the importance of learning throughout one's life.

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Cardiovascular disease is the number one killer of Americans (American Heart Association, 1990). American women, however, have not been thought of as a population at risk. According to internist and cardiovascular researcher Marianne Legato (1992), more than one third of all heart attacks in women go undiagnosed because the victim mistakes the symptoms for something else. Legato stated that most men and women think heart disease is a man's problem.

Contributing to the lack of concern for cardiovascular disease in women is the cardiovascular disease research. This research has been primarily focused on men (Legato, 1992). Perhaps one reason careful consideration has not been given to women is because signs of heart disease show up approximately 10 years later in women than in men. Women are protected through child-bearing years by estrogen (Legato, 1992). Upon reaching menopause, however, this advantage over men disappears and as Legato stated, heart disease is an equal-opportunity killer. According to the American Heart Association (1994), the National Center for Health Statistics has indicated that more women (479,359) than men (446,702) died of cardiovascular disease in the United States in 1991. National statistics have indicated also that more women than men have died from cardiovascular disease since 1984.

In recent years there has been growing national concern for women's health issues. Although it has not been documented, there has been recognition, for example, that women in non-traditional careers who have high levels of stress are at greater risk than
they were in the past for cardiovascular disease. Cardiologist Pamela Douglas (1992) suggested that women, just as men, must make lifestyle adjustments to decrease their risk of cardiovascular disease.

One lifestyle adjustment that many women have made is participation in regular exercise, particularly fitness walking. For the 5th consecutive year, walking is the most popular cardiovascular exercise in America. Walking is popular, because it is effective in improving cardiovascular fitness. For example, walking may reduce obesity, hypertension, and raise high density lipoprotein (HDL) cholesterol. Walking is also popular, because it is more safe than high-intensity athletics and above all, it's fun (Hawkins & Weigle, 1992).

Likewise, novel forms of walking such as walking with hand-held weights have become popular. While the primary reason the general public has adopted hand-weighted walking appears to be to expend more energy (burn more calories) and/or increase muscle tone, researchers have found their use to have a sound physiological basis. Although the use of hand weights during walking has generated contradictory literature, support for the use of hand weights while walking is rooted in the cardiovascular literature that examines combined upper and lower body exercise. For example, researchers have found that the addition of upper body exercise to lower body exercise increases aerobic training intensity (Secher, Clausen, Klausen, Noer, and Trap-Jensen, 1977).

Similar to the cardiovascular-disease literature, hand-weight literature has focused primarily on males (approximately 83%) as in Bryant et al., 1993; Owens et al., 1989; and Soule and Goldman, 1969 and almost always younger populations (approximately 94%) as in Bryant et al., 1993; Morrow et al., 1992, and Owens et al., 1989. Some of this literature may, however, be predicated on the findings of Porcari, Kline, Hintermeister, Freedson, Ward, Gurry, Ross, McCarron, and Rippe (1987). Porcari et al. found that fast
walking was not an adequate aerobic stimulus for some populations most of whom were younger males. A few investigators have previously examined female subjects (Morrow et al., 1992; Makalous et al., 1988; Francis & Hoobler, 1986, and Maud et al., 1986), but these investigators have focused on women in young adulthood (25 to 39 years). The physiological effects of hand-weighted walking on middle-aged females (40-59 years) has not been investigated.

With the addition of Stanford's finding in 1988 that there is a general decrease in cardiovascular fitness during mid-life, it is apparent that there exists a need for hand-weighted walking research which specifically examines the middle aged, female population. It was the purpose of this study, therefore, to investigate the physiological effect of hand-held weights during fitness walking on middle-aged women.

Statement of the Problem

The problem of this study was to investigate the effect of hand weights and exaggerated arm swing on heart rate, blood pressure, and ratings of perceived exertion during submaximal walking.

Purpose of the Study

The purposes of this study were the following:
1. To determine the effect of unexaggerated arm swing on heart rate, blood pressure, and perceived exertion during submaximal walking.
2. To determine the effect of unexaggerated arm swing with hand weights on heart rate, blood pressure, and perceived exertion during submaximal walking.
3. To determine the effect of exaggerated arm swing on heart rate, blood pressure, and perceived exertion during submaximal walking.
4. To determine the effect of exaggerated arm swing with hand weights on heart rate, blood pressure, and perceived exertion during submaximal walking.

5. To determine the effect of time and each of the treatments (1–4 previously mentioned) on heart rate, blood pressure, and perceived exertion.

Hypotheses

The following hypotheses were tested:

A. There were no significant differences among treatments a) unexaggerated arm swing, b) unexaggerated arm swing with hand weights; c) exaggerated arm swing, and d) exaggerated arm swing with hand weights over time with respect to heart rate.

B. There were no significant differences among treatments a) unexaggerated arm swing; b) unexaggerated arm swing with hand weights: c) exaggerated arm swing, and d) exaggerated arm swing with hand weights over time with respect to blood pressure.

C. There were no significant differences among treatments a) unexaggerated arm swing; b) unexaggerated arm swing with hand weights; c) exaggerated arm swing, and d) exaggerated arm swing with hand weights over time with respect to ratings of perceived exertion.

D. There were no significant differences for heart rate, blood pressure, or ratings of perceived exertion over time.
Definition of Terms

The following terms will be used throughout this investigation:

- **Blood pressure (BP)**—refers to both systolic blood pressure and diastolic blood pressure.
- **Diastolic blood pressure (DBP)**—the lowest pressure at the end of diastole which is the relaxation phase of the cardiac cycle (Little, 1985).
- **Exaggerated arm-swing walking (EAS)**—a pumping action of the arms while walking beginning with the arms fully extended (180 degrees) up to full flexion (45 degrees). Each arm swings opposite the striding leg and the shoulders do not move (Schwartz, 1990).
- **Hand weights (HW)**—0.45 kg hand-held weights manufactured by SLM Inc.
- **Perceived exertion (RPE)**—a subjective rating of physical effort on a traditional scale developed by Borg.
- **Submaximal**—an exercise intensity less than 70% of the predicted maximum heart rate or less than 60% maximal oxygen consumption (Guideline for Exercise Testing and Prescription, 1991). Age-predicted maximum heart rate and maximum oxygen consumption are measures of functional capacity.
- **Systolic blood pressure (SBP)**—refers to the highest pressure at the peak of the pulse wave which is during ventricular contraction (Little, 1985).
- **Unexaggerated arm swing walking (AS)**—a pumping action of the arms while walking beginning with the arms fully extended (180 degrees) up to 90 degrees. Each arm swings opposite the striding leg and the shoulders do not move (Schwartz, 1990).

Statistical Tests

- **Analysis of variance (ANOVA)**—an inferential statistical procedure used to compare two or more groups in terms of mean scores. (A one-way ANOVA compares two or more groups on the basis of one independent variable.)
Multivariate analysis of variance (MANOVA)—an extension of the analysis of variance in which two or more independent variables and two or more dependent variables are examined (Thomas & Nelson, 1985).

Post hoc procedure—a multiple comparisons procedure used to determine which group means are significantly different from the other group means. Examples of post hoc tests include Newman-Keuls, Tukey's HSD, and Scheffe's test.

Repeated measures design—an inferential statistical procedure used to make a generalization about a population when the same subjects provide data for more than one dependent variable, or are measured across all levels of an independent variable.

Sphericity—the characteristic of a matrix whose diagonal elements are equal and off-diagonal elements are zero; satisfies the circularity assumption underlying the repeated measures analysis (Kirk, 1982).

T-test for dependent samples—a statistical procedure used most often to compare two group means which are related, or correlated. This test is also referred to as a t-test for matched pairs (Hinkle, Wiershma, & Jurs, 1994).

List of Abbreviations

ACSM—American College of Sports Medicine.

BP—blood pressure.

bpm—beats per minute.

ECG—electrocardiogram; a device that detects and records the electrical currents of the heart.

F—an important distribution to inferential statistics named for R.A. Fisher.

GXT—graded exercise test; test during which the exercise intensity required is periodically increased typically using the standard Bruce protocol.
hr—hour.

kg—kilogram; 0.45 kg = 1 pound, 0.91 kg = 2 pounds, and 1 kg = 2.2046 pounds.

km—kilometer.

m—meter.

M—mean; mathematical average.

min—minute.

mL—milliliter.

s—seconds.

VO2max—maximum amount of oxygen one may take in, transport, and utilize.

Limitations of the Study

This study was subject to the following limitations:

1. The ability of the subjects to accurately reproduce the specified arm swing with each test.

2. The use of volunteer subjects.

Delimitations of the Study

This study was subject to the following delimitations:

1. The use of 0.45 kg hand weights for all subjects.

2. The use of a sedentary population.

3. The use of a female population between the ages of 40 and 59 years.
Assumptions About the Research Method

An analysis of variance with repeated measures has the following assumptions:
The sample was randomly selected from the population, randomly assigned to groups, or received all treatments in random order.
The dependent variable is normally distributed in the population.
The population variances for the test occasions are equal (homogeneity of variance).
(Hinkle, Wiersma, & Jurs, 1994)

This study had the following assumptions:
Subjects did not ingest any ergogenic aides that might influence test results.
Subjects did not ingest any medications or other substances that might influence test results.
Subjects remained sedentary and did not begin participation in any regular physical activity.

Organization of the Dissertation

This dissertation was organized in four additional chapters. Chapter two provides information regarding the existing literature which primarily addresses the effect of handheld weights while walking. Chapter three provides information regarding the research design and procedures for data collection. Chapter four provides a presentation of the findings of this study. Finally, chapter five provides a discussion of the findings, the conclusion drawn, and recommendations for further study.
CHAPTER 2

REVIEW OF RELATED LITERATURE

This study was conducted to determine the effect of arm swing and hand weights on heart rate, blood pressure, and perceived exertion during submaximal walking. Related literature reviewed in this chapter is classified under the following headings: (a) combined arm and leg exercise, (b) unexaggerated arm-swing walking with hand-held weights defined as walking with hand-weight movement from an extended-elbow position of 180 degrees up to and including 90 degrees elbow flexion, and (c) exaggerated arm-swing walking with hand-held weights defined as walking with hand-weight movement from an extended-elbow position of 180 degrees to a point beyond 90 degree elbow flexion. Unexaggerated arm-swing walking was identified as level I walking and exaggerated arm-swing walking was identified as walking levels II and III according to Schwartz (1990). In each section, the review of literature is presented in chronological order.

