ABSTRACT

Analysis of Exercise Intensity and Energy Expenditure of Women Participating in the Curves Exercise Program

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The Curves program is designed to improve fitness. The purpose of this study was to identify exercise intensity, HR and energy expenditure in a group of women participating in the Curves program. Seventy-eight women (53.6 ± 7.09 yrs, 192.1 ± 30.43 pounds, 43.5 ± 4.52 % fat) performed the Curves workout on two occasions. Results show that mean HR was 119 ± 15 b/min which was equivalent to 79% max HR or 63 % HRR. Thirty-three women (52.7 ± 6.68 yrs, 193.1 ± 31.73 pounds, 1.8 ± 0.28 L/min VO_2 max) performed the Curves 30-min workout on two occasions. Results show that the mean RER to perform the 30-min workout was 1.00 ± 0.07 and 0.98 ± 0.05 for the two sessions. Estimated caloric expenditure was 164.5 ± 25.19 kcals and 160.6 ± 28.36 kcals for the two sessions. Results indicate that the Curves program qualifies as moderate intensity exercise.

Analysis of Exercise Intensity and Energy Expenditure of Women Participating in the Curves Exercise Program

by

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A Thesis

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CHAPTER ONE

Introduction

Physical inactivity has become a major problem affecting the health of people in the United States. Approximately two thirds of adults in the United States are overweight, and 30% are classified as obese (National Institutes of Health [NIH], 2003). Twenty-nine percent of women in the United States have reported no leisure time activity in the previous month (National Heart, Lung and Blood, 1998). More than 60% of American adults are not regularly physically active, with 25% reporting no physical activity at all (ACSM, 2000). It is estimated that approximately two thirds of adults in the United States do not meet the current recommendations of at least 30 minutes of moderate physical activity on 5-7 days per week (Lind, 2005). Research shows that 29% of men and 44% of women, at any time, are attempting to lose weight (ACSM, 2000). Individuals who are overweight and/or obese are at a greater risk for conditions such as heart disease, diabetes, cancer, hyperlipidemia, hypertension, and hyperinsulinemia (ACSM, 2000). Approximately 50-60% of American adults over the age of 18 have a Body Mass Index (BMI) ≥ 25 (ACSM, 2000). Individuals with a BMI between 25 and 30 have increased from 44.3% to 52.6% from the late 1970's to the 1990's (ACSM, 2000).

With the number of individuals who are overweight and/or obese on the rise, weight loss and weight management programs are increasing in popularity. Curves has become a very popular form of exercise for women with over 4,000,000 members worldwide. The Curves workout program is a combination of exercise and nutrition activities specifically designed and geared towards women. The Curves workout program involves circuit training utilizing a combination of hydraulic equipment and recovery pads. One of the values of the Curves equipment is its ease of use. The model utilized by the Curves program is interval training which alternates hydraulic resistance training and calisthenics-type exercises done on the recovery pads. This training protocol uses pre-established spacing and sequencing of exercise and rest intervals to achieve benefits similar to those gained during exercise performed to exhaustion. Interval training can be designed by manipulating intensity, duration of exercise, and rest intervals to overload a specific energy system (McArdle, 2001). The Curves program utilizes these characteristics of interval training as the foundation of the workout.

Curves has addressed the need to create a setting in which the women who use Curves as an exercise resource are provided with the best potential for success based on the time and effort that they invest. One of the difficulties in dealing with overweight individuals participating in exercise programs is identifying and prescribing exercise intensity and determining the number of calories burned during each exercise session. A common method used to determine exercise intensity is to estimate the number of calories burned during exercise. The actual measurement of these variables is always preferred to estimating the same variables. Data has been collected on the calorie expenditure levels of many modes of activities of daily living, physical activity, and exercise. The caloric expenditure tables are based on the specific activity and the weight of the individual, and the tables provide an estimation of calories burned per minute.

While several research studies conducted at Baylor University have been conducted concerning the results from participation in the Curves program and following the prescribed diet, only one study (Greany 2005) has been conducted to determine what occurs during the Curves workout itself. Further research needs to be conducted to determine workload intensity and caloric expenditure for the Curves target population.

The proposed study is a component of ongoing Curves research conducted at Baylor University to determine the effects of the Curves program. This research was designed to assess several of the physiological variables that are involved in the Curves workout.

Statement of the Problem

What is the average exercise intensity and energy expenditure in a group of women participating in the Curves exercise program?

Purposes

1. The purpose of this study is to quantify energy expenditure in terms of calories burned per exercise session and amount of substrate (carbohydrate and fat) used for energy during the Curves circuit workout based on heart rate and VO_2 data.

2. The purpose of this study is to identify average exercise intensity, average HR and energy expenditure in a group of women participating in the Curves program.

Hypotheses

H_0: The caloric expenditure elicited during the Curves exercise program will contribute approximately 50% to the recommended exercise intensities for overweight, untrained individuals as described by the American College of Sports Medicine. (50% equals 150 of the 300 kcal per day to promote and maintain weight loss, typically 20 – 30 minutes of cardiovascular exercise)

H_1: Participants' VO_2 levels elicited during the Curves exercise program will fall within recommended exercise intensities as described by the American College of Sports Medicine (40-85% of VO_{2max}).

H_2: Participants' mean exercise heart rate levels elicited during the Curves exercise program will fall within recommended exercise intensities as described by the American College of Sports Medicine (55-80% peak HR, 40-85% of HRR).

Delimitations

The study will be conducted within the following parameters:

1. Seventy-eight (78) overweight females (ages 18-65, BMI > 27) participated in the study. Thirty-three sedentary, overweight females (ages 18-65, BMI > 27) participated in the VO_2 portion of the study.

2. Participants were recruited from the general public by radio and newspaper ads.

3. All familiarization and baseline testing sessions were conducted in the Exercise & Sport Nutrition Laboratory (ESNL) in the Department of Health, Human Performance & Recreation at Baylor University.

4. Exercise and testing sessions were conducted in the Student Life Center at Baylor University.

Limitations

1. Participants are responsible for following proper exercise guidelines for participating in the Curves program and exercise at recommended intensities.

Assumptions

1. Participants will workout at the suggested exercise intensity each exercise session.

2. Participants will follow the prescribed directions on how to use the Curves equipment.

Definition of Terms

BMI – a measurement of body overweight or obesity determined by dividing weight (kg) by height (m) squared. (kg/m^2)

Heart rate max – the highest heart rate value attainable during all out effort to the point of exhaustion.

Heart rate reserve – maximal heart rate minus resting heart rate multiplied by intensity and then adding resting heart rate. ($([HR_{max} – HR_{rest}] * intensity) + HR_{rest}$.

Obesity – an excessive amount of body fat, generally defined as more than 25% in men and 35% in women; in women a BMI of 30 or greater.

Overweight – body weight that exceeds the normal or standard weight for a particular individual based on sex, height, and frame size, a BMI of 25.0 to 29.9.

VANT – (ventilatory anaerobic threshold) - anaerobic threshold is defined as the oxygen uptake at which the blood lactate concentration begins to rise significantly above normal resting values. VANT is the point of inflection at which VCO_2 and therefore V_E increase relative to VO_2.

VCO_2 – the volume of CO_2 produced per minute.

V_E – the volume of air expired per minute.

VO_2 – maximal rate at which oxygen can be consumed by the body. VO_2 is the body's ability to deliver and extract oxygen.

CHAPTER TWO

Review of Literature

Curves is the largest fitness franchise in the world with over 9,500 locations worldwide. Curves clubs can be found in the United States, Canada, Europe, South America, Mexico, Australia, New Zealand, and the Caribbean. Curves is designed to allow for its participants to get a complete aerobic and strength training workout in 30 minutes. The system is built around easy-to-learn hydraulic resistance machines, so there are no weight stacks to change or manage. The Curves workout is a circle of resistance equipment with springy recovery boards between each station. Curves is designed to address several aspects of exercise such as physiology, psychology, and sociology specifically related to women.

A major challenge to exercise leaders and health promoters is to try to encourage low-active individuals to become regular exercisers (Parfitt, 1996). Exercise intensity is the most difficult of the four components of exercise (mode of activity, frequency, duration, intensity) to measure. Ways to express exercise intensity include VO_{2max}, maximal heart rate, heart rate reserve, and ratings of perceived exertion (Borg, 1982; Zeni, 1996). Individuals who can accurately identify their workload can provide adequate feedback and monitor that they are exercising at the appropriate intensity levels. This will help the individuals reach their exercise and fitness goals.

Current literature identifies a growing prevalence of sedentary individuals who become overweight or obese. Overweight is clinically defined as having a Body Mass Index (BMI) >25 and includes individuals who are obese, which is defined as having

BMI >30. Obesity has grown into an epidemic in the United States over the past decade. Recent data from the National Institutes of Health indicates that approximately two thirds of adults in the United States are overweight and 30% are classified as obese. Data compiled from the 1999-2000 National Health and Nutrition Examination Survey (NHANES) indicates that nearly 35 million women age 20 years or older are considered obese (NIH, 2003). The prevalence of obesity has more than doubled over the past 20 years (Teegarden, 2003). Obesity increases the risk for diabetes, heart disease, stroke, hypertension, gallbladder disease, osteoarthritis, sleep apnea and other respiratory disorders, and some forms of cancer (NIH, 2003).

Data indicates that most Americans do not engage in physical activity or exercise on a regular basis. More than 60% of American adults are not regularly physically active, with 25% reporting no physical activity at all (ACSM, 2000). Twenty-nine percent of women in the United States have reported no leisure time activity in the previous month (National Heart, Lung and Blood, 1998). It is estimated that approximately two thirds of adults in the United States do not meet the current recommendations of at least 30 minutes of moderate physical activity on 5-7 days per week (Lind, 2005). Research shows that 29% of men and 44% of women, at any time, are attempting to lose weight (ACSM, 2000).

With the number of individuals who are overweight and obese on the rise, weight loss and weight management programs are becoming more popular. Scientists and researchers continue to examine the most effective way to increase health and promote weight loss. One of the goals of Healthy People 2010 is to increase the proportion of adults who regularly participate in moderate physical activity of at least 30 minutes per day from 15% to 30% (U. S. Department of Health and Human Services, 2000). Research has indicated that only 22% of adult Americans regularly engage in activities designed to promote health and fitness (Department of Health and Human Services, 1996). Approximately 300,000 American deaths each year are linked to unhealthy dietary habits and lack of physical activity (NIH, 2003).

Research has shown that women are an at risk group when dealing with hypokinetic diseases. Specifically 29% of women in the United States have reported no leisure time activity in the preceding month (National Heart, Lung and Blood, 1998). It is hypothesized that there is a lack of knowledge concerning the potential effects of physical activity on cardiovascular fitness (Branch, 2000). Because of this and other similar statistics, women have been identified as a target group in public health initiatives to increase physical activity (Branch, 2000).

