PHYSIOLOGICAL RESPONSES TO A 60-MINUTE ZUMBA® CLASS IN COLLEGE AGE FEMALES

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ABSTRACT

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Purpose. The purpose of this study was be to determine the physiological responses throughout a 60 min Zumba® class and compare the average METs of the Zumba® class to the American College of Sports Medicine's definition of vigorous activity of 6 METs. **Methods.** 30 college age females were analyzed during a Zumba® class. Throughout the class, METs, caloric expenditure, kcal/min, HR, and VO_2 were recorded using a K4b2 Cosmed unit that the participant wore during the class. **Results.** There was no significant difference between the METs of the full Zumba® class and 6 METs (5.7 ± 1.8 vs. 6.0, $p < .05$). **Discussion**. Zumba® is classified as a moderate intensity activity and capable of meeting the ACSM's criteria if practiced for 60 min duration, 3-5 days per week. Taking three Zumba® classes per week would be the minimum recommended frequency with an increase for more fitness improvements or weight control.

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CHAPTER I

INTRODUCTION

Dr. Kenneth Cooper presented the concept of "aerobics" in 1969, which subsequently generated interest in numerous activities including cycling, swimming, jogging, rowing, stair climbing, and aerobic dance (Blair, Jacobs, & Powell, 1985). As promoted by Dr. Cooper, the main purpose of participation is to "get fit", or more specifically, improve the cardiorespiratory system to help prevent chronic diseases, decrease body fat, improve maximal oxygen consumption, and increase performance.

Alternative activities in the form of specialty group fitness classes have evolved as an attractive method of exercising in comparison to traditional modes. New and innovative classes such as water aerobics, RPM or Spinning®, Pump, Hi-Low, Taebo, Step, and cardio kickboxing or BodyCombat® are created by the fitness industry to motivate and maintain the attention of participants, as well as generate new marketing and funding streams. As a result of increasing program diversity, "aerobics" has become a generic term comprising several different exercise class formats (Rixon, Rehor, & Bemben, 2006).

No exercise class has been as commercially promoted as "aerobic dance". In 1969 Jacki Sorensen founded Aerobic Dancing, Inc. in which she choreographed danced steps and full body movements into a fitness-based routine put to music (Garrick & Requa, 1988; Foster et al., 2009; Sorensen, 1979). The success and popularity of her program spread and by 1985 there were more than 46 aerobic dance related formats being taught. Aerobic dance has been described as one of the most accepted methods of noncompetitive, free-time group exercise for health and psycho-physiological benefits (Angelis, Vinciguerra, Gasbarri, & Pacitti, 1998). America's enthusiasm for aerobic dance and fitness has turned it into more than a $5 billion a year industry (Stahmer, 1990).

The aerobic dance genre refers to an exercise class where sequences of choreographed, multi-directional movements are combined to the rhythm of specialized music (Angeli et al., 1994). These emerging programs are taught by instructors trained specifically for a particular aerobic dance format with the purpose of affecting the cardiorespiratory system.

One specialized aerobic dance program that has quickly risen in popularity to claim the title of the world's biggest and most successful format is Zumba® (Zumba® Fitness, 2010). Zumba® was created as a "happy accident" by Alberta "Beto" Perez in the mid-'90s. Beto Perez was a trained dancer and certified group exercise instructor in Colombia who at the time was teaching tap, funk, jazz, modern dance, and general aerobics. One day, Beto Perez forgot the standard aerobics music for his class and improvised a fitness dance class using popular Latin music he had in his car. His participants enjoyed the class so much he continued teaching using his innovative method and eventually moved to Miami to form the Zumba® company (Zumba® Fitness, 2010).

As of 2010, Zumba® classes were being held in over 125 countries, in more than 110,000 facilities, with 12 million weekly participants (Zumba® Fitness, 2010). Official training workshops are held in Mexico, Venezuela, Italy, England, Japan, Taiwan, Portugal, Canada, China, and throughout the United States to generate instructors able to teach worldwide. Commercial expansion of the company also included Zumbawear™ accessories, attire, and music CDs. In 2008, Zumba® launched the Zumba Fitness® Total Body Transformation System, fitness-dance DVD for home workouts, which was labeled a best-selling series. Additionally, it was the first business to produce a fitness video game on all three gaming systems: PlayStation 3, Xbox, and Nintendo Wii (Zumba® Fitness, 2010).

Zumba® is defined as "a Latin-inspired, dance-fitness class that incorporates Latin and international music and dance movements, creating a dynamic, exciting, exhilarating, and effective fitness system" (Zumba® Fitness, 2010, p. 5). Each class is presented as "exercise in disguise" and aims to create a party-like atmosphere so people of a variety of fitness levels and dance backgrounds can all participate in the same class. The classes and choreography can be easily mastered, thereby presenting an unintimidating and fun exercise opportunity for those previously uncertain about becoming involved in a group fitness class and looking to vary their workout routine or needing to begin a fitness regimen.