Combined Arm and Leg Exercise

In 1961, Astrand and Saltin investigated possible changes in maximal oxygen uptake and heart rate with various types of muscular work. These types of work included cycling in a sitting and supine position, arm and leg work on a bicycle, running on a treadmill at 7 mph, skiing, swimming, and arm cranking. Astrand and Saltin studied 7 subjects (6 males and 1 female) with a mean age of 31 years. Each of the subjects was well-trained, but not trained in any of the exercise modes used in this investigation.
The results indicated that oxygen consumption was slightly higher with uphill running than with cycling, cranking plus cycling, and skiing. Similar VO2 values were obtained for cycling, cranking plus cycling, and skiing. Heart rate was similar for cycling in a sitting position, simultaneous arm and leg work on a bicycle, running on a treadmill, and skiing. The metabolic cost (oxygen consumption) of supine cycling was approximately 15% lower than sitting cycling. The finding for swimming versus sitting cycling was similar. Maximal work with the arms was about 70% of the maximal oxygen consumption when cycling. From these results, Astrand and Saltin concluded that maximal oxygen consumption and heart rate are the same in maximal running or cycling in well-trained subjects. Astrand and Saltin did not find an increase in oxygen consumption with arm plus leg exercise as reported earlier by Astrand (1952).

Bergh, Kanstrup, and Ekblom (1976) investigated maximal oxygen uptake during exercise with various combinations of arm and leg work. Oxygen consumption was determined for 10 well-trained, male subjects with a mean age of 24 years. Work performed included uphill running, cycling, arm cranking, and combined arm cranking and cycling (A+L). The A+L work was performed four different ways including the arms doing 10%, 20%, 30%, or 40% of the same total work load. The leg work was performed also with submaximal and maximal arm work.

The statistical analysis reported was the student's t-test used to detect significant differences. The findings were as follows: a) oxygen consumption was the same during running as it was during all combinations of A+L exercise except with the arms at 10% and 40% of the total load; b) oxygen consumption for maximal running was greater than for maximal cycling, and that maximal arm work produces lower oxygen consumption.
than running, or cycling, and c) time to exhaustion is slower with arm and leg exercise than leg-cycling exercise alone.

Bergh et al. concluded that the differences in maximal oxygen consumption are, to some degree, dependent on the working muscle mass, and that A+L work is influenced by the ratio of the arm work to the total work load as well as the subjects level of fitness in arm work and cycling.

Secher, Clausen, Klausen, Noer, and Trap-Jensen (1977) stated that oxygen consumption during leg exercise is only slightly increased by the addition of arm exercise. To determine if exercise with one muscle group influences oxygen consumption in another active muscle group, these investigators studied the central and regional circulatory effects of adding arm cranking to leg work. Secher et al. investigated 7 subjects with a mean age of 23 years. All subjects were trained males who performed 2, 20-min bouts of cycling within 1 hr. The first 10 min of each bout consisted of arm exercise which was 38% to 62% of maximal oxygen consumption and leg work of 58% to 78% maximal oxygen consumption. During the last 10 min of exercise, subjects complete combined arm and leg work at 71% to 83% of their maximal oxygen consumption. The dependent variables measured included oxygen consumption, heart rate, blood pressure, cardiac output, blood flow, and lactate levels.

The statistical analysis used included the paired t-test. The results indicated that heart rate and lactate levels were significantly higher with combined arm and leg exercise than with either type of exercise alone. The results indicated also that arm exercise greater than 40% of the total exercise in addition to leg work caused a reduction in blood flow and oxygen consumption in the exercising legs without changes in blood pressure. Leg work in addition to arm work caused a decrease in blood pressure. The investigators suggested
that the oxygen supply to one large group of working muscle may be limited by vasoconstriction (constriction of blood vessels), or by a fall in blood pressure when another large muscle group is working simultaneously. Thus, oxygen consumption is only slightly increased (rather than the algebraic sum of the oxygen consumption during arm work plus the oxygen consumption during leg work) with the addition of arm to leg work.

More recently, Toner, Glickman, and McArdle (1990) studied cardiovascular adjustments to exercise distributed between the upper and lower body. Toner et al. studied circulatory differences between upper and lower body exercise in which the total amount of work was distributed between the upper and lower body. Six community college males with a mean age of years completed five combinations of cycling and arm cranking at one maximal and three submaximal intensities (levels 1 through 3). The ratio of arm power output to total power output was 0, 25, 50, 75, and 100%.

The dependent variables cardiac output, stroke volume, oxygen consumption, heart rate, and blood pressure were measured during the last 2 min of the 7 min work period.

A factorial analysis followed by a test for multiple comparisons was used to determine the significance. The results indicated that at each submaximal intensity the oxygen consumption, cardiac output, and heart rate were not different across exercise combinations. Heart rate during the ratio of 100% of the total work (arm-only exercise) was higher than 0% of the total work (leg-only exercise) at all submaximal work intensities (levels 1 through 3). At exercise levels 2 and 3, stroke volume at 50, 75, and 100% were lower than at 0%. The investigators concluded that involving the leg musculature to varying degrees during arm-leg exercise attenuates the hemodynamic differences observed during strict upper body versus strict lower body exercise (p. 773).
Thus, for individuals requiring the use of the upper body in exercise, rehabilitation, or in an occupation, the addition of the lower body to exercise may reduce the stress on the cardiovascular system observed during strict upper-body exercise.

Early investigators examined the cardiovascular responses to various forms of exercise combining the upper and lower body. In 1952, Astrand found a 10% increase in maximal oxygen consumption when comparing skiing to cycling. In 1961, Astrand and Saltin did not find increases in maximal oxygen consumption when comparing arm exercise to arm plus maximal leg exercise; however, Astrand and Saltin did find differences in oxygen consumption for different types of upper and lower body work. With further findings of differences in oxygen consumption (such as Gleser, Horstman, & Mello, 1974), investigators have attempted to determine why oxygen consumption is not simply the algebraic sum of leg work oxygen consumption plus arm work oxygen consumption. Suggestions for this finding included the influence of the ratio of the arm work employed to the total work employed, the degree of active muscle mass involved, vasoconstriction, and a fall in blood pressure. More recently, cardiovascular responses or adjustments (such as heart rate and blood pressure changes) to arm exercise alone have been examined. As suggested by this literature, combined arm and leg exercise may reduce the circulatory stress imposed by arm exercise alone. These cardiovascular dynamics are especially significant since upper-body exercise is a common activity for many individuals. (Some of these individuals include persons using the wheelchair for locomotion and persons engaged in arm-cranking exercise for rehabilitation following a myocardial infarction.)
Unexaggerated Arm-Swing Walking with Hand-Held Weights (ASHW)

With the exception of some unpublished investigations during World War II, Soule and Goldman (1969) were the first to investigate the energy cost of loads carried on the head, hands, and feet. Subjects included 10 healthy untrained volunteers who were tested at the United States Army Research Institute of Environmental Medicine in Natick, Massachusetts. All subjects were males between 20 and 23 years old. Each subject walked for 20 min on a treadmill at 4.0, 4.8, or 5.6 km/hr carrying 1) no load, 2) 4-kg gloves, 3) 7-kg gloves, 4) 6 kg on each foot, or 5) 14 kg on the head. All subjects dressed in fatigues and combat boots as investigators attempted to determine the energy cost of the maximum load. Energy costs were calculated in milliliters of oxygen consumed per minute. Resting levels of oxygen consumption and maximum oxygen consumption were determined for each subject. The statistical design was not mentioned.

Soule and Goldman (1969) found a mean total increase in energy cost with increases in speed for each of the loads. Weight carried on the head and hands did not produce great increases in energy cost. Weight carried on the head was 1.2 times the energy cost of the no load condition at all speeds, and weight carried in the hands was generally 1.9 times the cost of the no load condition. There was, however, a dramatic increase in energy cost for loads carried on the feet. The energy cost of the load carried on the feet was 4.2 times that of the no load at 4.0 km/hr, 5.8 times the cost of the no load at 4.8 km/hr, and 6.3 time the cost of the no load at 5.6 km/hr. Thus, investigators found the "penalty" for carrying loads on the feet to be "extreme."
Almost 20 years later (1986), Francis and Hoobler examined changes in oxygen consumption associated with treadmill walking and running with light hand weights. Investigators studied 5 male and 5 female volunteers between 21 and 41 years (with a mean of 27 years).

Subjects walked and ran for 6 min on a treadmill at 4.8, 5.6, and 8 km/hr carrying 1) no load, 2) 0.91 kg in each hand, and 3) 1.81 kg in each hand. The small dumbbells were swung 40 to 50 degrees and 30 to 40 degrees, respectively. While running, weights were carried perpendicularly to subjects' sides in a bent-elbow position with an arc of 25 to 35 degrees. Oxygen consumption was determined. The effect of walking and running speed and load conditions was statistically examined using a two-way analysis of variance with repeated measures. Significant main effects and interactions were examined with a Tukey test for multiple comparisons.

Francis and Hoobler (1986) found no significant difference in oxygen consumption with either load (0.91 kg or 1.81 kg) while walking. While running, significant, but small increases in oxygen consumption (1.8 ml/kg/min at 0.91 kg and 2.7 ml/kg/min at 1.81 kg) were found.

Investigators concluded that although exercising with light hand weights has become popular, the aerobic benefit may be marginal at best. In addition, the slight increase in oxygen consumption while running may be inconsequential since using weights may increase stress on the extremities. The investigators suggested that it may be simpler to increase aerobic gains by increasing either intensity or mileage.

In 1988, Makalous, Arujo, and Thomas followed Soule and Goldman in an investigation of energy expenditure during walking with hand weights. Makalous et al.,
however, studied 11 obese adults (three men and eight women). Subjects ranged in age from 27 to 43 (mean age of 34 years) and were otherwise healthy.

Subjects performed three, 30 min walking tests at 3.4 mph which included 1) normal walking; 2) walking with increased arm movement, and 3) walking with increased arm movement while holding 0.45 kg hand weights in each hand. Increased arm swing was defined as moving hand weights from an extended position at the side up to waist level with 90 degree elbow flexion.