Exercise has been acclaimed as an important component of weight reduction and weight management programs, especially when combined with healthy eating habits (Visona, 2002). Increased physical activity and exercise have been shown to be factors that contribute to improving cardiorespiratory fitness, optimal body composition, and weight loss/weight maintenance. Adoption of a lifestyle which includes physical activity and exercise is known to provide numerous health benefits, including reduced risk for the development of chronic diseases such as coronary heart disease, diabetes, hypertension, colon cancer, and osteoporosis as well as a reduced risk of all-cause mortality (Branch, 2000).

The benefits of proper nutrition and exercise are important issues for women. Overweight individuals are less likely to participate in a regular exercise program and the dropout rate from short-term exercise interventions is approximately 20-40% (Jakicic, 1995). Women who are physically active have been shown to experience a delay in all-cause mortality and have better mental health (King, 1993). Research has consistently indicated that exercise has a favorable effect on mood and general well-being (Annesi, 2000). A review of 16 studies concluded that self-concept is heightened through exercise. The proposed agents for this change have been hypothesized to include feelings of well-being, goal achievement, a sense of competence, mastery, or control and reinforcement from significant others (Annesi, 2000).

One of the hypothesized issues with the trend of inactivity is that the public perception that relatively intense, protracted exercise is necessary to realize health and fitness goals (Goss, 2003). There is a common misconception that for exercise to be beneficial it must be undertaken at intensities that evoke pain or discomfort and is perceived to be hard (Goss, 2003). Recent reports from governmental agencies, such as NIH and NHANES, as well as research studies are striving to dispel this myth and pass information along to the general public concerning the appropriate exercise intensities to reduce risk of all-cause mortality and improve health. A major challenge to exercise leaders and health promoters is to try to encourage low active individuals to become regular exercisers (Parfitt, 1996). One of the important aspects of this challenge is to find a mode of exercise that is acceptable to the target population. This chosen mode of exercise should be enjoyable to the participant, the participant must be able to regularly participate in the mode, and it is necessary to show that the exercise is effective in improving the fitness levels of the participants (Grant, 2002).

In addition to mode, the other components of exercise are frequency, duration, and intensity. While frequency and duration are straightforward, intensity is more complex. Performance of exercise elicits both subjective (perceived exertion, affect, motivations), and objective (oxygen consumption and heart rate responses) responses (Schaeffer, 1995). Ways to express exercise intensity include VO_{2max}, maximal heart rate, heart rate reserve, and ratings of perceived exertion (Borg, 1982; Zeni, 1996). If individuals can accurately identify their workload, this could assist researchers in identifying an individual's energy expenditure for the specific performed work (Machinnon, 1999). In a meta-analysis of interventions that were focused on increasing physical activity, studies indicated that the selected intensities by non-athletic individuals are generally within the ACSM recommendations. However, the mean intensity varied considerably from study to study (Lind, 2005). On average, participants tended to choose intensities of physical activity that approximated the level of transition from aerobic to anaerobic metabolism (Lind, 2005).

The Curves fitness and weight-loss program has become a popular means of promoting health and fitness among women. Over 4 million women belong to approximately 9,000 Curves centers worldwide. The Curves program involves a 30-minute circuit training program, suggested to be done three times a week, involving use of bi-directional hydraulic exercise machines that train all major muscle groups interspersed with calisthenics-type exercises designed to maintain an elevated heart rate and increase energy expenditure. Curves is an exercise and weight-loss facility dedicated to providing affordable, fun, one-stop exercise and nutritional information designed especially for women. The Exercise & Sport Nutrition Lab at Baylor University has been conducting extensive studies on the efficacy of the Curves program. Preliminary results have shown that the Curves program is highly effective in promoting weight loss, improving markers of health, and improving fitness.

VO_2

Maximal oxygen uptake, or VO_2, is the main criterion used to measure cardiovascular fitness. VO_2 is defined as the maximal rate at which oxygen can be consumed by the body per minute (Holland, 1994). VO_2 can be defined as the body's ability to deliver and extract oxygen. VO_2 is an indicator of fitness and efficiency of the cardiovascular system. Measurements of oxygen consumption are used to make judgments about cardiovascular function, predict endurance, and to estimate energy expenditure at rest and at exercise (McLaughlin, 2001). VO_2 is expressed with the Fick equation which identifies the physiological components of VO_2. The Fick equation is: VO_2 = cardiac output (Q) * $aVO_{2difference}$. VO_2 is measured by open circuit spirometry in which an individual breathes into a closed system that analyzes the air that the individual exhales. This expired air is analyzed, and VO_2 levels are determined.

VANT (Ventilatory Anaerobic Threshold)

Anaerobic threshold is a parameter that is typically used to measure sub-maximal cardiovascular fitness. Anaerobic threshold is defined as the oxygen uptake at which the blood lactate concentration begins to rise significantly above normal resting values (Holland, 1994). Ventilatory threshold is a non-invasive method that relies on the assumption that the H^+ ions of lactic acid are buffered by blood bicarbonate, producing excess CO_2, which in turn increases expired minute ventilation (V_E) (Bosquet, 2002; Holland, 1994). The transition from rest to sub-maximal exercise consists of a short delay followed by a rapid increase in pulmonary VO_2 leading to the attainment of steady state within 2-3 minutes (Pringle, 2003). During exercise, ventilation increases linearly with respect to oxygen consumption. About half way to maximal oxygen consumption, ventilation increases excessively with respect to oxygen consumption (Bischoff, 1995). Anaerobic threshold is the point of inflection at which VCO_2 and therefore V_E increase relative to VO_2. When the metabolic demands of exercise begin to exceed the delivery of oxygen to working muscles, anaerobic metabolism begins by increasing levels of blood lactate and lactate pyruvate ratios. This causes the slope of the VCO_2 curve to increase (Nueberg, 1988).

In a study of 40 weeks of exercise training, the mean anaerobic threshold increased from 72% to 81% of VO_{2max} (Denis, 1982). In a study conducted with 20 weeks of training, VANT significantly increased over pre-study values (Prud'homme, 1984). Research conducted with women found that the ventilatory threshold is coincident with the highest rate of fat oxidation during treadmill running at 75% VO_{2peak} (Astorino, 2000). On average, participants tended to choose intensities of physical activity that approximated the level of transition from aerobic to anaerobic metabolism (Lind, 2005). The Heritage Family study concluded that sedentary individuals who exercised at intensities recommended by the ACSM achieved more benefits if they trained above their ventilatory threshold than if they trained below their ventilatory threshold (Gaaskill, 2001).

Heart Rate

Heart rate can be used as an index of intensity, as it is the primary method used by the ACSM of prescribing and monitoring the intensity of physical activity (Lind, 2005).

Heart rate is used as a measure of exercise intensity because of the relatively linear relationship between heart rate and VO_2. There are several methods utilized to determine maximal heart rate. One common way to use heart rate is the percent of HR_{max} model. With this model, HR_{max} is determined and exercise intensity is calculated based on HR_{max}. HR_{max} can be calculated by using the Karvonen formula of $HR_{max} = 220 - age$. Typically 70-85% of an individual's HR_{max} is used to prescribe exercise intensity. Seventy percent of HR_{max} is the lower limit, and 85% of HR_{max} is the upper limit. Heart rate reserve is another way to determine exercise intensity. Heart rate reserve (HRR) is maximal heart rate minus resting heart rate multiplied by intensity and then adding resting heart rate. $([HR_{max} - HR_{rest}] * intensity) + HR_{rest}$. Suggested ranges for exercise intensity are 60-80% of heart rate reserve (ACSM, 2000). The suggestion is that exercise should be done at a heart rate that falls within the lower and upper calculated limit. With HR_{max} and / or HRR information, ranges can be set for exercise prescription based on each individual.

Exercise Energy Expenditure

Energy expenditure is an important aspect of weight loss. One of the factors of energy expenditure is the calories burned from exercise. Specific recommendations with regard to the amount of exercise are important in developing successful exercise programs. Energy expenditure from exercise is one of the components of the ACSM recommendations for a 300 kcal per day caloric deficit to promote and maintain weight loss. The other main components of expenditure, in addition to exercise, are daily activity and basic metabolic rate (BMR). The balancing component is the amount of calories taken in through food. This can be expressed as caloric deficit = calories in (food) – calories out (calories burned).

VO_2 Monitoring - K4b^2

Several physiological responses to physical activity and exercise are used to evaluate cardiorespiratory fitness, including oxygen consumption, and heart rate. Measuring these variables during exercise, particularly maximum exercise, increases the chance of detecting any coronary artery disease or pulmonary disease. A sub-maximal exercise test costs less than a maximal test and is more practical when the assessment needs to be done outside of a laboratory setting. Although less sensitive and specific for detecting disease or estimating maximal oxygen consumption, correctly performed sub-maximal tests can provide a valid estimate of cardiorespiratory fitness.

Cardiopulmonary exercise testing is a non-invasive method that utilizes breath-by-breath measurement of respiratory gas exchange which yields the determination of maximal oxygen uptake and anaerobic threshold (Nueberg, 1988). During VO_2 tests, patients breathe through a non-rebreathing valve that separates expired air from inspired room air. Oxygen and CO_2 levels are monitored by sensors, and the data is displayed through a computer program. During exercise, both aspects of the Fick equation ($VO_2 = Q * aVO_{2diff}$) are utilized for work. The heart rate response is complimented by muscle vasodilatation and non-working muscle vasoconstriction that redistributes cardiac output to permit optimal O_2 extraction by working muscles (Nueberg 1988).

Automated metabolic gas systems can be classified as laboratory based, semi-portable, or portable. The benefits of a portable unit enhance the ability to measure the energy cost of a wide variety of activities outside the laboratory. The Cosmed K4b^2 is a portable system that has been evaluated against criterion such as the Douglas bag method. The K4b^2 measures oxygen consumption and carbon dioxide production on a breath-by-breath basis in addition to ventilation, fraction of expired oxygen (F_ECO_2), and heart rate (McLaughlin, 2001). K4b^2 is the first portable system designed by Cosmed to measure gas exchange on a true breath-by-breath basis. The technology enables the exploration of physiological responses in the field during very fast and brief events or while recording data over a longer period of time. K4b^2 accurately measures over 30 physiological parameters including VO_2, VCO_2, heart rate, and ventilation.

The Cosmed K4b^2 system uses a bi-directional digital turbine. It opposes a very low resistance to flow. The air passing through the helical conveyors makes a spiral motion which causes the rotation of the turbine rotor. The rolling blade interrupts the infrared light beamed by the three diodes of the optoelectronic reader. Every interruption represents 1/6 turn of the rotor: this provides that ability to measure the number of turns the turbine makes.

The O_2 and CO_2 analyzers are temperature-controlled, and the internal pressure and expired flow are monitored for a higher reliability of the measurements.
The K4b^2 uses Nafion Permapure which is a semi-permeable capillary tube capable of removing the humidity in excess without altering the gas concentrations. The analyzers' calibration is automatic and shows both graphically and numerically the flow and concentration signals and the accuracy of the baseline/gain. The PC software, running on Windows™, allows the user to manage data stored in the Portable Unit or data that is transmitted to a PC.