Metabolic measurements were made. Heart rate was also continuously measured. Total energy expenditure and substrate utilized were calculated from oxygen consumption and respiratory exchange ratio. An analysis of variance with repeated measures was used to determine the effect of the three exercise conditions. A Newman-Keuls procedure was used for post hoc comparisons.

Investigators found that increased arm-swing walking with hand weights resulted in increased heart rate (127 bpm versus 120 bpm), increased oxygen consumption (1.168 L/min versus 1.086 L/min), and greater energy expenditure (171.5 kcal versus 159.7 kcal) when compared to normal walking. Increased arm-swing walking without weights produced no significant increases over normal walking. Makalous et al. concluded that hand-weight use increases the energy demand of walking in obese persons, but only to a small degree.

In 1989, Owens, Al-ahmed, and Moffatt examined the physiological changes that occurred during walking and running with hand-held weights. The dependent variables of oxygen consumption, heart rate, respiratory exchange ratio, and perceived exertion were measured for 10 male volunteers who had a mean age of 26 years.
Subjects completed four submaximal treadmill tests scheduled on four separate occasions. Subjects carried no weight and weights of 0.45, 1.36, and 2.27 kg in each hand while walking, or running for 5 min at 4.8, 6.4, 8.0, and 9.6 km/hr and 4% grade. Subjects used normal arm-swing patterns. Steady state oxygen consumption (VO2) and respiratory exchange ratio were determined. Heart rate was recorded with an ECG. A four-way analysis of variance with repeated measures was used to test for main-effect differences of speed and load conditions. Differences between treatment means were determined using the Fisher least significant differences procedure.

Owens et al., found that hand-weight use did not significantly increase VO2 at either walking speed (4.8 or 6.4 km/hr), but they did find increases in VO2 during both running speeds (8.0 and 9.6 km/hr) with VO2 the highest while subjects carried a 2.27 kg hand weight in each hand. Results indicated that walking with hand-held weights of 2.27 kg or less with increased (or unexaggerated) arm swing is insufficient for significant increases in VO2, or heart rate. Running with hand-held weights of at least 2.27 kg (with 2.27 kg being perhaps the weight threshold) can increase VO2.

Abadie (1990) compared the effects of walking with wrist weights and hand weights to determine if wrist weights yielded the same benefit as hand weights without the exaggerated blood pressure response Graves, Pollock, Montain, Jackson, and O'Keefe (1987) found with the use of hand weights. Abadie tested 19 untrained volunteers (11 males and 8 females) between 20 and 35 (mean of approximately 28) years old. Following a practice session, subjects completed three submaximal exercise tests which were separated by 48 hr. Each test was 6 min long at 3 mph and an 8% grade. One of three conditions (no weights, hand weights, or wrist weights) was employed for each test. Subjects were instructed to lift the weights from an extended elbow position of
180 degrees to a 90 degree angle at the shoulder (arms parallel to the treadmill belt). Abadie measured heart rate, systolic and diastolic blood pressures, oxygen pulse, and absolute and relative oxygen consumption. A multivariate analysis of variance with repeated measures was used to determine significant differences among dependent variables. A univariate test by analysis of variance was used to determine which dependent variables were significant. A Tukey test was used to determine which mean differences were significant.

Heart rate was found to be significantly greater during the hand-weight (HW) condition than the wrist weight (WW) or no-weight (NW) conditions. Heart rate was greater for the WW than the NW condition. Systolic blood pressure was significantly greater for the HW versus the WW or NW conditions. (Differences did not exist in systolic blood pressure between the WW and NW conditions.) Diastolic blood pressure was significantly greater for the HW versus the WW or NW conditions and did not differ between the WW and NW conditions. Finally, oxygen consumption was significantly greater with both the use of hand weights and wrist weights versus the use of no weights.

From these results, Abadie concluded that 2.72 kg hand weights and 2.72 kg wrist weights are effective in increasing the energy cost of walking. Furthermore, Abadie noted the use of wrist weights may serve as a viable alternative to the use of hand weights, which can produce an exaggerated diastolic blood pressure response during walking.

Recently (1992), Morrow, Bishop, and Ketter studied energy expenditure during self-paced walking with hand weights. Subjects included 18 physically active female volunteers with a mean age of 22 years. Subjects walked at their own pace (a pace they could maintain for 20 min while holding weights) for 3 min with a 0, 0.5, or 1.4 kg load. Arm swing level was approximately 0.3 meters which according to Morrow et al., was
consistent with general public use" (p. 436). The physiological variables measured included oxygen consumption, heart rate, and perceived exertion. Heart rate, oxygen consumption, and perceived exertion were measured. Walking speed was also measured.

An analysis of variance for repeated measures was used for data analysis and the Tukey multiple comparisons test was used to contrast means. Investigators found that each of the three weight levels produced significant differences in walking speed, and heart rate. Significant differences were found in perceived exertion only between the 0.5 and 1.4 kg, hand-weight levels. No significant differences were found for oxygen consumption at any of the hand weight levels.

A conclusion was drawn that walkers who expect to increase caloric expenditure, or increase exercise intensity by adding weights may not be successful unless strict attention is paid to both walking speed and arm swing. Furthermore, walking with hand-held weights of 1.4 kg, or more may be contraindicated for persons who must limit heart rate due to ischemic, or heart rate controlling, medications.

In summary of the ASHW literature, the early investigation by Soule and Goldman (1969), which was designed to determine the most efficient means of carrying weight, inadvertently prompted further investigations of weighted walking. In this day of exercise and physical fitness; however, the mode of exercise which expends the most energy rather than conserves energy is the most desirable. As Soule and Goldman found distinct differences between the energy cost of weight carried on the feet versus weight carried in the hands, investigators further examined weight carried in the hands (Francis & Hoobler, 1986, and Borysyk et al., 1986). Subsequent investigators, during the next 2 decades examined hand-weighted exercise under variable conditions. These conditions such as weighted walking with an arm swing (Abadie, 1990 and Makalous et al., 1988),
weighted walking at variable treadmill speeds and grades (Abadie, 1990), and weighted
walking with different loads (Owens, 1989) were theoretically intended to produce
alternative forms of walking that would elicit an exercise intensity greater than that of
natural walking. From these studies, investigators generally agree that slight increases
(beyond natural walking) in exercise intensity can be produced with alternative forms of
weighted walking, but that it is probably easier to increase exercise intensity by walking
faster or for a longer distance.

**Exaggerated Arm-Swing Walking with Hand-Held Weights (EASHW)**

Zarandona, Nelson, Conlee, and Fisher (1986) studied the effect of hand-carried
weights on heart rate, blood pressure, and oxygen consumption. Their underlying purpose
was to determine if carrying hand weights increased the metabolic cost of exercise, or if it
elicited a pressor reflex (heart rate and blood pressure rise disproportionately to oxygen
consumption). Subjects included 30 trained, male runners and joggers with a mean age of
29 (range of 16 to 51) years. Subjects were recruits from the local running club and the
local University (Brigham Young University).

Each subject performed two separate tests—walking at 3.5 mph and running at 7 mph
during each of the three treatment conditions of no weights, 0.45 kg weights, and 2.27 kg
weights. Arm swing with weights was described as exaggerated. Subjects were tested for
4 min. During the fourth minute, heart rate, blood pressure, and oxygen consumption
were recorded. Analysis of variance was the statistical test used to test for changes
among the three treatments. A Newman Keuls test was used to examine differences
between means.
Zarandona et al., (1986) found a significant increase in oxygen consumption while walking and running with the 2.27 kg weights over both the no load and 0.45 kg load conditions. Only walking with 2.27 kg weights, however, produced increases in heart rate. Oxygen pulse (the amount of oxygen used per heart beat) did not differ for any of the treatment conditions. Significant increases in systolic blood pressure were found for the 2.27 kg weight condition versus the no weight condition. (Only 14 subjects produced blood pressure scores as treadmill and arm movement noises prevented accurate measurement. Investigators could not report any BP scores for the running test.) Investigators also found that BP and heart rate rose proportionately to oxygen consumption and that perceived exertion rises as well. Thus, Zarandona et al., determined that hand weights do not produce increased stress on the circulatory system without increases in aerobic conditioning. Investigators suggest that carrying hand weights can increase the training intensity for walkers or joggers who cannot, or do not, wish to exercise at a higher speed.

Maud, Stokes, and Stokes (1986) examined the effects of "normal" and vigorous arm swing with and without 1.36 kg hand weights while walking at 4 mph. Researchers tested 20 subjects (ten men and ten women) with a mean age of 27 years. The four tests included normal walking (NU), NU with 1.36 kg weights, walking with a vigorous arm swing (VU), and VU with 1.36-kg weights. The sequence was randomized. Data was collected for the dependent variables of heart rate (HR), oxygen consumption (VO2), stride frequency (SF), and Borg's perceived exertion (RPE).

The statistical analysis included an analysis of variance and Duncan's new multiple range test. Significant increases (p<0.05) were reported for HR, VO2, and RPE.
SF significantly decreased when comparing NU, NU with weights, and VU and VU with weights. Also NU was significantly different than VU in terms of VO2. Significant differences were found for VO2 regarding gender for all four conditions. Maud et al. noted that when weight carried was relative to body weight, no differences existed. Women perceived the work load to be greater during VU with weights, but not under the other three conditions. Maud et al. concluded that to increase significantly the energy cost of carrying 1.36 kg hand weights, the arms must be vigorously swung.

Graves, Pollock, Montain, Jackson, and O’Keefe (1987) studied the effects of hand weights in walking, using 12 subjects (healthy, male volunteers) ranging in age from 25-38 with a mean age of 31 years. These subjects had not participated in a regular exercise program for at least 1 year.

Subjects completed three submaximal tests (submaximal test at 60% and 75% maximal heart rate, a submaximal test with a workload which previously produced 75% max heart rate-75WL adjusted) and two maximal graded exercise tests (GXT). The submaximal tests were performed for 8 min each with no load, 0.45 kg hand weights, and 1.36 kg hand weights. Average speed and grade for the submax 60 and 70 tests were approximately 3.7 mph and 8% grade and 3.7 mph and 11% grade, respectively. Submax 75WL adjusted was performed with no load and 1.36 kg hand weights and the treadmill grade was adjusted for subjects to maintain 75% maximal heart rate reserve. During the last 2 days of testing, subjects completed a maximal GXT at 4 mph and 4% grade elevated 4% every 3 min until exhaustion. One GXT was performed with hand weights and one was performed without hand weights. During all testing with hand weights, subjects were instructed to swing the hand weights to shoulder height with the elbow bent.
The dependent variables of heart rate, oxygen consumption, ventilation, blood pressure, respiratory exchange ratio, perceived exertion, and rate pressure product responses to hand weight use (during sub maximal and maximal exercise) were evaluated using an analysis of variance with repeated measures statistical design. The multiple comparisons test used to determine which means differed significantly was the Tukey test.

Graves et al. determined that systolic blood pressure and rate pressure product were significantly greater during exercise with hand weights. Physiological responses to maximal exercise with and without 1.36 kg weights were similar. Logically, time to exhaustion was reduced with hand weights. Investigators concluded that 1.36 kg hand weights can increase the metabolic cost of training and may be beneficial for individuals who must limit their walking speed, or individuals who do not wish to run. For persons with whom increasing afterload is a problem, however, the exaggerated blood pressure response during hand weight use may pose a serious problem.

Auble, Schwartz, and Robertson (1987) conducted a study in which walking with and without hand weights was compared. Subjects included 9 physically active men with a mean age of 28 years. Subjects performed a modified Astrand graded exercise test to determine maximum oxygen consumption, and maximum heart rate. (Subjects ran at 6 mph and 0% grade of 5 min. Speed was increased by 1 mph for 2 min and the treadmill was elevated 2% every 2 min that followed.)

Following diagnostic testing, subjects walked at a speed of 4 and 6 mph carrying weights of 0.45, 0.91, and 1.36 kg. As with the previous investigations, the six hand-weight tests were performed in random order. Leg stride and arm-pump (LSAP) frequency were controlled by an audible tone. Arm swing movement included movements of 0.61 m, 0.76 m, 0.91 m, and 1.07 m which was movement over one's head.
The physiological variables oxygen consumption, carbon dioxide production, expired ventilation, and respiratory quotient were measured. The effect of walking speed, pump height, and hand weights on the aerobic metabolic requirements of walking were statistically analyzed using 3 separate two-way analyses of variance with repeated measures. Pairwise comparisons were made using either simple main effects or Newman-Keuls multiple range test with an alpha level of $p < 0.05$.

Auble et al., (1987) found that adding hand weights significantly increases oxygen consumption by 2.1 mL/kg/min to 25.5 mL/kg/min beyond normal walking. (Oxygen consumption increased as the pump height, hand weight, and walking speed/LSAP frequency increased.) Auble et al., concluded that walking with exaggerated arm swing "...provides a combined upper and lower body aerobic stimulus that is sufficient for endurance training for persons with poor to excellent levels of aerobic fitness" (p. 133).

Another study was published in 1987 by Miller and Stamford who compared the energy cost and intensity between genders and weighted walking and running. Subjects included 7 moderately trained college students (4 men and 3 women). The mean age of male subjects was 23 ± 4.5 years and the average age of the female subjects was 25 years.

During testing sessions, subjects walked and ran at various speeds and walked with hand weights and ankle weights. (A separate, diagnostic testing session was used to determine maximal oxygen consumption.) The four tests were as follows: 1) walking at 2, 3, or 4 mph; 2) walking at 2, 3, or 4 mph with ankle weights, 3) walking at 2, 3, or 4 mph with hand weights, and 4) walking at 2, 3, or 4 mph with both hand weights and ankle weights. A fifth session required running at 5, 6, or 7 mph. The treadmill was not elevated. Hand weights weighing 2.25 kg each were carried with an exaggerated swing.
from the umbilicus to the sternoclavicular joint (with the elbow bent). Ankle weights of 2.25 kg were fastened around the malleolus.

Expired gas was collected and heart rate was measured continuously. Data pertinent to energy cost and oxygen consumption were statistically analyzed with a two-way analysis (by gender and treatment) of variance with repeated measures. Investigators found no differences between the sexes, and thus, combined the data for further analysis. A two-way analysis (by speed and load) of variance with repeated measures was applied to each physiological variable associated with walking. A one-way analysis of variance with repeated measures was also used to determine if any differences existed among treatments with each variable. A Newman-Keuls test was used to contrast means.

Miller and Stamford found no differences between genders in walking, weighted walking, or running (relative to body weight). Non-weighted walking at 4 mph had a significantly higher energy cost than walking at 2 or 3 mph. In contrast to walking, the caloric cost of running did not depend upon speed. Carrying hand weights increased the energy cost (by approximately 1 kcal/mile) in comparison to the energy cost of wearing ankle weights. The gross energy cost of weighted walking was comparable to the energy cost of running.

In 1988, Graves, Martin, Miltenberger, and Pollock investigated the effect of walking with hand weights, wrist weights, and ankle weights on hemodynamic responses and energy cost. Volunteers included 12 sedentary men between the ages of 18 and 23 years. Subjects completed a diagnostic treadmill test to determine the treadmill speed and grade that would elicit a 75% maximum heart rate reserve. To compare blood pressure responses with weights, subjects completed three treadmill tests at 75% maximum heart
rate reserve with hand weights, wrist weights, and ankle weights. (Subjects were
instructed to swing hand weights to shoulder height with the elbow bent and to maintain a
comfortable stride length when wearing the ankle weights.) To compare energy cost
responses to each of the weighted conditions, subjects first performed a diagnostic grade
adjusted test to elicit a heart rate response equal to 60% maximum heart rate reserve.
After the speed and grade (6.3, 1.4%) were determined, subjects completed exercise trials
with no load, hand weights, wrist weights, and ankle weights.

Oxygen consumption, minute ventilation, and respiratory exchange ratio, heart rate,
blood pressure, and perceived exertion were measured. Each of the physiological variable
responses to each of the weighted conditions (exercise with hand weights, wrist weights,
and ankle weights) was evaluated with an analysis of variance with repeated measures.
Similar to the previous walking investigation, an alpha level of 0.05 was required for
significance. The multiple comparisons procedure used was the Tukey test.

Graves et al., (1988) found no significant differences in systolic blood pressure with
any of the exercise conditions. A significant difference in diastolic blood pressure (+ 4.4
mmHg), however, was found for the hand weight versus no weight condition.
Furthermore, investigators determined that oxygen consumption and heart rate increased
in all treatment conditions when each was compared to the no load condition. Graves et
al. concluded that gripping hand weights may be responsible for slight increases in
diastolic pressure. Also, the use of 1.36 kg hand weights, or wrist weights increases the
energy cost of walking more than 1.36 kg ankle weights and increased energy expenditure
can occur with little change in perceived exertion.

Bryant, Goss, Robertson, Metz, and Feingold (1993) compared the physiological
responses of four protocols that employed different amounts of hand-weighted exercise.
Sixteen moderately trained males with a mean age of 26 years were recruited to complete each protocol.

The treadmill protocols were as follows: a) uphill running (UR) at 3.36 m/s and 2.5% grade increased every 3 min; b) uphill walking (UWHW) at 1.79 m/s, 5% grade increased every 3 min, and 1.36 kg hand weights; c) walking (WHW) at a constant 1.79 m/s and 0% grade with hand weights increased 0.91 kg every 3 min, and d) standing in place (SHW) while pumping hand weights similarly to WHW. During exercise with hand weights, subjects were instructed to pump hand weights from the mid thigh to the top of the ear.

Peak heart rate, oxygen consumption, ventilation and respiratory exchange ratio were statistically examined using a one-way analysis of variance with repeated measures. The multiple comparisons procedure used was the Tukey test with an alpha level set at \( p < 0.01 \) for determining significance.

Bryant et al., (1993) found that all dependent physiological variables, except peak respiratory exchange ratio, were greater in UR and UWHW than WHW or SHW. Peak respiratory exchange ratio was greater in UR and UWHW than in WHW. Peak oxygen consumption and peak heart rate were greater in WHW than in the SHW condition. Mean peak oxygen consumption was 97.5%, 69.5% and 60% of UR for the UWHW, WHW, and SHW conditions, respectively. Thus, Bryant et al., concluded that walking while pumping hand weights with an exaggerated arm swing allows the exerciser to maximally stress the oxygen transport system similarly as one would with uphill treadmill running.

In a summary of the EASHW literature, investigators generally found increases in heart rate and oxygen consumption. Thus, investigators suggest that such exercise
provides a sufficient stimulus for endurance training. It is important to note; however, that one study revealed no changes in oxygen consumption and two studies (including one ASHW study) found elevated blood pressure responses. These findings may contraindicate EASHW as a fitness modality. It is hoped that as more studies in the area of weighted walking are completed and replicated, more consistent findings will arise.

The literature regarding walking and hand-held weights was reviewed. This literature provided the basis for the research question addressed and research design developed in this study.
CHAPTER 3

RESEARCH DESIGN

This study was designed as a true-experimental investigation with multiple treatments to determine the effect of hand weights and exaggerated arm swing on heart rate, blood pressure, and perceived exertion during submaximal walking. This study included 20 women who volunteered to complete all four treatments. The treatments were assigned in random order to control for a learning effect.

Procedure for Data Collection

On the scheduled testing days, subjects reported to room T123B at Brookhaven College in Dallas, Texas. Physician clearance, medical history, and informed consent were obtained prior to all testing. Subjects were instructed not to ingest caffeine, tobacco, heavy meals, or participate in strenuous activity for at least 12 hr prior to testing (Graves et al., 1988). Also, subjects were instructed to retire at the usual time the night before testing. When possible, time of day for testing was kept constant to control for diurnal variations in heart rate and blood pressure. Descriptive data were obtained, which included age, height, weight, pre-exercise heart rate, and pre-exercise blood pressure. Each subject was given an orientation to treadmill walking on the same day as their first test (to avoid requiring a fifth visit).

Before each test, subjects were instructed to pump their arms alternately with each stride by bending the arm at the elbow. The specific instructions given (180 degrees extension to 90 degrees flexion or 180 degrees extension to 45 degrees flexion) depended
upon the arm-swing test to which the subject was randomly assigned. Subjects were instructed not to move their arms at the shoulders and to use a relaxed grip when using the 0.45 kg hand weights.