The $K4b^2$ has been studied for reliability and validity. In one study, no significant differences in VO_2 were seen at rest and at a workload of 250 watts. However, $K4b^2$ values were significantly higher by a small amount at workloads of 50, 100, 150, and 200 watts. The authors of the study concluded that the $K4b^2$ was acceptable for measuring VO_2 across a wide range of exercise intensity (Macfarlane, 2001). In another study, during all work rates up to maximal work rates during maximal bicycle exercise tests, there was no significant difference between the VO_2 measured by a mixing box system and the Cosmed $K4b^2$. This study concluded that the $K4b^2$ was valid and suitable for breath-by-breath measurements during field experiments (Macfarlane, 2001).

In a study on the reliability of the $K4b^2$, no significant differences were noted between the test-retest on the following variables: V_E, VO_2, VCO_2, F_E, O_2, and F_ECO_2 (Duffield, 2004). The same study addressed the validity of the $K4b^2$ and found no significant differences between the $K4b^2$ and the metabolic cart for V_E. However, values for VO_2, VCO_2, and F_ECO_2 were significantly higher than values from the metabolic cart (Duffiled, 2004). No significant differences were observed for any variable between either test involving the Cosmed unit as the sole measurement device. Therefore, the conclusion is that the $K4b^2$ had satisfactory reliability.

A study conducted by McLaughlin et. al., (2001) was designed to assess the accuracy of the $K4b^2$ by comparing it to the Douglas airbag method. The values of the $K4b^2$ were significantly higher than the Douglas bag method from 50-200 watts. However, the magnitude of these differences were small and only reached statistical significance because of the extremely small standard errors. Also, no significant differences were found in V_E between the two methods from rest to a workload of 150 watts. All K4b^2 values were within 5% of Douglas bag values. Even when the differences between the two methods were significantly different, the magnitude of the differences was small. These findings suggest that the K4b^2 portable metabolic system is acceptable for VO_2 measurements over a wide range of exercise intensities (McLaughlin, 2001).

Heart Rate Monitoring

The evaluation of an individual's heart rate started as the simple task of palpating an artery (typically the radial or carotid) and counting the number of beats. Technological developments led to the invention of the stethoscope which provided better evaluation of the heart and its functioning. At the beginning of the 20th century, the ECG was invented, and electrical activity could be recorded. In the 1980s, wireless heart rate monitoring was developed (Achten, 2003).

A heart rate monitor can be a useful tool to help individuals determine and follow appropriate exercise prescription. Many individuals might not be able to accurately take their own pulse by the palpation method. One of the benefits of heart rate monitoring is the information gathered provides information for people who exercise leisurely and wonder why they cannot lose any weight. This is where the use of a heart rate monitor can be beneficial. If you know your target heart rate zones, the monitor can inform you to increase or decrease intensity. With a heart rate monitor you can ensure that you are exercising at an appropriate intensity.

Heart rate measuring systems consist of three parts: the transmitter (typically a rubber belt), the receiver, and the electronics (typically in a wrist watch microprocessor). The transmitter detects every heartbeat through two electrodes with ECG accuracy and transmits the heart rate information wirelessly to the receiver though a low frequency electromagnetic field with a frequency of 5.2 kHz ± 5%. The typical reception range is 80-100 cm. The receiver receives the transmission and passes a digital pulse with a 5 volt amplitude corresponding to each heart beat to the electronic equipment. The microprocessor, contained in the wristwatch, calculates a value for current heart rate based on the time interval between the pulses sent by the receiver to the microprocessor. This calculation contains a certain amount of averaging and other techniques such as an algorithm to ensure a reliable and stable heart rate reading. The microprocessor conducts the following steps: receiving of the electric heart beat pulse from the receiver, calculating the times between the pulses, performing the error checks, calculating the heart rate, and sending the heart rate signal to the display on the wristwatch (Boudet, 2001). Achten and Jeukendrup (2003) have identified four studies in which research conducted with heart rate monitors that utilize the chest electrode model of heart rate monitoring are valid when compared with ECG data.

An individual's maximum heart rate (HR_{max}) is often the easiest value to achieve in older participants, and it may be the most practical to measure (Misquita, 2001). A study of exercise prescription in older women indicates that heart rate expressed as a percentage of maximal heart rate is an appropriate method of prescribing exercise in healthy, sedentary women from ages 60-72 (Kohrt, 1998). Based on the target population, there are specific heart rate zones that are the foundation of exercise intensity. Heart rate zones are typically calculated as a percentage of VO_{2max} or HR_{max}. The typical target heart rate zone for individuals with a goal of managing body weight is 55-69% of maximal heart rate (ACSM, 2000). Using this information, feedback can be provided based on the amount of time that it takes individuals to reach their target heart rate zone, the amount of time that the individual remains in the target heart rate zone, and the amount of time spent above their target heart rate zone. Another variable of interest is the amount of time that an individual takes to reach steady state exercise.

Heart rate and VO_2 are linearly related over a wide range of sub-maximal intensities (Astrand, 1986). Based on previous research, a nomogram was conducted to predict VO_{2max} from heart rate data. Understanding this relationship can lead to the ability to estimate VO_2 based on heart rate which can give a fair reflection of the intensity of work that is being performed (Achten, 2003). The relationship between heart rate and VO_{2max} is linear and is reflected in the slope of an HR-VO_{2max} curve. This relationship is curvilinear at very low intensities and toward maximal exercise (Davies, 1968).

There are several factors that can influence exercise heart rates. The basic factors consist of the intensity of the workout, biomechanical adaptations of the mode of exercise, and environmental factors. In a study conducted with older women, HR max was achieved in only 62% of participants in which a heart rate plateau was reached (Misquita, 2001). Arm level and the type of arm exercise have been suggested as possible factors that may affect heart rate during aerobic exercise (Carroll, 1991). Rate of Perceived Exertion (RPE) has been found to be higher during arm work than leg work (Pivarnik, 1988). Issues that can affect heart rate include cardiovascular drift, hydration status, temperature, and altitude (Achten, 2003). Validations of heart rate monitoring have shown correlations between heart rate monitoring and ECGs typically in the range of 0.94 to 0.99 (Lind, 2005).

To date there has been only one study conducted with the Curves circuit. The study conducted by researchers at the University of Wisconsin-LaCrosse studied women 20-55 years old who were recruited from two Curves locations. The women completed a maximal treadmill test and two 30-minute Curves workouts. The mean BMI of the 15 participants was 27.9 ± 6.0. Mean VO_{2max} was 29.2 ± 7.0. Mean HR_{max} was 169 ± 12. The measures of exercise intensity were highly correlated between the two workouts (r=0.885 to 0.964). The mean caloric expenditure was 184 ± 23.5. The energy expenditure averaged 6.4 kcals/min. This is comparable to other circuit weight-training programs (Greany, 2005). The conclusions from the study indicate that the Curves workout is a good low to moderate intensity exercise program (Greany, 2005).

Instrumentation provides the ability to perform valid and reliable field tests for VO_2, heart rate, and energy expenditure. These instruments provide a way to analyze specific exercise programs such as the Curves workout circuit. The proposed study is designed to quantify energy expenditure in terms of calories burned per exercise session and identify exercise intensity and average heart rate in a group of women participating in the Curves program.

CHAPTER THREE

Methods

This study is a component of ongoing Curves research conducted at Baylor University to determine the effects of the Curves exercise and diet program. This research was designed to assess several of the physiological variables that are involved in the Curves workout.

Participants

The participants in the study were women who have qualified for and participated in one of the Baylor University/Curves research studies. Seventy-eight (78) women participated in the study. Sixty-one (61) healthy, untrained, and moderately overweight female participants between the ages 18 to 65 participated in the heart rate monitor portion of the study. Thirty-three (33) healthy, untrained, and moderately overweight female participants between the ages 18 to 65 participated in the VO_2 portion of the study. Sixteen (16) women participated in both portions of the study. Moderately overweight was defined as having a Body Mass Index (BMI) between 27 and 31. Participants were not allowed to participate in this study if they had any metabolic disorder including known electrolyte abnormalities; heart disease, arrhythmias, diabetes, or thyroid disease; uncontrolled hypertension, hepatorenal, autoimmune, or neurological disease; and/or, if they have taken weight-loss dietary supplements (e.g.,thermogenics, etc) or medications within three months prior to the start of the study. The only exception was if the prospective subject had a medical condition or history that the subject's personal physician felt was controlled and therefore was not a limitation for her to participate in the study. Participants also were not eligible to participate in the Curves research if they had lost more than 20 pounds in the last six months.

Study Sites

All familiarization and baseline testing assessments were conducted in the Exercise & Sport Nutrition Laboratory (ESNL) in the Department of Health, Human Performance, and Recreation at Baylor University. Data for the research was gathered at the Curves circuit in the Student Life Center (SLC) at Baylor University, Waco, TX.

Exercise Site

The Curves circuit for this (and other Baylor studies) is located on the third floor of the Student Life Center (SLC) at Baylor University, Waco, TX. All exercise, heart rate, and VO_2 testing familiarizations and assessments were conducted at the SLC. Curves circuit equipment was used for the study. The Curves circuit located in the Baylor SLC is similar to Curves franchises and includes all of the machines that Curves has available. The Curves circuit is comprised of stations that individuals rotate around during a workout. The circuit is set up with hydraulic resistance exercise machines alternating with recovery pads. Individuals do calisthenics-type exercises on the recovery pads which are designed to maintain an elevated heart rate. Individual resistance machines are used for the following muscle groups: abdominal curl / back extension, hip adduction / hip abduction, biceps curl / triceps extension, chest press / seated row, triceps pushdown / upright row, leg extension / leg curl, chest fly / shoulder retraction, shoulder press / pull up, leg press, squat, trunk rotation, and hip extension.

Study Design

The primary Baylor University and Curves study that the women participated in involved baseline testing followed by 14 weeks of exercise at the Curves circuit. Participants for the heart rate and VO_2 study were recruited from individuals in the primary study. Participants participated in heart rate monitoring and VO_2 testing during regular exercise sessions during selected weeks of their 14-week study. Each participant had data collected two times during a seven-day span. Participants were allowed to participate in both the heart rate and VO_2 portions of the studies. For participants who volunteered for both studies, separate testing sessions were made for VO_2 testing and HR monitor testing. For these studies, the independent variable was the Curves workout. Dependent variables were exercise heart rate, sub-maximal VO_2, and caloric expenditure.