During the 5 min warm-up period of stretching and treadmill walking at 2 mph, subjects were read standardized instructions for giving ratings of perceived exertion. The instructions were given according to Koltyn, O'Connor, and Morgan (1991) for the traditional Borg rating scale.

Following familiarization with equipment and procedures, subjects were instructed that the criterion for submaximal test termination was 10 min (or volitional cessation if necessary). Subjects performed a continuous treadmill test with a constant treadmill speed of 3 mph which is a fitness-walking pace (Hawkins & Weigle, 1992) and a grade of 0 to simulate natural walking as much as possible. Heart rate was monitored digitally and recorded with ratings of perceived exertion during the last 30 s of every 2 min. Blood pressure was measured during the last 30 s of the 3rd and 9th min. (The arm cuff was removed following each blood pressure measurement to prevent interference with elbow flexion. Such interference occurred during the pilot study.)

Following submaximal testing, subjects were given 3-5 min of active recovery (2 mph, 0% grade) with continued heart rate monitoring and an additional 5-10 min rest period. Also, according to Guidelines for Exercise Testing and Prescription (1991), blood pressure was monitored during recovery at approximately 2-min intervals. The first testing session (which included the orientation) lasted approximately 1 hr and the three subsequent tests lasted 30-45 min.
Instrumentation

The following instrumentation was used for the collection of data:

1. A pacer heart rate monitor model number 145930 by Polar Electro Oy. was used to record heart rate at 2-min intervals.

2. A mercury sphygmomanometer and an inflatable arm cuff by American Diagnostic Corporation was used to ascertain all blood pressures by auscultation. Blood pressures were obtained in the standing position. The first and the onset of the fourth phase of Korotkoff sounds were recorded as the systolic and diastolic blood pressures. To obtain blood pressures during exercise with hand weights, subjects were instructed to drop their right arm to the side and continue their arm-swinging motion with the left arm.

3. A traditional Borg scale with ratings from 6 to 20 was used to obtain ratings of perceived exertion (RPE).

Population

Subjects included 20 female volunteers from the Dallas, Garland, and Irving communities. All women were non-smokers and free of major medical risk (in accordance with the American College of Sports Medicine guidelines) except for those risks associated with sedentary living such as obesity. Subjects had not participated in regular exercise during the past 12 months and agreed not to begin an exercise program until all testing was completed. Subjects were between the ages of 40 and 57 years. All subjects provided physician clearance (if 50 years or older), written informed consent (in accordance with the American College of Sports Medicine guidelines), and completed a physical activity readiness questionnaire (PAR-Q), and a medical history questionnaire prior to participating in the study.
Selection of Subjects

Subjects were volunteers from the cities of Dallas, Garland, and Irving, Texas. Subjects were recruited through verbal requests to friends, North Lake College students, members of the Dallas Business Woman's Association, the Dallas/Fort Worth woman's coffee house, electronic mail at the LeCroy Center for Educational Telecommunications, Dallas, and electronic mail at Brookhaven College, Dallas. Each subject was promised a personalized exercise prescription in exchange for her participation. (Also, subjects were given $20 at the end of their fourth test.) Following physician clearance, consent, and the completion of history questionnaires, subjects completed their four treatments with a minimum of 48 hr separating each test.

Analysis and Interpretation of the Data

The data were analyzed and interpreted as follows:

A Statistical Package for the Social Sciences (SPSS) computer program was written for the data analysis (Chang, Du, & Austen, 1994). Statistical differences among treatments for each dependent variable (i.e., heart rate, perceived exertion, systolic blood pressure, and diastolic blood pressure) were examined using a three-way analysis of variance with repeated measures (ANOVA RM). The ANOVA RM was used since the study included three independent variables (arm swing, hand weights, time) and the subjects, who constituted one group, received all four treatments (Hinkle, Wiersma, & Jurs, 1994). The study was determined to be a true-experimental design since the subjects received the treatments in random order. An alpha level of \( p < 0.0125 \) was established \( a \) priori to acknowledge that multiple dependent variables were analyzed (Thomas & Nelson, 1985). No significant \( F \) values were found for the interactions of the independent variables. Thus, the main effects (means across rows and columns) were examined.
Significant F values were explored using a) a t-test for each significant main effect with two levels and b) a multivariate analysis of variance command with a repeated measures analysis for the main effects with three or more levels of the independent variable. A separate descriptive analysis for the physical and physiological characteristics of the subjects was completed using *Statistics with Finesse* by Bolding, 1989.

Following the development of the research design, the data were collected and the findings were determined. These research findings are presented in the next chapter.
CHAPTER 4

PRESENTATION OF THE FINDINGS

It was the purpose of this study to determine the effect of hand-held weights and exaggerated arm swing on heart rate, blood pressure, and ratings of perceived exertion during submaximal walking. Time was also examined for its influence on the dependent variables. Volunteer subjects (N= 20) received all treatments. The four treatments, were given in random order. The treatments included treadmill walking at 3 mph with (a) unexaggerated arm swing without hand weights, (b) unexaggerated arm swing with 0.45 kg hand weights, (c) exaggerated arm swing without hand weights, and (d) exaggerated arm swing with 0.45 kg hand weights. Heart rate and perceived exertion were recorded during the last 30 s of every 2 min. Blood pressure was recorded during the first 30 s of the 3rd and 9th min. The duration of each test was 10 min. The results are presented in this chapter under the following headings: Descriptive Data for Subjects, and Inferential Analysis of Data.

Descriptive Data for Subjects

Twenty women between the ages of 40 and 57 years (M= 46.70 ± 5.27) volunteered from the Dallas, Garland, and Irving communities. All subjects were non-smokers and free of any major medical risk except those associated with sedentary living such as obesity. Subjects (N= 3) suspected to have hypertension (according to Guidelines for Exercise Testing and Prescription, 1991) were excluded from the study and referred to a physician. Subjects had not participated in regular exercise during the past year.
Regular exercise constituted three or more exercise sessions of 20-30 min each week. Subjects (N= 2) greater than 90.72 kg. were excluded from the study since the treadmill belt did not accurately function for persons at this weight. Subjects' descriptive data for weight, height, pre-exercise heart rate, pre-exercise systolic blood pressure, and pre-exercise diastolic blood pressure are presented in Table 1.

As shown in Table 1, the weight of the subjects ranged from 50.40 to 90.72 kg. (M= 70.19 ± 10.74). The height of the subjects ranged from 156.21 to 176.53 cm. (M= 166.18 ±5.67). Pre-exercise heart rates ranged from 62 to 116 bpm (M= 86.30 ± 11.50). Pre-exercise blood pressures ranged from 90 to 158 mmHg (M= 118.46 ± 14.85) for systolic and from 60 to 105 mmHg (M= 80.24 ± 7.03) for diastolic.

Table 1

**Physical and Physiological Characteristics of the Subjects (N= 20)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>46.70</td>
<td>±5.27</td>
<td>40 - 57</td>
</tr>
<tr>
<td>Weight (kg.)</td>
<td>70.19</td>
<td>±10.74</td>
<td>50.40 - 90.72</td>
</tr>
<tr>
<td>Height (cm.)</td>
<td>166.18</td>
<td>±5.67</td>
<td>156.21 - 176.53</td>
</tr>
<tr>
<td>Pre-exercise HR</td>
<td>86.30</td>
<td>±11.50</td>
<td>62 - 116</td>
</tr>
<tr>
<td>Pre-exercise SBP</td>
<td>118.46</td>
<td>±14.85</td>
<td>90 - 158</td>
</tr>
<tr>
<td>Pre-exercise DBP</td>
<td>80.24</td>
<td>±7.03</td>
<td>60 - 105</td>
</tr>
</tbody>
</table>

*Note. HR = heart rate in bpm, SBP= systolic blood pressure in mmHg, DBP= diastolic blood pressure in mmHg.*
Inferential Analysis of the Data

The three-way analysis of variance with repeated measures violated the assumption of sphericity, thus the multivariate analysis of variance (MANOVA) included in the SPSS program was examined for significant F values. (The MANOVA is robust to this assumption according to Hinkle et al, 1994). An alpha level of 0.0125 (.05 divided by 4) was used to protect the alpha level that may inflate with the (four) separate analyses of the dependent variables. The dependent t-test was used as a secondary analysis to further examine significant differences.

As depicted in Table 2, the data analysis for the dependent variable of heart rate yielded a significant F for the main effects A, which is arm swing (F= 12.89, p= 0.002), and B, which is hand weight (F= 9.77, p= 0.006), only. The main effect C, which is time, was not significant (F= 1.92, p= 0.116). No interaction among arm swing, hand weight, or time was found. Arm swing by hand weight was not significant (F= 0.93, p= 0.347); arm swing by time was not significant (F= 1.00, p= 0.413); hand weight by time was not significant (F= 1.52, p= 0.205), and the second order interaction arm swing by hand weight by time was not significant (F=0.39, p= 0.832).

Significant F values for the main effects of A and B were examined with the dependent t-test since there were only two levels of each variable and the levels were related. The means for each of the levels of variable A (A1 and A2) were 113.07 and 118.09, respectively. The means for each of the levels of variable B (B1 and B2) were 117.16 and 124.76, respectively. A secondary analysis using the dependent t-test indicated that the means for A2 (EAS) and B1 (ASHW) were not significantly different, and that EASHW was significantly different than AS, EAS, and ASHW regarding heart rate (Table 3).
Table 2

*F Values for the Interaction and Main Effects of Heart Rate*

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>U/ME</th>
<th>F Value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>12.89*</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>9.77*</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1.92</td>
<td>0.116</td>
<td></td>
</tr>
<tr>
<td>AxB</td>
<td>0.93</td>
<td>0.347</td>
<td></td>
</tr>
<tr>
<td>AxC</td>
<td>1.00</td>
<td>0.413</td>
<td></td>
</tr>
<tr>
<td>BxC</td>
<td>1.52</td>
<td>0.205</td>
<td></td>
</tr>
<tr>
<td>AxBxC</td>
<td>0.39</td>
<td>0.832</td>
<td></td>
</tr>
</tbody>
</table>

Note. A = Arm swing, B = Hand Weights, C = Time;
* = significant at p = 0.0125.
Table 3

Treatment Means (+SD) for Heart Rate

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Heart Rate (in bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unexaggerated Arm Swing (A1)</td>
<td>113.07 ±12.65 a</td>
</tr>
<tr>
<td>Exaggerated Arm Swing (A2)</td>
<td>118.09 ±16.26 b</td>
</tr>
<tr>
<td>Un. Arm Swing &amp; Hand Weight (B1)</td>
<td>117.16 ±10.41 a</td>
</tr>
<tr>
<td>Exag. Arm Swing &amp; Hand Wgt. (B2)</td>
<td>124.76 ±12.24 b</td>
</tr>
</tbody>
</table>

Note. a&b= Matching letters indicate no significant differences (p≥ 0.0125) between any two treatments. Varying letters indicate significant differences between treatments in that column.

The data analysis for the dependent variable systolic blood pressure was not significant either in terms of interaction of the independent variables, or their main effects. The main effect A was not significant (F= 7.52, p= 0.013), the main effect B was not significant (F= 6.41, p= 0.020), and the main effect C as not significant (F= 4.43, p= 0.049).

Arm swing by hand weight was not significant (F= 3.72, p= 0.069), arm swing by time was not significant (F= 0.59, p= 0.450), hand weight by time was not significant (F= 0.02, p= 0.893), and arm swing by hand weight by time was not significant (F= 2.60, p= 0.123). The means were not determined since the analysis indicated no significance (Table 4).
Table 4

F Values for the Interaction and Main Effects of SBP

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>I/ME</th>
<th>F Value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>7.52</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>6.41</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>4.43</td>
<td>0.049</td>
</tr>
<tr>
<td></td>
<td>AxB</td>
<td>3.72</td>
<td>0.069</td>
</tr>
<tr>
<td></td>
<td>AxC</td>
<td>0.59</td>
<td>0.450</td>
</tr>
<tr>
<td></td>
<td>BxC</td>
<td>0.02</td>
<td>0.893</td>
</tr>
<tr>
<td></td>
<td>AxBxC</td>
<td>2.60</td>
<td>0.123</td>
</tr>
</tbody>
</table>

Note. A= Arm Swing, B= Hand Weight, C= Time;
* = significant at p=0.0125.

The data analysis for the dependent variable diastolic blood pressure yielded results similar to those of systolic blood pressure. No interaction nor main effects were found for the independent variables. The main effect A was not significant (F= 2.17, p= 0.157), the main effect B was not significant (F= 5.19, p= 0.034), and the main effect C was not significant (F= 0.00, p= 0.967). Arm swing by hand weight was not significant (F= 3.83, p= 0.065), arm swing by time was not significant (F= 0.04, p= 0.848), hand weight by time was not significant (F= 0.04, p= 0.848) and arm swing by hand weight by time was not significant (F= 0.03, p= 0.865). (See Table 5.)
Table 5

F Values for the Interaction and Main Effects of DBP

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>V/ME</th>
<th>F Value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBP</td>
<td>A</td>
<td>2.17</td>
<td>0.157</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>5.19</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>0.00</td>
<td>0.967</td>
</tr>
<tr>
<td></td>
<td>AxB</td>
<td>3.83</td>
<td>0.065</td>
</tr>
<tr>
<td></td>
<td>AxC</td>
<td>0.04</td>
<td>0.848</td>
</tr>
<tr>
<td></td>
<td>BxC</td>
<td>0.04</td>
<td>0.525</td>
</tr>
<tr>
<td></td>
<td>AxBxC</td>
<td>0.03</td>
<td>0.865</td>
</tr>
</tbody>
</table>

Note. A = Arm Swing, B = Hand Weight, C = Time;
* = significant at p = 0.0125.

Finally, the data analysis for the dependent variable ratings of perceived exertion yielded significant main effects for all independent variables, A, B, and C. These effects were examined since no interaction was found. The main effect A was significant (F = 11.60, p = 0.003), the main effect B was significant (F = 24.45, p = 0.000), and the main effects C was significant (F = 11.57, p = 0.000). Arm swing by hand weight was not significant (F = 0.29, p = 0.597), arm swing by time was not significant (F = 2.04, p = 0.098), hand weight by time was not significant (F = 2.25, p = 0.072), and arm swing by hand weight by time was not significant (F = 0.45, p = 0.769). (See Table 6.)
Table 6

F Values for the Interaction and Main Effects of RPE

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>ME</th>
<th>F Value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPE</td>
<td>A</td>
<td>11.60*</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>24.45*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>11.57*</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>AxB</td>
<td>0.29</td>
<td>0.597</td>
</tr>
<tr>
<td></td>
<td>AxC</td>
<td>2.04</td>
<td>0.098</td>
</tr>
<tr>
<td></td>
<td>BxC</td>
<td>2.25</td>
<td>0.072</td>
</tr>
<tr>
<td></td>
<td>AxBxC</td>
<td>0.45</td>
<td>0.769</td>
</tr>
</tbody>
</table>

Note. A = Arm Swing, B = Hand Weight, C = Time;
* = significant at p = 0.0125.

Significant F values for the main effects of A and B were examined with a dependent t-test. The main effects for C were examined using a multivariate analysis of variance command with a repeated measures analysis since there are 5 levels of C (time). The means for each of the levels of A (A1 and A2) were 9.8 ± 1.82 and 10.5 ± 1.71, respectively. The means for each of the levels of B (B1 and B2) were 11.17 ± 1.67 and 12.15 ± 1.64, respectively. The secondary analysis with the dependent t-test indicated the means for A2 (EAS) and B1 (ASHW) were significantly different, and that EASHW was significantly different than AS, EAS, and ASHW regarding ratings of perceived exertion.
The means for C were as follows: $C_1 = 10.19 \pm 1.19$; $C_2 = 10.58 \pm 1.23$; $C_3 = 11.01 \pm 1.37$; $C_4 = 11.31 \pm 1.67$, and $C_5 = 11.45 \pm 1.82$.

(See Tables 7 and 8.)

Table 7

<table>
<thead>
<tr>
<th>Treatment</th>
<th>RPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unexaggerated Arm Swing (A1)</td>
<td>9.80 ± 1.82 a</td>
</tr>
<tr>
<td>Exaggerated Arm Swing (A2)</td>
<td>10.50 ± 1.71 b</td>
</tr>
<tr>
<td>Un. Arm Swing &amp; Hand Weight (B1)</td>
<td>11.17 ± 1.67 a</td>
</tr>
<tr>
<td>Exag. Arm Swing &amp; Hand Wgt. (B2)</td>
<td>12.15 ± 1.64 b</td>
</tr>
</tbody>
</table>

Note. a&b= Matching letters indicate no significant differences $(p > 0.0125)$ between any two treatments. Varying letters indicate significant differences between treatments in that column.
Table 8

*Treatment Means (+SD) for RPE over Time (in min.)*

<table>
<thead>
<tr>
<th>Time (in min)</th>
<th>RPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 (C1)</td>
<td>10.19 ± 1.19</td>
</tr>
<tr>
<td>4 (C2)</td>
<td>10.58 ± 1.23 a</td>
</tr>
<tr>
<td>6 (C3)</td>
<td>11.01 ± 1.37</td>
</tr>
<tr>
<td>8 (C4)</td>
<td>11.31 ± 1.67 a,b,c</td>
</tr>
<tr>
<td>10 (C5)</td>
<td>11.45 ± 1.82 a,b,c,d</td>
</tr>
</tbody>
</table>

Note. a= significantly different from 2 min (<0.05);
b= significantly different from 4 min (<0.05);
c= significantly different from 6 min (<0.05);
d= significantly different from 8 min (<0.05).

The statistical findings have been presented in this chapter. The summary, conclusions, discussion, and recommendations for further study are presented in the next chapter.
The purpose of this investigation was to determine the effect of hand-held weights and exaggerated arm swing on heart rate, ratings of perceived exertion, and blood pressure. The problem of this study was to determine the effect of hand weights and/or arm swing during fitness walking on middle-aged, sedentary women.

Summary

Following computation of the descriptive statistics for the physical and physiological characteristics of the subjects, a three-way analysis of variance with repeated measures was applied to the data. The assumption of sphericity was not met; thus, the results were determined from the multivariate analysis portion of the SPSS program. Since the data sets were not parallel following data collection (2x2x5; 2x2x5; 2x2x2; and 2x2x2), four separate analyses were completed. The alpha level was set at p<0.0125 (Bonferroni Technique) to protect the alpha level from inflation.

The initial analyses indicated that there were significant differences (p < 0.0125) among the treatments for the dependent variables of heart rate and ratings of perceived exertion. No significant differences were found for the dependent variable of blood pressure. The results for the dependent variable of heart rate indicated that unexaggerated arm swing walking (AS= 113.07 ±12.65) was significantly different than exaggerated arm swing walking (EAS= 118.09 ± 16.26), and that unexaggerated arm swing walking with hand...
weights (ASHW = 117.16 ± 10.41) was significantly different than exaggerated arm swing walking with hand weights (EASHW = 124.76 ± 12.24). Exaggerated arm swing walking (EAS) elicited a significantly higher heart rate than unexaggerated arm swing walking (AS), and exaggerated arm swing walking with 0.45 kg hand weights (EASHW) elicited a significantly higher heart rate than unexaggerated arm swing walking with 0.45 kg hand weights (ASHW). A secondary analyses using the dependent t-test indicated that EASHW was significantly different than AS, EAS, and ASHW, and that EAS and ASHW were not different regarding heart rate.

The results for the dependent variable ratings of perceived exertion (RPE) also indicated that unexaggerated arm swing walking (AS = 9.80 ± 1.82) was significantly different than exaggerated arm swing walking (EAS = 10.50 ± 1.71) and that unexaggerated arm swing walking with hand weights (ASHW = 11.17 ± 1.67) was significantly different than exaggerated arm swing walking with hand weights (EASHW = 12.15 ± 1.64). In addition, the RPE analysis indicated that there were significant differences across time (2 min = C1; 4 min = C2; 6 min = C3; 8 min = C4, and 10 min = C5). RPE at 2 min was significantly different than RPE at 4, 8, and 10 min. RPE at 4 min was significantly different than RPE at 8 and 10 min. RPE at 6 min was significantly different than RPE at 10 min. RPE at 8 min was significantly different than RPE at 10 min. A secondary analysis with the dependent t-test determined that RPE was significantly higher for EASHW than that of AS, EAS, ASHW, and that ASHW was perceived to be significantly more difficult than EAS.