Table 1

Study Timeline

Step	Portion of the study
1	Recruitment of participants through media
2	Participants call the ESNL and complete telephone screening
3	Participants sign up for, and attend familiarization session
4	Participants schedule and complete baseline testing session
5	Participants report to SLC and complete workout familiarization session
6	Participants complete HR monitor and/or VO_2 familiarization session
7	Participants complete HR monitor and/or VO_2 testing sessions

Entry and Medical Screening Session

Participants were recruited by radio and newspaper ads in Waco, Texas, and surrounding communities. The ads briefly described the study, outlined qualifications, and instructed participants to call the ESNL. Participants who expressed interest in participating in this study were interviewed on the phone to determine if whether they qualified to participate in this study. Participants believed to meet eligibility criteria attended an entry/familiarization session. Any subject who did not meet entry criteria was required to obtain medical clearance from her personal physician prior to participating in baseline assessments. Participants who met eligibility criteria attended an entry/familiarization session for the study.

Medical Monitoring

Interested participants were invited to familiarization sessions. During this time, participants signed consent forms and completed medical history information. Participants then completed a general exam to determine whether the subject met entry criteria to participate in the study. A trained researcher evaluated the medical and training history questionnaires to determine whether the subject met entry criteria and was eligible to participate in the study. Trained non-physician exercise specialists certified in CPR supervised participants undergoing exercise assessments. A telephone and an automated electronic defibrillator were located in the laboratory in case of any emergencies, and there were no less than two researchers working with each subject during testing sessions. In the event of any unlikely emergency, one researcher would check for vital signs and begin any necessary interventions while the other researcher contacted Baylor’s campus police, which is standard university policy. Instructions for emergencies were posted above the phone in the ESNL in the event that any other research investigators were available for assistance. Participants were asked to report any unexpected problems or adverse events they encountered during the course of the study to the ESNL staff.

Familiarization Session

Participants eligible to participate in the study were introduced to the study protocol via a verbal and written explanation outlining the study design. During this session, participants signed informed consent statements and completed personal and medical histories. The purpose of the program was described to the participants along with the protocol to be followed and the experimental procedures used. Informed consent statements were in compliance with the Human Participants Guidelines of Baylor University and the American College of Sports Medicine. All eligible participants signed university-approved informed consent documents, and approval was granted by the Institutional Review Board for Human Participants. At the conclusion of the familiarization session, participants were given an appointment time to perform baseline assessments.

Baseline Testing Session

The baseline testing sessions used in this study provided information that was used in the analysis of the data for the heart rate and VO_2 studies. Participants reported to the ESNL for clinical assessments. Upon reporting to the lab, participants completed a battery of tests. The tests associated with this study were height, body weight, DEXA, and VO_{2max} treadmill test. Body weight was measured using a calibrated digital scale with a precision of $\pm$ 0.02 kg (Health-O-Meter, Bridgeview, IL). Standard protocols were used that included the removal of shoes and any other items (keys, etc.). Body composition and bone density measurements were determined using a Hologic 4500W dual-energy x-ray absorptiometry (DEXA). The DEXA body composition test required the participant to lie down on her back in a standardized position in a pair of shorts/t-shirt or a gown. A low dose of radiation then scanned the participant's body from head to toe for approximately six minutes. The DEXA segmented regions of the body (right arm, left arm, trunk, right leg, and left leg) into three compartments for determination of fat, soft tissue (muscle), and bone mass. Upon completion of the scan, the data were analyzed by a technician, and body fat percentage was determined by the DEXA software. Because women of childbearing age participated in this study, each subject completed a questionnaire related to their menstrual cycle timing, sexual activity, use of birth control pills, and desire to become pregnant. Heart rate was determined by palpitation of the radial artery using standard procedures for supine and standing methods (ACSM, 2000).

Maximal cardiopulmonary measurements were obtained using a Parvo Medics 2400 TrueMax metabolic measurement system (Sandy, UT). Participants were attached to a Quinton 710 ECG (Bothell, WA) and walked on a Trackmaster TMX425C treadmill (Newton, KS). Participants performed a maximal cardiopulmonary exercise stress test to assess aerobic capacity and anaerobic threshold. The participants performed a standard symptom-limited Bruce treadmill maximal exercise test. Maximal heart rate values were gathered from the ECG readings that were observed during the test. All testing was conducted in the Exercise & Sport Nutrition Laboratory (ESNL) in the Department of Health, Human Performance, and Recreation at Baylor University. Participants reported to the ESNL lab on their scheduled day of testing without having worked out 48 hours prior and in a 12-hour fasted state at week 0 and after weeks 2, 10, 11, and 14. Cardiopulmonary exercise tests were performed by certified exercise physiologists in accordance to standard procedures described by the American College of Sports Medicine's (ACSM) Guidelines for Exercise Testing and Prescription. This involved preparing the subject's skin for placement of 10 ECG electrodes. Electrode sites were cleansed with sterile alcohol gauze using a circular motion. The site was allowed to air dry or dried with a gauze pad. Electrodes were placed on the right subclavicular fossa (RA), left subclavicular fossa (LA), right abdomen (RL), left abdomen (LL), 4th intercostals space at the right sternal border (V1), 4th intercostals space at the left sternal border (V2), equidistant between V2 and V4 (V3), 5th intercostal space at the midclavicular line (V4), 5th intercostal space at the anterior axillary line (V5), and 5th intercostals space at the axillarly line (V6) of the chest. The participant was attached to a Quinton 710 ECG. Resting blood pressure, heart rate, and a 12-lead ECG were obtained. The exercise specialist reviewed the 12-lead ECG to ensure that no contraindications for exercise testing were apparent based on the ACSM guidelines. Participants then stood on a treadmill. A sterile mouthpiece attached to a head harness was secured on the participant. The participant then had a nose clip placed on her nose. Resting expired gases were collected using the Parvo Medics 2400 TrueMax Metabolic Measurement System. Once the participant was ready to begin the test protocol, the participant straddled the treadmill with both legs while the treadmill was turned on at a speed of 1.7 mph and at a 0% grade. The participant then used one foot to repeatedly swipe the belt in order to gauge the speed of the motion. Once the participant was familiar with this speed, she stepped onto the belt while still gripping the handrail with both hands. Once the participant became comfortable walking on the treadmill, she let go of the handrail(s) and began walking freely. The participant then performed a standard symptom-limited Bruce treadmill maximal exercise test.

The participants were encouraged to exercise to their maximum unless the participant experienced clinical signs to terminate the exercise test as stated by the ACSM's Guidelines for Exercise Testing and Prescription (i.e., angina, dyspnea, dizziness, a decline in systolic blood pressure, dangerous dysrhythmias [increasing or multi-form premature ventricular contractions, ventricular tachycardia, supraventricular tachycardia, new atrial fibrillation, or A-V block], lightheadedness, confusion, ataxia, cyanosis, nausea, excessive rise in systolic blood pressure over 250 mmHg or diastolic over 120 mmHg, chronotropic impairment, failure of the monitoring system, or other signs or symptoms for terminating the test). The test could also be terminated at the request of the participant. Once the exercise test was complete, the participant was observed for a 3-6 minute active recovery period (walking 2.0 mph) followed by a 3-6 minute seated recovery period. The normal exercise time to maximum of the Bruce treadmill protocol for untrained women is typically about 9 minutes (near the completion of stage III or just entering stage IV). Heart rate, ECG tracings, and expired gases were monitored continuously throughout the exercise test. Blood pressure and ratings of perceived exertion were obtained toward the end of each stage. Participants were asked to report any unusual signs or symptoms to the exercise specialists during the exercise test. These tests determined maximal aerobic capacity and anaerobic threshold to determine the effects of the exercise training on fitness and exercise capacity.

VANT was determined by identifying the VO_2 level that the individual attained that corresponds with three consecutive RER readings over 1.00 during the maximal treadmill test. If the test was stopped before three consecutive RER readings over 1.00, the highest VO_2 obtained was used for VANT.

Familiarization Session with Curves Workout Circuit

Once the participants completed their baseline testing session at the ESNL, they were cleared to begin the workout portion of the study. The participants reported to the Curves workout facility in the SLC. Each subject was led through an orientation by a Curves workout supervisor, who explained the concept of the workout, and showed the women how to use the machines, recovery pads, and stretching protocols. The orientation was conducted with demonstration, modeling, and hands on experience. The women were also asked if they would like to participate in the heart rate and VO_2 studies. The women were shown how to log in their attendance and how to fill out the weekly medical monitoring forms. Participants participated in the Curves 30-minute fitness program three times per week throughout the 14-week investigation. Participation involved exercising with hydraulic resistance exercise machines involving bi-directional resistance that worked all major muscle groups interspersed with calisthenics-type exercises on the recovery pads. Workout supervisors monitored exercise sessions and recorded attendance. Workout supervisors conducted data collection sessions for one week between each of the five testing sessions of the standard 14-week study, and in between each of the four testing sessions of the extension if they chose to participate in the one-year study extension. Each participant had data collected two times during a seven-day span.

Familiarization Session with HR Monitors

Each participant used both a heart rate monitor wristwatch and a telemetry strap (a combination of a sensor strap that is in the front and an elastic strap which fits around the back) during the data collection sessions. A heart rate monitor watch was worn to receive the data transmitted from the telemetry strap. The women completed a familiarization with the telemetry strap and the monitor wristwatch, and the women were instructed as to their responsibilities for the use of the equipment before the study began. During the workout via cues from the audio CD, the women were instructed to step away from the machines and check their heart rate. These heart rate checks occur every 8.5 minutes. The women were instructed to find their pulse and count the number of heart beats in a 10-second time period, using the start and stop prompts from the CD for the 10 second interval. The heart rate checks were the only feedback cues that the women received in terms of their workload during the circuit. At the end of the session, the women returned the heart rate monitor wrist watch and the telemetry strap to the workout supervisor. Women were instructed that the heart rate monitor testing sessions were to be done twice within a seven-day span, not on consecutive days and not on a day that they did any testing in the ESNL.

Familiarization Session with Portable VO_2 Metabolic Cart

Each subject wore the Cosmed $K4b^2$ portable metabolic cart during the VO_2 portion of the study. The Cosmed $K4b^2$ is comprised of a portable unit, a face mask, and a battery pack. The women wore a harness in which the portable unit was attached to the front, the battery was attached to the back of the harness, and the face mask was attached to the portable unit. Familiarizations with the Cosmed $K4b^2$ included measuring the participants for the proper facemask size (small, medium, large). Familiarizations also described how the facemask functioned as it was different from the Hans-Rudolph device that was used in the ESNL during baseline testing. The main difference in the two devices was the $K4b^2$ did not have a nose clip and a mouthpiece that was placed inside the participant's mouth. The Cosmed device used a facemask that covered both the nose and mouth to collect expired gases. Women were instructed on how to use the equipment with the harness and unit in place. One was to ensure that women not change any movements they typically do, but also to make sure that the lines that connect the pieces of the unit did not become tangled or caught on any piece of equipment. Once the women were familiarized with the portable metabolic cart, appointments were made for their testing sessions. Women were instructed that the VO_2 testing sessions were to be done twice within a seven-day span, not on consecutive days and not on a day that they did any testing in the ESNL.