The results for blood pressure (systolic and diastolic) indicated that no significant differences were elicited by any of the treatments (AS, ASHW, EAS, or EASHW). Furthermore, no significant differences in blood pressure were found over time.
The following is a summary of the findings as related to the null hypotheses of the study:

A. There were no significant differences among treatments a) unexaggerated arm swing walking, b) unexaggerated arm swing walking with hand weights, c) exaggerated arm swing walking, and d) exaggerated arm swing walking with hand weights with respect to heart rate. **REJECT**

B. There were no significant differences among treatments a) unexaggerated arm swing walking, b) unexaggerated arm swing walking with hand weights, c) exaggerated arm swing walking, and d) exaggerated arm swing walking with hand weights with respect to blood pressure. **ACCEPT**

C. There were no significant differences among treatments a) unexaggerated arm swing walking, b) unexaggerated arm swing walking with hand weights, c) exaggerated arm swing walking, and d) exaggerated arm swing walking with hand weights with respect to ratings of perceived exertion. **REJECT**

D. There were no significant differences for heart rate, blood pressure, or ratings of perceived exertion over time. **REJECT**

Conclusions

The following conclusions were drawn and generalized to middle aged sedentary women.

**Heart Rate**

1. Exaggerated arm-swing walking (EAS) and walking with hand weights (ASHW) do not have a significantly different effect on heart rate, thus, the walker may choose to exaggerate arm swing, or use 0.45 kg hand weights to increase heart rate.
2. Exaggerated arm-swing walking with 0.45 kg hand weights is effective in significantly increasing heart rate above simple walking (AS), walking with an exaggerated arm swing (EAS), and walking with 0.45 kg hand weights (ASHW).

Blood Pressure

3. Blood pressure is not significantly increased either with the use of an exaggerated arm swing, hand weights, or a combination of both. Therefore, use of an exaggerated arm swing, 0.45 kg hand weights, or a combination of both while walking may be regarded as safe alternatives to simple walking.

Ratings of Perceived Exertion

4. Walking with hand weights of 0.45 kg (ASHW) is not different than walking with an exaggerated arm swing (EAS) regarding heart rate, but ASHW is perceived to be significantly more difficult than EAS.

5. As would be expected, use of 0.45 kg hand weights, exaggerated arm swing, or a combination of both of these types of walking, are perceived to be significantly more difficult than simple walking (AS). Furthermore, walking with hand weights (0.45 kg) and an exaggerated arm swing is perceived to be significantly more difficult than walking with an exaggerated arm swing (EAS), or walking with 0.45 kg hand weights (ASHW).

Discussion

Comparisons of the findings of this investigation with related literature are presented in this section. Implications for the results of this study are also discussed.

Exaggerated arm swing walking with hand weights (EASHW) was determined to elicit a significantly higher heart rate than simple walking (AS), walking with an
exaggerated arm swing (EAS), or walking with 0.45 kg hand weights (ASHW).

Unexaggerated arm swing walking (AS) and exaggerated arm swing walking (EAS) also significantly differed regarding heart rate.

The EASHW findings of this study are consistent with the findings of two similar studies investigating young men (Owens et al., 1989 & Bryant et al., 1993) and one study investigating young men and women (Maud et al., 1986). The non-significant ASHW findings of this study did not support the findings of three other researchers (Morrow et al., 1992; Abadie, 1990, & Makalous et al., 1988). The focus of this study was untrained women and light weights while the focus of these researchers was trained subjects and/or heavy weights. Logically, significant increases in heart rate would be more likely with heavier weights, but the use of lighter weights for the untrained population in this study was more realistic.

Not only was heart rate significantly greater for EASHW, but ratings of perceived exertion (RPE) were significantly greater also. In fact, RPE was greatest for EASHW, and as one would expect, RPE increased for all modes of walking beyond simple walking (AS). Since ratings of perceived exertion are highly correlated (0.80 to 0.90) with heart rate (Guidelines for exercise testing and prescription, 1991), it is logical that EAS and ASHW, which elicited higher heart rates than AS, were perceived as more difficult than AS. Also, EASHW which elicited the highest heart rate was perceived as the most difficult. ASHW, however, which elicited virtually the same heart rate as EAS, was perceived to be significantly more difficult than EAS. This finding is consistent with that of Graves et al. (1987). As time increased, RPE increased, as expected, with RPE being greatest toward the end of the exercise.

No significant differences were found for blood pressure during any of the treatments used in this study. Thus, the results of this study do not support Abadie (1990), Graves et
al. (1987), or Zarandona et al. (1986) who reported a significant increase in systolic blood pressure, or Graves et al. (1988) who found a significant increase in diastolic blood pressure. In this study, the use of light weights and specific instruction not to grip the hand weights tightly (as suggested by Leonard Schwartz, M.D. who designed Heavy Hands) may have been instrumental in facilitating non-significant differences either in systolic or diastolic blood pressure.

Based on the results of this study, the use of 0.45 kg hand weights with an exaggerated arm swing while walking is an effective means of increasing heart rate. This mode of walking may be particularly attractive to and recommended for persons who cannot or do not wish to increase walking speed or mileage. For the general population of untrained middle-aged women; however, this mode of walking is not the preferred mode. The preferred mode of walking is without hand weights and without an exaggerated arm swing since both modes of walking (separately or combined) are perceived to be significantly more difficult than simple walking (AS). As Porcari et al. (1987) determined, fast walking is an adequate cardiovascular stimulus for most people. Finally, fast walking is easy to do and it's free.

Although more research is necessary, walking with hand-held weights and an exaggerated arm swing (EASHW) may be recommended for some populations. EASHW is a safe alternative for middle-age women since blood pressure remains unaffected. Persons who cannot walk fast, such as persons with orthopedic problems who enjoy walking, may benefit from EASHW. Persons walking together of disparate fitness levels may both effectively train if the more fit walker adopts EASHW. For smaller increases in heart rate, the more fit walker may choose to use either an exaggerate arm swing (EAS), or use 0.45 kg hand weights (ASHW) since their effects are virtually the same. EAS and ASHW are also safe alternatives to simple walking (AS) since blood pressure is not
affected by either mode. The more likely choice would be EAS; however, since ASHW is perceived to be more difficult. Finally, the walker who wants variation may effectively choose EASHW, EAS, or ASHW with EASHW perceived as the most difficult yet the most effective in increasing heart rate.

Should the walker chooses to adopt EASHW, it is recommended that the walker use the weights as prescribe by L. Schwartz, M.D. in *The heavy hands walking book*. Schwartz suggested that the hand weights be gripped loosely to prevent exaggerated blood pressure increases and that the weights be carried with a pumping action to get the documented increase in heart rate and consequent cardiovascular benefit.

The findings of this study are specific in focus as the physiological effect of hand-held weights while walking was examined. These findings; however, add to the existing literature, a means by which women may control their risk of cardiovascular disease. This research project represents one contribution to the field of research for women and cardiovascular disease which, according to Legato (1992), must be expanded.

**Recommendations for Further Study**

As a result of this investigation, the following recommendations for further study are suggested:

1. Replication of this study with male and female persons with hypertension to determine if the use of hand weights is safe, or contraindicated for these persons. This study suggests that blood pressure is unaffected by hand weighted arm-swing walking. Past studies; however, such as Zarandona et al., 1986, and Graves et al., 1987 suggested that blood pressure significantly increases with the use of hand weights.
2. Replication of this study at less than 3 mph with special populations including those persons who cannot walk fast enough (such as persons who are orthopedically challenged or involved in cardiac rehabilitation) to reach their training range for cardiovascular conditioning. Since slow walking alone will not produce a sufficient stimulus for cardiovascular conditioning, an alternative mode such as hand-weighted exercise with exaggerated arm swing may afford slow walkers the same physiological benefits as those associated with fast walking.

3. Replication of this study with moderately trained women and the dependent variable oxygen consumption. It is necessary to determine the effects of hand-weighted walking with arm swing on oxygen consumption since oxygen consumption is a measure of metabolic cost. Although it is believed that exercise-induced increases in heart rate are directly reflective of increase in oxygen consumption, the use of hand weights may produce increases in heart rate which are disproportionate with increases in oxygen consumption. This disproportionate rise is known as a pressor reflex (Zarandona et al., 1986). The pressor reflex which may cause increases in stress on the circulatory system without generating increases in aerobic conditioning.

It is suggested that the population investigated be moderately trained since the equipment for an oxygen consumption test in addition to the equipment and protocol used in the present study may generate difficulty and considerable discomfort.

4. Replication of this study in which the initial session is an orientation to treadmill walking. This orientation session would precede and, thus, be separate from all testing sessions. A separate orientation would give subjects more time to become familiar with treadmill walking since many women in this study had not used a treadmill, previously.
5. A study comparing the effects of hand weights on smokers and non-smokers. Smokers who are at greater risk for cardiovascular disease than non-smokers, may be another population who could benefit from the use of exaggerated arm swing walking (EASHW).

6. A study comparing men and women and ratings of perceived exertion during exaggerated arm swing walking with hand weights. As Mihevic and Morgan (1980) suggested, it has been assumed that males and females perceive exertion during exercise similarly. Some of the RPE literature; however, has indicated gender differences (Koltyn, O'Connor, & Morgan, 1991).
APPENDIX A
HUMAN SUBJECTS APPROVAL FROM
THE UNIVERSITY OF NORTH TEXAS
INSTITUTIONAL REVIEW BOARD
June 7, 1994

Karen Austen
11991 Audelia Rd. #1604
Dallas, TX 75243

Dear Ms. Austen:

Your proposal, "The Effect of Hand-Held Weights and Exaggerated Arm Swing on Heart Rate, Blood Pressure, and Rate of Perceived Exertion During Submaximal Walking", has undergone Full Board Review by the University of North Texas Institutional Review Board and has been approved.

Good luck on your project.

Sincerely,

Dr. Sandra Terrell, Chair
Institutional Review Board
APPENDIX B

INFORMED CONSENT FORM FOR SUBJECTS
Informed Consent for Submaximal Walking Test  
Karen C. Austen, M.Ed.  
The University of North Texas

Explanation of the Exercise Test
You will perform four, 10-min walking tests on a motor-driven treadmill. Each of the four tests will be completed on different days separated by a minimum of 72 hr. Each test will be preceded by a warm up period during which you will stretch and can walk easily for 2-5 min. Each test session will require one the following:

1) walking at a fitness pace of 3.0 mph without weights
2) walking at the same pace with 1 lb hand-held weights
3) walking at the same pace with exaggerated arm swing
4) walking at the same pace with exaggerated arm swing and the 1 lb hand-held weights.

The tests will be given in random order. During testing, heart rate and blood pressure will be monitored and you will be asked to rate the intensity of the exercise on a scale of 6-20 of the exercise. The test will normally terminate at the end of the 10-min period unless there are signs of fatigue, or discomfort. Should you feel discomfort such as dizziness, chest pain, or difficulty breathing, you are encouraged to stop the test at any time. Each test will be followed by a cool down period similar to the warm up period.

Risks and Discomfort
There exists the possibility that certain changes may occur during the test. The changes may include abnormal blood pressure, fainting, disorder of the heart rate, and in rare instances, heart attack, or death. Every effort will be made to minimize these risks through preliminary examination and by observations during testing. Emergency equipment and trained personnel will be available through (911) the city of Dallas emergency medical services. The primary investigator is currently trained in and available to perform cardiopulmonary resuscitation.

Benefits to be Expected
The results obtained from the exercise test may assist in the determination of the type of physical activities in which you might engage with minimal or no hazard.

Inquiries
Any questions about the procedures used in the walking test, or in the estimation of functional capacity are encouraged. If you have any doubts or questions, please ask me for further explanation. (I can be reached at home at 214-234-2441.)

Freedom of Consent
Your permission to perform this walking test is voluntary. You are free to deny consent if you desire.
I have read this form and I understand the test procedures and the risks associated with them. I hereby consent to participation as a subject in this study. I understand that my participation is voluntary and that I may withdraw from the study at any time. I further understand that the University of North Texas and Brookhaven College are not responsible in any manner for my well-being during this investigation.

Signature of volunteer subject

Date

Witness

Questions:
Response:
Physician signature: optional.
APPENDIX C

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE

(PAR-Q)
PHYSICAL ACTIVITY READINESS QUESTIONNAIRE

For most people, physical activity should not pose any problem or hazard. PAR-Q has been designed to identify the small number of adults for whom physical activity might be inappropriate or those who should have medical advice concerning the type of activity most suitable.

1. Has your doctor ever said you have heart trouble?
2. Do you frequently suffer from pains in your chest?
3. Do you often feel faint or have spells of severe dizziness?
4. Has your doctor ever said your blood pressure was too high?
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?
6. Is there a good physical reason not mentioned here why you should not follow an activity program even if you wanted to?
7. Are you age 50 or over? If you are 50 years or more, do you have a physician's release for moderate exercise with you?

If the answer is yes to any of these questions, exercise testing should be postponed. Medical clearance may be necessary.

APPENDIX D

MEDICAL HISTORY FORM
UNIVERSITY OF NORTH TEXAS
MEDICAL HISTORY FORM

All information is private and confidential. Please print.

Today's Date ____/____/____

Name

First Middle Last

Home Address

Number and Street Telephone Home

City State Zip Code

Permanent Address (if different from above)

Number and Street Telephone Home

City State Zip Code

Social Security Number Date of Birth Age ___

- / / Sex M ___

F ___

Marital Status

_____ Single _____ Married _____ Divorced _____ Widowed _____ Separated

How long have you been this marital status? ______________________
PRESENT HISTORY

Check (✓) the blank in front of those questions to which your answer is yes. Leave others blank.

Has a doctor ever said that your blood pressure was too high?
Has a doctor ever said that your blood pressure was too low?
Do you ever have pain in your heart or chest?
  Does it happen at rest?
  Does it happen during exertion?
Are you often bothered by a thumping of the heart?
Does your heart often race like mad?
Do you ever notice extra heart beats?
Do you ever notice skipped heart beats?
Are your ankles often badly swollen?
  Does the swelling improve when off your feet?
Do cold hands or feet trouble you even in hot weather?
Has a doctor ever said that you had or have heart trouble?
Has a doctor ever said that you had or have an abnormal electrocardiogram (ECG or EKG)?
Has a doctor ever said that you have had a heart attack or coronary?
Do you suffer from frequent cramps in your legs?
Do you often have difficulty breathing?
Do you sometimes get out of breath when sitting still?
Do you sometimes get out of breath while sleeping?
Has a doctor ever told you your blood fats (cholesterol or triglycerides) level was high?

List any medications or supplements you are now taking, the date you started taking each drug, and how much you take (dosage), if known:

<table>
<thead>
<tr>
<th>Medication</th>
<th>Date started</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>month year</td>
<td></td>
</tr>
<tr>
<td></td>
<td>month year</td>
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<td></td>
<td>month year</td>
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<td></td>
<td>month year</td>
<td></td>
</tr>
</tbody>
</table>

List any drug allergies:
PAST HISTORY

Do you presently have or have you ever had any of the following? (if yes, please specify approximately when and if it is still active).

Heart attack
Rheumatic fever
Heart murmur
Disease of the arteries
Varicose veins
Arthritis or joint pain:

Diabetes Mellitus (if yes, are you on medication?)
Abnormal blood sugar test
Phlebitis
Dizziness or fainting episodes
Epilepsy or seizures
Stroke
Diphtheria
Scarlet fever
Infectious mononucleosis
Anemia
Hypothyroidism
Hyperthyroidism
Pneumonia
Bronchitis
Asthma:
Allergy induced
Exercise induced
Stress (psychologic) induced
Abnormal chest X-Ray
Emphysema
Other lung diseases
Jaundice or gallbladder problems
Kidney stones
Prostatic problems
Diseases of the Central Nervous System
Emotional problems
Cancer
Broken bones—specify:

Comments:
APPENDIX E

LETTER TO HAND WEIGHT CORPORATION
Karen C. Austen
11991 Audelia Road, View
Dallas, Texas 75243

March 3, 1994

Brian Hawkins
SLM Fitness
43 W. 23rd St.
Suite 300
New York, NY 10010-4203

Dear Mr. Hawkins:

Thank you for talking with me today concerning my research with hand-held weights and middle-aged women. As you requested, I have enclosed my dissertation proposal. I trust that you will find all of the answers to your questions.

Following satisfactory examination, I would appreciate your participation in this project. It is important that I note that I may, or may not, find statistical significance with heavy hands and I am compelled to report any findings. I do believe, however, that this research will be an extremely valuable addition to the existing literature.

I appreciate your time and effort in sending the needed research materials—6 pairs of 1-lb weights, literature which is specific to my study as I have a large collection of varied hand-weight literature, and funding for each of my subjects (N=30) who would be paid a minimum of $5 per test session for 4 sessions. Minimal funding is $600.00.

I am aware that I have given you a short timeline. Whatever you can do within these parameters is very much appreciated. I look forward to hearing from you soon. Again, thank you.

Sincerely,

Karen C. Austen
214-234-2441
APPENDIX F
RESPONSE FROM HAND-WEIGHT CORPORATION
March 7, 1994

Ms. Karen C. Austen
11991 Audeli Road., View
Dallas, TX 75243

Re: Heavyhands Study

Dear Karen:

Pursuant to our telephone conversation last week, enclosed please find two Heavyhands ComboPacs for your use in the study.

In regards to potential funding, we will need to discuss this at a later date as I will have to speak with the Senior Vice President of Fitness Marketing.

In the meantime, should you require anything additional, please don't hesitate to contact me at (212) 675-0070, extension 230.

Cordially,

SLM FITNESS

Brian Hawkins
Fitness Product Manager

SLM
Encs.
APPENDIX G

LETTER TO SUBJECTS

TO SCHEDULE TIME FOR EXERCISE PRESCRIPTION
Dear Jane,

Thank you for your participation with my doctoral dissertation entitled THE EFFECT OF HAND-HELD WEIGHTS AND EXAGGERATED ARM SWING ON HEART RATE, BLOOD PRESSURE, AND RATINGS OF PERCEIVED EXERTION DURING SUBMAXIMAL WALKING. As I mentioned, I am an exercise physiologist and I would like to meet with you to write a personalized exercise program if you have an interest in beginning regular exercise. If you are not sure that you want to begin regular exercise, I am also available to answer any questions you have regarding exercise.

I would like to meet with you on either Friday, June 24, 1994 or Saturday, June 25, 1994. Please call me to schedule a 30-min visit in the library at Brookhaven College on either of these days. I am available from 9am-3pm on Friday and 10am-1:30pm on Saturday. I will schedule your visit as you call ("first come first serve"). If I am not home when you call, please leave a message with the date and time convenient for you and I will return your call to confirm your appointment.

Please be prepared with a fitness goal in mind. Some examples of fitness goals include cardiovascular fitness, toning, weight management, general strength, and flexibility.

Again, thank you for your very valuable contribution to this study that I plan to publish within the next year. I look forward to hearing from you soon. Have a wonderful summer and good health to you!

Sincerely,

Karen C. Austen
RAW DATA SHEET

Name: 
Age: 
HRmax: 220 
HRsubmax: 
Height: 
Weight: 
% Fat: 
RHR: 
RBP: 

Warm up: Stretch 
3-5 min, 2 mph 
change t-mill to 3.0 and choose AS tnt
1. 2.30 hr = , RPE = 
bp = 
3. 4.30 hr = , RPE = 
5. 6.30 hr = , RPE = 
bp = 
7. 8.30 hr = , RPE = 
bp = 
10. 10.30 hr = , RPE = 
11. 2 mph Post Ex 
bp = 
13. Cool Down bp = 
14. 15. Cool Down hr = , RPE 
bp = 
16. Rest 
17. Rest 
bp = 
19. Rest 
20. Rest 
Stretch 

Local RPE (Borg Scale 6-20) 
Arms-
Legs-

Note:
Watch- mode, chron, reset(hold), start eg 2.30.00s
APPENDIX I

PHOTOGRAPH OF

UNEEXAGGERATED ARM-SWING WALKING
REFERENCES


The University of North Texas, Denton.

The University of North Texas, Denton.

The University of North Texas, Denton.

The University of North Texas, Denton.