Assessment and Workout Schedule

The study included baseline testing followed by 14 weeks of exercise using the Curves circuit. The participants were required to work out an average of three (3) times a week for the duration of the study. Sign-in logs were used to track attendance and protocol compliance. Participants participated in heart rate monitoring and VO_2 testing during regular exercise sessions during the 14-week study. Each participant had data collected during two exercise sessions during a seven-day span. Participants were allowed to participate in both studies. In these cases, separate testing sessions were made for VO_2 testing and HR monitor testing.

HR Monitor Testing

The participant's heart rate data were collected with the use of a Polar E600 wireless heart rate monitor. The heart rate monitor functioned through the use of a telemetry strap that was placed against the skin at the base of the pectoral muscles and attached with an elastic strap. The transmitter detected an individual's heartbeat through the electrodes that were against the chest and transmitted the information though a low frequency electromagnetic field to the wristwatch receiver. The microprocessor, contained in the wristwatch, calculated a value for current heart rate and sent the heart rate signal to the display on the wristwatch (Boudet, 2001). Polar hardware and software were used to download and analyze data that were collected from the heart rate monitor during the exercise sessions. The Polar E600 PC Interface, which connects to a PC through a USB port, downloaded and stored heart rate data from the Polar E600 wristwatch to a PC. The Polar E Series software and Polar E600 PC Interface recorded and downloaded heart rate data for the purpose of analyzing data and tracking participant progress over time.

When the participants arrived for their testing session they were given a telemetry strap and heart rate monitor to put on before their workout. Once the women were ready to workout, the workout supervisor ensured the functioning of the heart rate monitoring equipment. Once the equipment was determined to be working and measuring an appropriate heart rate, the women began their workout. The workout supervisors started the heart rate monitoring equipment, and it ran for the duration of the workout. The participants performed the workout as described in the familiarization session with

Curves Workout circuit section. They also performed the tasks at the heart rate checks as described in the familiarization session with HR monitors section.

VO_2 Testing

VO_2 data during the exercise program was collected with the use of Cosmed K4b^2 portable metabolic unit. The Cosmed K4b^2 was fixed to the patient during the test by an anatomic harness. The Cosmed K4b^2 was comprised of a portable unit, which contained O_2 and CO_2 analyzers, sampling pump, UHF transmitter, barometric sensors and electronics. The portable unit was powered by the rechargeable battery fixed to the back side of the harness. The portable unit was calibrated to room air and reference gas before each workout. The participant's demographic data was entered into the Cosmed software.

When the participants arrived for their testing session, the harness was placed on them and tightened to their preference. The headpiece and facemask were placed on the participant and secured through the use of four Velcro straps. One final room air calibration was completed. The sampling line was placed in the optical gas reader, and the data began transmission to the telemetry unit and recording on the portable unit. Once the women were ready to workout, the workout supervisor ensured the functioning of the VO_2 equipment. Once the equipment was determined to be working and collecting data, the women began their workout, and the test was started on the unit. The unit ran for the duration of the test and was stopped by the workout supervisor at the conclusion of the workout. The participants performed the workout as described in the familiarization session with Curves Workout circuit section.

Data Analysis

The data collected from the Polar heart rate testing sessions was downloaded using the Polar E600 PC interface and analyzed using the Polar software and SPSS. Data collected from the Cosmed K4b^2 VO_2 testing sessions was downloaded and analyzed using the Cosmed software. This data was then exported to a SPSS file for statistical analysis. Data from the maximal treadmill exercise testing sessions was entered into SPSS. Editing functions of both the Polar and Cosmed software programs were utilized to smooth any data that was considered out or range of acceptable or possible values. Data that falls out of the acceptable or possible ranges can be caused by electrical interference, a blocking of the transmission signal (from the HR strap to the HR monitor watch or from the portable VO_2 unit to the computer).

Descriptive statistics were determined for all participants and for each study. Descriptive statistics that were reported were age, height, weight, BMI, and body fat. Other data was collected for the variables of exercise heart rate, percentage VO_{2max}, MET_{max}, and VANT. Descriptive statistics were used to determine means and percentage of maximum for comparing sub-maximal exercise tests with maximal exercise tests. Fifteen second HR and thirty second VO_2 values recorded during the circuit training session were analyzed using repeated measures analysis of variance (ANOVA).

HR monitors were used to directly measured HR values. The metabolic data was used to directly measure energy expenditure and VO_2. Mean values for heart rate, VO_2, caloric expenditure, and RER were calculated. Dependent t-tests with Pearson product correlation were used to compare the reliability of the mean values for the two heart rate exercise sessions and the reliability of the mean values for the two VO_2 monitor sessions.

Maximal heart rate and peak VO_2 were determined from the subject's maximal treadmill test from their most recent testing session and were used to calculate each individual's percentage of maximal heart rate that the subject exercised at during the exercise sessions. In addition, Ventilitory Anaerobic Threshold (VANT) was determined using standard procedures to determine the highest aerobic workload the subjects were able to exercise at before reaching VANT. Observed HR and VO_2 responses during the Curves exercise sessions were compared to VANT values and ACSM exercise standards. Correlation was determined by the Pearson product moment correlation coefficient. This measure indicates the linear relationship between two variables. R^2 was calculated for all correlations. R^2 is the relative predictive power of a model. R^2 is a descriptive measure between 0 and 1. The closer R^2 is to one, the greater ability to predict from the model.

All data were considered statistically significant when the probability of type I error is 0.05 or less. If a significant group, treatment and/or interaction alpha level is observed, least significant differences (LSD) post-hoc analyses will be performed to determine where significance was obtained.

CHAPTER FOUR

Results

Seventy-eight (78) sedentary, overweight females (ages 18-65, BMI > 27) participated in the study. Thirty-three sedentary, overweight females (ages 18-65, BMI > 27) participated in the VO_2 portion of the study. All subjects completed the study with no adverse affects. Table 2 contains the descriptive data for all 78 participants in the study. The mean BMI (33.1 ± 5.48) classifies the average individual in the study as obese, class I by ACSM guidelines. The mean body fat percentage (43.5 ± 4.5 %) is classified in the unhealthy range (too high) by the ACSM guidelines.

Table 2

Participant Descriptive Data (n=78)

Variable	Minimum	Maximum	Mean ± SD
Height (inches)	59.8	72.0	64.0 ± 2.71
Weight (pounds)	136.6	302.0	192.1 ± 30.43
Age	24	66	53.6 ± 7.09
BMI	23.42	55.35	33.1 ± 5.48
Body Fat %	33.4	54.5	43.5 ± 4.52

The information in Table 3 describes the data from the 78 maximal treadmill tests conducted during the baseline testing sessions. The mean VO_{2max} level was 20.6 ± 4.0 ml/kg/min. This classifies as low for the mean age of the participants. The mean treadmill time, (5.33 ± 1.54 minutes) shows that the average woman stopped the treadmill test during stage two of the maximal treadmill protocol. The mean VO_2 at VANT was 18.2 ± 3.70 ml/kg/min. VANT occurred at a mean of 88.6 ± 10.14% of the mean VO_{2max}. The mean HR_{max} for the treadmill test was 152 ± 17 bpm. This HR_{max} value was used for calculations concerning maximal heart rates and HRR for the exercise sessions.

Table 3

Participant Baseline Treadmill Data (n=78)

Variable	Minimum	Maximum	Mean ± SD
VO_{2max} (ml/kg/min) (treadmill)	12.5	31.2	20.6 ± 3.99
VO_2 (L/min) (treadmill)	1.27	2.71	1.8 ± 0.31
MET_{max} (treadmill)	3.6	8.9	5.9 ± 1.14
VO_2 at VANT (ml/kg/min) (treadmill)	10.5	29.6	18.2 ± 3.70
VANT % of VO_{2max} (treadmill)	44.87	100	88.6 ± 10.14
Treadmill test time (minutes)	1.17	8.17	5.3 ± 1.54
Treadmill HR (bpm)	104	195	151 ± 17

Table 4 lists the heart rate variables that were collected for all 78 of the participants during the study. Supine and resting heart rate data were collected before the maximal treadmill test. HR_{max} data was collected during the individual participant's last stage of the treadmill test. This value was the highest heart rate recorded on the ECG. The exercise heart rate values were collected via heart rate monitors during the two exercise sessions that the women completed. Percentage of HR_{max} was calculated using the Karvonen formula. Resting heart rate ranges (supine = 66 ± 9 bpm, standing 76 ± 12 bpm) fall within the normal ranges for sedentary, healthy women.

Table 4

Resting Heart Rate Variables (n=78)

	Mean Heart rate (bpm) (Mean ± SD)	% HR_{max} [a]
Resting HR (supine)	66 ± 9	44.1 ± 7.29
Resting HR (standing)	76 ± 12	51.0 ± 9.61

[a] = maximum heart rate from treadmill tests was used to calculate % HR_{max}.

The data in Table 5 indicate the heart rate values for the 78 participant's exercise sessions at the Curves circuit. The mean maximal heart rate from the treadmill test was 151 ± 17 bpm. The mean heart rate for the first exercise session was 120 ± 16 bpm. The mean heart rate for the second exercise session was 117 ± 16 bpm. Sixty (60) percent HRR was calculated with the ACSM formula $([HR_{max} – HR_{rest}] * .60) + HR_{rest}$. Eighty (80) percent HRR was calculated with the ACSM formula $([HR_{max} – HR_{rest}] * .80) + HR_{rest}$. HR_{max} was measured from the maximal treadmill test. HR_{rest} was measured from supine resting values during lab baseline testing sessions. Sixty percent HRR was calculated at 117 ± 11 bpm. Eighty percent HRR was calculated at 134 ± 14 bpm. The mean HR for the first exercise session falls within the 60-80% HRR. The mean HR for the second exercise session falls within the 60-80% HRR. The mean HR for both exercise sessions combined falls within the 60-80% HRR recommendation. Based on the data collected for exercise heart rate levels, study H_2 is accepted. The Pearson correlation for exercise heart rate for the two exercise testing sessions was r=0.81. R squared for exercise heart rate for the two exercise testing sessions was r^2=0.66. The Pearson correlation for $\%HR_{max}$ for the two exercise testing sessions was r=0.80. R squared for $\%HR_{max}$ for the two exercise testing sessions was r^2=0.64. The Pearson correlation for %HRR for the two exercise testing sessions was r=0.78. R squared for %HRR for the two exercise testing sessions was r^2=0.61.

Table 5

Exercise Heart Rate Variables (n=78)

	Mean Heart rate (bpm) (Mean ± SD)	% HR_{max}[a]	%HRR[a]
Exercise HR Test 1 (circuit)	120 ± 16	79.8 ± 9.54	64.3 ± 16.11
Exercise HR Test 2 (circuit)	117 ± 16	78.8 ± 10.53	61.4 ± 17.32
Exercise HR Tests 1 & 2 (circuit)	119 ± 15	79.01 ± 9.52	62.9 ± 15.75

[a] = maximum heart rate from treadmill tests was used to calculate % HR_{max} and HRR.

Figure 1 shows the mean heart rate values during the Curves workout. Heart rate data was recorded every 15 seconds for the duration of the workout.

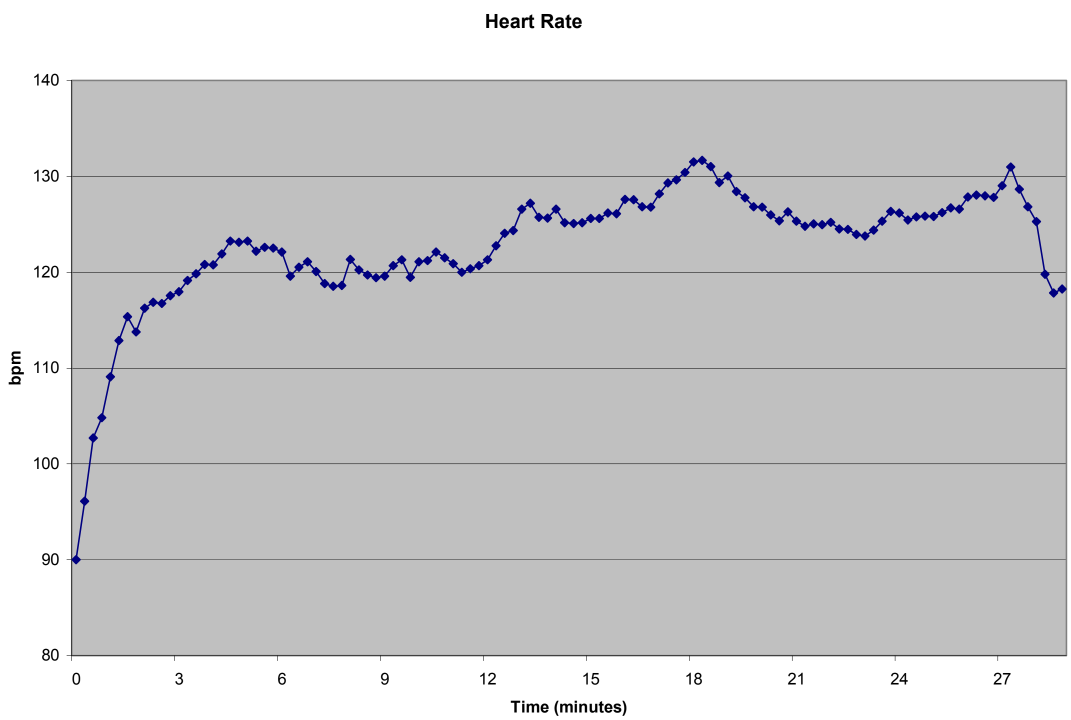

Figure #1. Mean Heart Rate Values

Table 6 contains the descriptive data for the 33 participants in the VO_2 portion of the study. The mean BMI (32.8 ± 5.89) classifies the average individual in the study as obese, class I. The mean body fat percentage (42.4 ± 4.9%) is classified in the unhealthy range (too high).

The data in Table 7 describe the data from the maximal treadmill tests conducted during the baseline testing sessions for the 33 participants in the VO_2 portion of the study. The mean VO_{2max} level (20.7 ± 3.70 ml/kg/min) classifies as low for the mean age of the participants. The mean VO_2 at VANT was 18.4 ± 3.45 ml/kg/min. VANT occurred at a mean of 89.5 ± 9.46% of the mean VO_{2max}. The mean treadmill time, (5.5 ± 1.48

Table 6

VO_2 Participant Descriptive Data (n=33)

Variable	Minimum	Maximum	Mean ± SD
Height (inches)	59.8	72.0	64.5 ± 3.01
Weight (pounds)	136.6	302.0	193.1 ± 31.73
Age	24	62	52.7 ± 6.68
BMI	23.4	55.4	32.8 ± 5.89
Body Fat %	33.4	52.3	42.4 ± 4.90

minutes) shows that the average woman stopped the treadmill test during stage two of the maximal treadmill protocol. The mean HR_{max} for the treadmill test was 151 ± 15 beats per minute.

Table 8 lists heart rate variables that were collected for the 33 VO_2 participants in the study. Percentage of HR_{max} and percent HRR were calculated using ACSM formulas. Resting heart rate ranges (supine = 64 ± 9 bpm, standing 75 ± 9 bpm) fall within the normal ranges for sedentary, healthy women.

The data in Table 9 indicate the heart rate values for the exercise sessions at the Curves circuit for the 33 participants in the VO_2 portion of the study. The mean maximal heart rate from the treadmill test was 151 ± 15 bpm. The mean heart rate for the first exercise session was 120 ± 13 bpm. The mean heart rate for the second exercise session was 116 ± 15 bpm. Sixty percent HRR was calculated at 117 ± 10 bpm. Eighty percent HRR was calculated at 134 ± 13 bpm. The mean HR for the first exercise session falls

Table 7

VO_2 Participant Baseline Treadmill Data (n=33)

Variable	Minimum	Maximum	Mean ± SD
VO_{2max} (ml/kg/min) (treadmill)	14.9	26.8	20.7 ± 3.70
VO_2 (L/min) (treadmill)	1.28	2.32	1.8 ± 0.28
MET_{max} (treadmill)	4.3	7.6	5.9 ± 1.10
VO_2 at VANT (ml/kg/min) (treadmill)	12.1	26.1	18.4 ± 3.45
VANT % of VO_{2max} (treadmill)	61.73	100	89.5 ± 9.46
Treadmill test time (minutes)	3.27	7.65	5.5 ± 1.48
Treadmill HR (bpm)	108	178	151 ± 15

within the 60-80% HRR recommendation. The mean HR for the second exercise session falls within the 60-80% HRR recommendation. The mean HR for both exercise sessions combined falls within the 60-80% HRR recommendation. Based on the data collected for exercise heart rate levels, study H_2 is accepted. The Pearson correlation for exercise heart rate for the two exercise testing sessions was r=0.72. R squared for exercise heart rate for the two exercise testing sessions was r^2=0.52. The Pearson correlation for $\%HR_{max}$ for the two exercise testing sessions was r=0.77. R squared for %HR_{max} for the two exercise testing sessions was r^2=0.59. The Pearson correlation for %HRR for the two exercise

Table 8

VO_2 Participant Resting Heart Rate Variables (n=33)

	Mean Heart rate (bpm) (Mean ± SD)	% HR_{max} [a]
Resting HR (supine)	64 ± 9	43.15 ± 6.88
Resting HR (standing)	75 ± 9	50.35 ± 8.18

[a] = maximum heart rate from treadmill tests was used to calculate % HR_{max}.

testing sessions was r=0.74. R squared for %HRR for the two exercise testing sessions was r^2=0.55.

Table 9

VO_2 Participant Exercise Heart Rate Variables (n=33)

	Mean Heart rate (bpm) (Mean ± SD)	% HR_{max} [a]	%HRR [a]
Exercise HR Test 1 (circuit)	120 ± 13	80.39 ± 9.30	65.53 ± 15.52
Exercise HR Test 2 (circuit)	116 ± 15	77.68 ± 10.68	60.83 ± 17.59
Exercise HR Tests 1 & 2 (circuit)	118 ± 13	79.03 ± 9.39	63.18 ± 15.46

[a] = maximum heart rate from treadmill tests was used to calculate % HR_{max} and HRR.

One way to express exercise intensity is in terms of METs. The women who participated in the VO_2 portion of the study had MET levels measured for both the maximal treadmill session and the exercise sessions. Table 10 lists the mean MET levels for the treadmill and the exercise sessions. The mean MET_{max} for the treadmill was 5.90 ± 1.05. The first exercise session MET mean was 3.62 ± 0.69. The second exercise session mean was 3.60 ± 0.82. When comparing the MET_{max} from the treadmill values to the MET levels for the exercise sessions, the % of MET_{max}, falls within the ACSM recommendations for exercise. The Pearson correlation for $\%MET_{max}$ for the two exercise testing sessions was r=0.66. R squared for $\%MET_{max}$ for the two exercise testing sessions was r^2=0.44.

Table 10

Percentage METs (n=33)

	Min	Max	Mean ± SD	% of MET_{max}
Mean METs (treadmill)	4.3	7.6	5.90 ± 1.05	-
Mean METs (exercise test 1)	2.3	5.2	3.62 ± 0.69	61.36
Mean METs (exercise test 2)	2.0	5.6	3.60 ± 0.82	61.01

Table 11 describes the variables that were collected during both of the exercise testing sessions for the 33 women that participated in the VO_2 portion of the study. The mean RER for the first exercise testing session was 1.00 ± 0.07. The mean RER for the second exercise testing session was 0.98 ± 0.05. The caloric expenditure for the first 30-minute exercise session was 164.5 ± 25.19 kcals. The caloric expenditure for the second

30-minute exercise session was 160.6 ± 28.36 kcals. This results in an average of 5.5 kcals per minute for the first exercise session and 5.4 kcals per minute for the second exercise session. Based on the caloric expenditure data, the Curves workout contributes over 50% of the ACSM recommendation for 300 kcals per day caloric deficit to promote and maintain weight loss. Based on this information, H_0 is accepted. The Pearson correlation for $\%VO_{2max}$ for the two exercise testing sessions was r=0.83. R squared for $\%VO_{2max}$ for the two exercise testing sessions was r^2=0.69. The Pearson correlation for RER for the two exercise testing sessions was r=0.74. R squared for RER for the two exercise testing sessions was r^2=0.55. The Pearson correlation for caloric expenditure for the two exercise testing sessions was r=0.78. R squared for caloric expenditure for the two exercise testing sessions was r^2=0.61.

Table 11

VO_2 Participant Exercise VO_2 Variables (n=33)

	Test 1 Mean ± SD	Test 2 Mean ± SD
RVO_2	12.9 ± 2.40	12.8 ± 2.87
AVO_2	1,116.6 ± 179.96	1,089.8 ± 202.57
RER	1.00 ± 0.07	0.98 ± 0.05
METs	3.62 ± 0.69	3.60 ± 0.82
Kcals (30 minute circuit)	164.5 ± 25.19	160.6 ± 28.36
Kcals (per minute)	5.5	5.4

Figure 2 shows the changes in oxygen use during the Curves workout. Data was collected every 30 seconds for the duration of the workout.

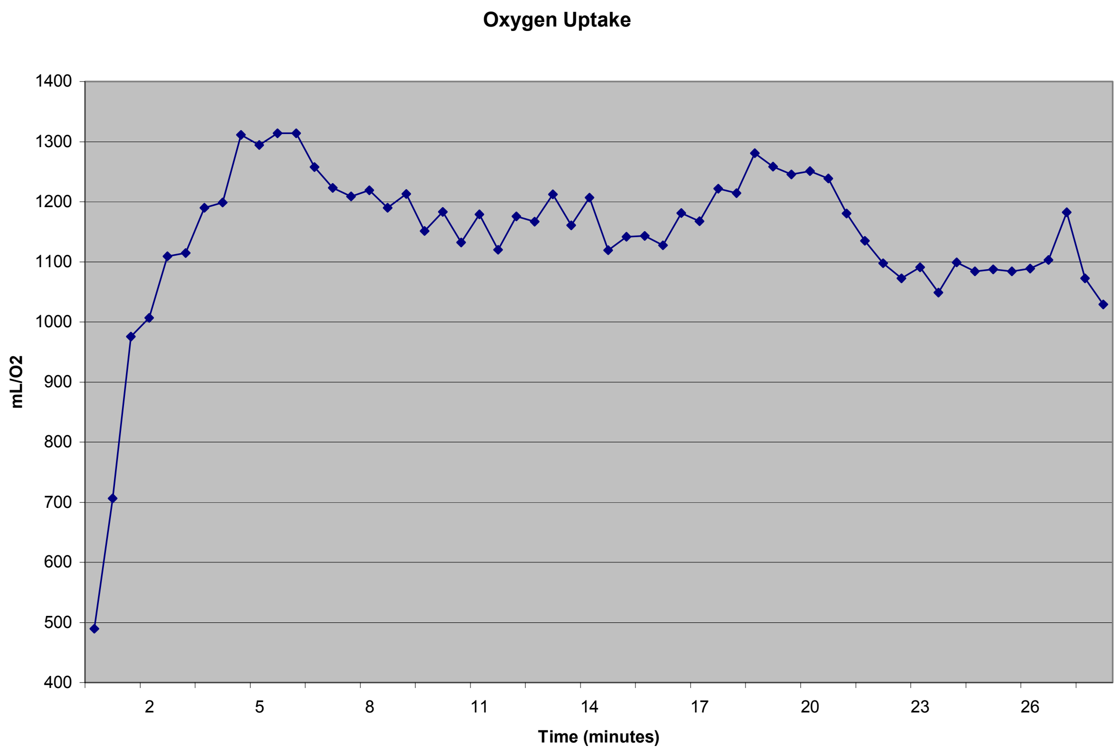

Figure #2. Mean Oxygen Uptake Values

One of the factors involved in exercise programs is the consistency of intensity of exercise. One of the important variables of the study was to determine what percentage of VO_{2max} the women were exercising at during the Curves workout. The mean percentage of VO_{2max} for the first exercise session was 64.15 ± 11.93%. The mean percentage of VO_{2max} for the second exercise session was 62.40 ± 11.65%. Based on this data, the women were exercising within the recommended range for percentage of VO_{2max}. The correlation for the exercise session in terms of percentage of VO_{2max} was r=0.83. Therefore, H_1 is accepted. This study compared the 33 participants in the VO_2

portion of the study to determine the correlation of the two exercise sessions. The correlations for the variables ranged from 0.74 (RER) to 0.85 (ExHR). Table 12 lists the variables measured and their correlations between exercise testing session one and exercise testing session two.

Table 12

Correlations for Heart Rate and VO_2 Variables (n=33)

	Mean Test 1	Mean Test 2	$r =$	$r^2 =$
Circuit Heart rate (submax) (bpm)	121.0	119.3	0.85	0.72
RVO_2	12.9	12.8	0.82	0.67
AVO_2	1,116.6	1089.8	0.78	0.61
% VO_{2max}	64.15	62.40	0.83	0.69
RER	1.00	0.98	0.74	0.55
METs	3.62	3.60	0.81	0.66
Kcals	164.5	160.6	0.78	0.61

CHAPTER FIVE

Discussion

The completed study is a component of ongoing Curves research conducted at Baylor University to determine the effects of the Curves exercise program. This research was designed to assess several of the physiological variables that are involved in the Curves workout. This study was designed to identify average exercise intensity, average HR and energy expenditure in a group of women participating in the Curves program. This study was also designed to quantify energy expenditure in terms of calories burned per exercise session and amount of substrate (carbohydrate and fat) used for energy during the Curves circuit workout based on heart rate and VO_2 data.

The importance of research studies such as the current study are to improve the health of individuals. Healthy People 2010 is a national health promotion and disease prevention initiative. The goals are to increase the quality and years of healthy life. The Healthy People 2010 project has a specific focus area for physical activity and fitness. The primary goal of Healthy People 2010 focus area 22 is to improve health, fitness, and quality of life through daily physical activity. There are five objectives in the Healthy People 2010 objectives that are applicable to the population of this study. Table 13 lists the goals of Healthy People 2010 focus area 22.

General Exercise

The current public health recommendation for physical activity is for individuals to participate in at least 30 minutes of moderate intensity physical activity on most, preferably all days of the week (ACSM, 2000). Programs that are conducted at least 3 days a week of at least a sufficient intensity and duration to expend approximately 250-

Table 13

Healthy People 2010 Physical Fitness Objectives

Objective	Description
Objective 22-1	Reduce the proportion of adults to 20% who engage in no leisure time physical activity. (In 1997, the level was 40%).
Objective 22-2	Increase to at least 30% the proportion of adults who engage regularly, preferably daily, in moderate physical activity for at least 30 minutes per day. (In 1997, 15% met this goal).
Objective 22-4	Increase to at least 30% the proportion of adults who perform physical activities that enhance and maintain muscular strength and endurance. (In 1998, 18% met this goal).
Objective 19-1	Increase to at least 60% the proportion of adults who are at a healthy weight. (In 1998-1994, 42% met this goal).
Objective 19-2	Reduce to less than 15% the proportion of adults who are obese. (In 1988-1994, 23% were obese).

300 kcal per exercise session (for a 75kg individual) are suggested as a threshold level for total body mass and fat mass loss. This level of activity generally requires 30-45 minutes of exercise per session (ACSM, 2000). Research on circuit training shows that

participation in circuit training increases strength, improves body composition, and produces a slight increase in VO_{2max} (Jackson, 1992). These recommendations encourage the public to engage in at least moderate amounts and moderate intensities of daily physical activity (activities that are approximately 3-6 METs) (ACSM, 2000). This level represents the lower end on the intensity scale to improve fitness for many sedentary, overweight, asymptomatic individuals (ACSM, 2000). Because of the fitness levels of the women in the study, this low end of the intensity scale is an appropriate place to start because of the high level of intensity of exercise for the women. Exercising at the middle or upper level of the range would be difficult or impossible because of the high level of intensity of exercise for the women. When exercise is performed above the minimum threshold, the volume of training (kcal) is an important determinant of the increase of VO_{2max} (ACSM, 2000). Research has shown that results at 12 months of exercise, there did not seem to be any additional benefit of vigorous exercise intensity over moderate exercise intensity (Jakicic, 2003).

The Curves exercise program qualifies as moderate intensity exercise. This identifies the Curves program as the minimum recommended intensity of exercise for exercise program recommendations by the CDC (1995), Surgeon General (1996), ACSM (2001), Institute of Medicine (2002), and the International Association for the Study of Obesity (2003) (Jakicic, 2003). The current research is consistent with previous research that focused on increasing physical activity. These previous studies indicate that the selected intensities by non athletic individuals are generally within the ACSM recommendations. On average, participants tended to choose intensities of physical activity that approximated the level of transition from aerobic to anaerobic metabolism.

Specifically, the selected intensities are within the ranges for $\%HR_{max}$, VO_{2max} (Lind, 2005).

Height and Weight

The mean height for the participants in the study was 64.0 ± 2.71 inches. The mean weight for the study was 192.1 ± 30.43 pounds. Based on the height and weight data from this study, the 1995 USDA Healthy Weight Ranges for Men and Women suggest a weight range of 111-146. Using this data to determine relative body weight, the average individual in the study is 149.49% of their desirable weight. Based on the USDA standards, this classifies the average participant as moderately obese (Nieman, 2003). Therefore, suggestions of participation in exercise and caloric restriction would be indicated for these women. Research suggests that modest reductions in body weight (5-10%) can significantly improve health (ACSM, 2000).

Body Mass Index

Body Mass Index (BMI) is an important index because of its curvilinear relationship with all-cause mortality. As BMI increases, the risk of cardiovascular complications increase as well (McArdle, 2001). Fifty-five to sixty percent of adults over the age of 18 in the United States are classified as overweight (BMI ≥ 25). Twenty-two percent of adults are obese (BMI>30) (ACSM, 2000). Recent evidence indicates that there is a significant increase in health risk with a BMI ≥ 25 (ACSM, 2000). Data from the World Health Organization classify the mean BMI in this study (33.1 ± 5.48) for the mean age (53.6 ±7.09) as obesity class I (Heyward, 2002). BMIs ≥ 30 are considered a risk factor for coronary heart disease (Heyward, 2002). The National Institutes of Health suggest that individuals with a BMI ≥ 25 or over are indicated as individuals who should loose weight. Therefore, suggestions of participation in exercise and caloric restriction to lower BMI would be indicated for these women.

Body Composition

The mean percentage of body fat (43.5 ± 4.52%) for the mean age (53.6 ± 7.09) in this study is classified as high (>35%) (Jackson, 1992). A classification of high body fat suggests that the individual is overweight to a degree of potentially causing adverse health consequences. People with this classification should be encouraged to lose weight. (Jackson, 1992). Based on criteria developed by Lohman, Houtkooper and Going, the mean percentage of body fat (43.5 ± 4.52%) for the mean age (53.6 ± 7.09) in this study is classified as obese (>38%) (Lohman, 1997). Percent body fat norms classify the mean participant in this study as unhealthy (too high) (Nieman, 2003). ACSM standards place the mean age and mean percent fat in the 10^{th} percentile (37.9% fat) (ACSM, 2000). Therefore, activities (both exercise and nutrition) that work toward lowering percent body fat, would be indicated for these women.

VO_{2max}

Maximal oxygen uptake has been accepted as the gold standard for cardiovascular fitness (ACSM, 2000). Literature has shown that aerobic training of fewer than two days per week at less that 40-50% of VO_2R, and for a duration of less than 10 minutes is not generally sufficient for developing and maintaining fitness in health adults (ACSM, 1998). For this study, the mean VO_{2max} levels were 20.6 ± 3.99 ml/kg/min. Based on the VO_{2max} criteria used by the Cooper Institute for Aerobics Research, the mean VO_{2max} levels for this study classify as poor (Heyward, 2002). The ACSM classifies the mean age and mean VO_{2max} in this study in the 10^{th} percentile (22.3 ml/kg/min) (ACSM, 2000).

The ACSM guidelines recommend an exercise intensity of 50-85% VO_{2max}. The mean percentage of VO_{2max} for the first exercise session was 64.15 ± 11.93%. The mean percentage of VO_{2max} for the second exercise session was 62.40 ± 11.65%. Based on this data, the women were exercising within the recommended ACSM range for percentage of VO_{2max}. The correlations for the exercise session in terms of percentage of VO_{2max} was r=0.83. Therefore, H_1 is accepted.

VANT

VANT was determined from data gathered during the maximal treadmill test. VANT is defined as the oxygen uptake at which the blood lactate concentration begins to rise significantly above normal resting values. VANT is the point of inflection at which VCO_2 and therefore VE increase relative to VO_2. VANT was determined by identifying the VO_2 level that the individual attained that corresponds with three consecutive RER readings over 1.00 during the maximal treadmill test. If the test was stopped before three consecutive RER readings over 1.00, the highest VO_2 obtained was used for VANT. The mean VO_2 at VANT for the entire group of 78 participants was 18.2 ± 3.70 ml/kg/min. VANT occurred at a mean of 88.6 ± 10.17% of the mean VO_{2max}. The mean VO_2 at VANT for the VO_2 group (n=33) was 18.4 ± 3.45 ml/kg/min. VANT occurred at a mean of 89.5 ± 9.46% of the mean VO_{2max}. The high VANT levels indicate that the women were exercising at a level at which they were mostly using carbohydrates for fuel. The predominant use of carbohydrates indicates that the women are nearing maximal work, and therefore not able to continue to increase the exercise intensity for long periods of time.

HR_{max}

After age 25, maximal heart rate declines about 7-10 beats per decade. The variable of HR_{max} is a component of cardiac output, and part of the equation for the physiological definition of VO_{2max} (Jackson, 1992). Based on this information as the women continue to age, this change in HR_{max} can affect VO_2 levels, and all equations that use HR_{max} as a component (Karvonen formula and HRR). The recommendation for intensity of exercise is 55-90%HR_{max} (Heyward, 2002). The maximal heart rate method is suggested for use with older clients as it is a more accurate estimate of VO_{2peak} than %HRR (Heyward, 2002). For the current study, HR_{max} was determined by the highest heart rate recorded by the ECG during the maximal treadmill test. The method of measuring HR_{max} is preferred to using the Karvonen formula (age predicted HR_{max}, 220-age), in older individuals (Heyward, 2002). Research by Kohrt indicates that heart rate when expressed in terms of maximal heart rate is an appropriate method of prescribing exercise intensity in healthy sedentary women (Kohrt, 1998). The %HR_{max} data from this study are consistent with research conducted by Laukkanen with aerobic dancers who participated in floor based aerobic classes. The mean %HR_{max} for the Curves study was 79.01 ± 9.52%. The mean %HR_{max} for the Laukkanen study was 80% (Laukkanen, 2001).

Resting Heart Rate

Typical resting heart rates are about 70-80 beats per minute (Jackson, 1992). The resting heart rate values for this study were 66.2 ± 9.05 bpm (supine) and 76.5 ± 12.45 bpm (standing). Based on the data collected, resting heart rates for this study were within the normal expected ranges.

Heart Rate Reserve

Heart rate reserve method takes into account both the maximal heart rate as well as the resting heart rate. $HRR = ([HR_{max} – HR_{rest}] * intensity) + HR_{rest}$. The ACSM recommends using 40-85%HRR for exercise prescription (Heyward, 2002). Based on the mean heart rates for this study, the %HRR for the first exercise session was 64.3 ± 16.11%. The %HRR for the second exercise session was 61.4 ± 17.32%. The %HRR for the average of the two exercise session was 62.9 ± 15.75. Based on the heart rate reserve method, this study shows the Curves circuit to be an appropriate workout in terms of %HRR intensity level.

METs

METs (metabolic equivalent) are another way to identify exercise intensity. METs are multiples of the resting metabolic rate. One MET equals 3.5 ml/kg/min. The mean MET level for this study for the first exercise session was 3.62 ± 0.69 METs. The mean MET level for the second exercise session was 3.60 ± 0.82. Based on the Met classification of physical activity done by women, the Curves workout classifies as moderate intensity (2.8-4.3 METs) (McArdle, 2001). The mean treadmill MET_{max} for this study was 5.90 ± 1.05 METs. This MET_{max} level falls in the heavy category for exercise intensity (4.4-5.9 METs) (McArdle, 2001). The MET_{max} values suggest the women were at or near maximal exertion for the maximal treadmill test.

Caloric Expenditure

The interaction of physical activity intensity, duration, and frequency determines net caloric expenditure for the given mode of exercise (ACSM, 2000). The ACSM recommends a combination of reduction in energy intake and increases in energy expenditure through structured exercise and other forms of physical activity to be a component of weight loss programs (ACSM, 2000). This recommendation suggests a target range of 150-400 kcals of energy expenditure per day in physical activity and / or exercise (ACSM, 2000). Significant health benefits can be recognized with participation in a minimum of 150 minutes (2.5 hours) of moderate intensity exercise per week, and overweight and obese individuals should progressively increase that level as an exercise goal (ACSM, 2000). The mean kcals per session for this study was 164.5 ± 25.19 for the first exercise session and 160.6 ± 28.36 for the second exercise session. The number of calories burned and the length of the exercise session resulted in 5.5 kcals per minute for the first workout and 5.4 kcals per minute for the second workout. This level of caloric expenditure is consistent with a study by Branch who measured moderate intensity exercise in women. The Branch study's moderate intensity group exercised at a level of 4.78 kcals per minute (Branch, 2000).

One guideline for caloric expenditure is burning 4 kcals per kilogram of body weight per exercise session (Jackson, 1992). The mean weight in kilograms for this study was 87.31 ± 13.83. Therefore the guideline would be to burn 349.24 kcals per exercise session. The mean kcals per session for this study was 164.5 ± 25.19 for the first exercise session and 160.6 ± 28.36 for the second exercise session. This research shows the Curves circuit to burn approximately 1.9 kcals per kilogram of body weight. While the Curves workout does not meet the 4 kcal per kilogram of body weight guideline, the caloric expenditure they achieved is reasonable. Because of the fitness levels of the individuals they are exercising at levels that are too high to achieve the 4kcal per kilogram level.

The women in this study had a mean VO_2 (L/min) of 1.8. Using the criteria of 5 kcals per liter of oxygen, these women were capable of burning 9 kcals per minute of exercise. Based on a 30 minute workout (consistently at a VO_2 (L/min) of 1.8) the women could burn 270 calories during the workout. Because of the low aerobic capacity of the women and their exercise intensity, they were burning 164 (61% of 270) and 160 (59% of 270) calories for the two workouts. Women with higher aerobic capacities could burn more calories during the workout. If a woman had a VO_2 (L/min) of 3.0, that would result in the potential to burn 15 kcals per minute. Based on a 30 minute workout (consistently at a VO_2 (L/min) of 3.0) the women could burn 450 calories during the workout.

Respiratory Exchange Ratio

Respiratory Exchange Ratio (RER) is used to determine the type of fuel (primarily fat or carbohydrate) being used by the muscles. RER is the ratio between the amount of carbon dioxide produced and the amount of oxygen consumed. When only fats are being used, RER = 0.71. When only carbohydrates are being used, RER = 1.00. RER values closer to 1.00 indicate that carbohydrate is the preferred fuel during heavy exercise. Resting RER values are typically 0.75-0.81. Maximal exertion typically is indicated by an RER of 1.15 (Nieman, 2003). In this study, the mean RER for the first exercise session was 1.00 ± 0.07. The mean RER for the second exercise session was 0.98 ± 0.05. RER values of 0.95 indicate the use of 84% carbohydrates and 16% fat. RER values of 1.00 indicate the use of 100% carbohydrates and 0% fat (Wilmore, 2004). Therefore the study indicates that the individuals are exercising using primarily carbohydrate as the primary fuel for their activity. The data from this study show that the women are working at intensity levels that would be very difficult or impossible to increase.

Comparison of Curves Workout Studies

The current research is consistent with the only other research conducted with variables associated with exercise during the Curves circuit. Research was conducted on 15 women who participated in a maximal treadmill test and two Curves workout sessions (Greany, 2005). Tables 14 and 15 compare the two studies of the Curves workout program. The participants in the current study weighed more (by an average of 20.28 pounds) than the Greany study (Greany, 2005). The current study's participants were older (by and average of 10.9 years) and had higher BMIs (by an average of 5.2). The Greany study (Greany, 2005) participants had higher levels for both VO_{2max} (higher by an average of 8.6 ml/kg/min) and HR_{max} (higher by an average of 18 beats).

Table 14

Comparison of Curves Workout Studies Baseline Data

Variable	Greany and Procari (*n*=15) (2005)	Current Study (*n*=78) (2006)
Weight	171.82 ± 43.34	192.1 ±30.43
Age	42.7 ± 11.0	53.6 ± 7.09
BMI	27.9 ± 6.0	33.1 ± 5.48
VO_{2max}	29.2 ± 7.0	20.6 ± 3.99
HR_{max}	169 ± 12	151 ± 17

Because of the similarities in the exercise testing sessions, the mean scores for the two workouts are reported for the Greany study (Greany, 2005). The current study's participants exercised at a higher percentage of their VO_{2max} and a higher percent of their HR_{max}. Participants form the Greany study (Greany, 2005) exercised at a higher heart rate level and expended more total calories for the workout and more calories per minute.

Table 15

Comparison of Curves Workout Studies Exercise Data

Variable	Greany and Procari (*n*=15) (2005)	Current Study (*n*=33) Session 1 (2006)	Current Study (*n*=33) Session 2 (2006)
$\%VO_{2max}$	59 ± 7.3	64.15 ± 11.93	62.40 ± 11.65
Heart rate	126 ± 12	120 ± 13	116 ± 15
$\%HR_{max}$	75 ± 6.9	80.39 ± 9.30	77.68 ± 10.68
Kcals (30 min. workout)	184 ± 23.5	164.5 ± 25.19	160.6 ± 28.36
Kcals/min	6.42 ± 0.79	5.5 ± 25.19	5.4 ± 28.36

Conclusion

The results of the current study show the Curves circuit exercise program to be classified as moderate exercise intensity. The levels of exercise fall within the recommended ranges for $\%HR_{max}$, %HRR, and $\%VO_{2max}$, and exercise METs for this population of subjects. Exercise at this intensity and duration meet the recommendations of 30 minutes of moderate physical activity. Energy expenditure from the Curves circuit can contribute over 50% of the ACSM recommendations for a 300 kcal per day caloric deficit to promote and maintain weight loss in this population of sedentary and low aerobically fit females. In individuals with higher maximal oxygen uptakes, the exercise intensities elicited by the Curves circuit would be sufficient to expend a large portion of this recommended daily energy expenditure.

This study provides information that can be used to provide feedback for the Curves population. The data from this study can be helpful to women who are participating in Curves with little or no exercise experience. The ability to identify workloads and intensity is important to any exercise program. The ability to provide feedback on exercise intensity as well as reassurance that the women are working at levels (%HR_{max}, %HRR, %VO_{2max}, kcals) that will help them reach their goals is an important part of any exercise program.

A longer study with more participants would be beneficial to better understand the entire client base that Curves is attempting to reach. A study that tracked women through several months would be beneficial to determine if they remain at the same exercise intensities as their exercise related variables (specifically VO_{2max} and kcals) change over time.

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