In addition to the party-like atmosphere, Zumba® has achieved international success due to its revolutionary approach to three group fitness components: music, choreography, and variability. Instead of using the 32-count, premixed group fitness music, Zumba® allows the use of normal songs (Zumba® Fitness, 2010). The focus is not on counting beats and repetitions over the music to construct a final product, but to instead let the movements follow the musical style. The choreography in Zumba® is based on the different sections a song is broken into: verse, chorus, bridge (Zumba® Fitness, 2010). One step is assigned to each musical section and performed every time that part is repeated, creating approximately 4-6 choreographed movements that flow continuously and repeatedly throughout the song. Each rhythm – Meringue, Cumbia, Reggeaton, Salsa, etc. – has a set of four core steps based off of modern and historical dance moves that are simple and easy to perform. Variations on arm movements, leg movements, directional changes, speed, and beat create unlimited options to accommodate all fitness levels (Zumba® Fitness, 2010). Through this revolutionary "Zumba® formula", a dynamic, new aerobic dance class has been fashioned.

Participants not only enjoy Zumba® as an exciting experience, but also as a form of aerobic exercise to improve or maintain health and physical fitness. With 23.7% of Americans indicating they partake in no physical activity and only 49.1% meeting the American College of Sports Medicine (ACSM) recommendations, obesity rates have risen to affect 300 million people worldwide (Haskell et al., 2007; Racette, Deusinger, & Deusinger, 2003). The ACSM, American Heart Association (AHA), Center for Disease Control (CDC), and several more associations recognize the importance of exercise in order to avoid adverse consequences associated with inactivity and obesity, such as an increased risk of certain cancers, respiratory conditions, depression, coronary heart disease, type 2 diabetes, hypertension, dislipidemia, and stroke (ACSM, 2009; Haskell et al., 2007; Racette, Deusinger, & Deusinger, 2003). Both The Harvard Alumni Health Study and The Aerobics Center Longitudinal Study demonstrated a decreased risk of mortality with involvement in moderate to vigorous physical activity and energy expenditure (Lee & Paffenbarger, 2000; Stofan, DiPeitro, Davis, Kohl, & Blair, 1998).

The ACSM has published physical activity guidelines to help the public understand the frequency, intensity, and duration of each mode of fitness. Aerobic activities are defined as dynamic and continuous, using large muscle groups, and needing oxygen for most of the energy during performance (ACSM, 2009). The ACSM recommends that healthy adults engage in moderate exercise 5 days a week for 30 min each day or vigorous activities 3 days a week for 20 min each day for health maintenance and chronic disease reduction (ACSM, 2009). For an exercise to be considered moderate to vigorous, 40-85% maximal oxygen uptake (VO_2max) or 60-95% maximum heart rate (HRmax) must be achieved (ACSM, 2009). Additionally, the ACSM classifies intensity level in metabolic equivalent (MET) values, where vigorous activity is defined as > 6 METS and moderate activity 3-6 METS (ACSM, 2009). An energy expenditure volume of approximately 1000 kcal/wk, collected through varying combinations of exercise intensities and physical activities, has been related to health benefits (ACSM, 2009; Lee, Rexrode, Cook, Manson, & Buring, 2001). Sedentary or unfit individuals are encouraged to begin at the lower end, 40-50% VO_2max, of these ranges with the goal of gradually increasing the exercise intensity. If lower intensities are chosen, the activity should be performed for a longer amount of time. Additional benefits can be obtained through more exercise.

Zumba® is considered an aerobic activity and produce high amounts of energy expenditure. Since the format employs a new class composition, it is impractical to generalize the caloric expenditure and aerobic intensity of a Zumba® class from previous data collected on other fitness dance classes. It is important to supply an accurate report on intensity and expenditure in Zumba® since many people participate in aerobic activities as part of their fitness program. There has been little research done on the physiological effects of a Zumba® class, and whether or not it meets the intensity criteria recommended by the ACSM guidelines.

Statement of the Problem

Zumba® has claimed to be an appropriate activity to be included in an exercise prescription for improving cardiorespiratory fitness and able to elicit high energy expenditures. Due to limited research, the intensity of a Zumba® class remains unknown. The purpose of this study was to determine the energy expenditure throughout a 58.6 min Zumba® class and compare the average METs of the Zumba® class to the ACSM's definition of vigorous activity of 6 METS.

This research, conducted during Summer and Fall of 2013, concerned the energy expenditure during a 58.6 min Zumba® class. Thirty women between the ages of 18 and 30 served as participants. All participants were required to attend three familiarization Zumba® classes identical to the Zumba® class where data was collected. A $K4b_2$

Cosmed unit was secured to each participant and recorded the variables of kilocalories (kcal), heart rate (HR), oxygen consumption (VO_2), carbon dioxide production (VCO_2), ventilation (V_E), respiratory exchange ratio (RER), and metabolic equivalents (METs) levels during rest and the 58.6 min Zumba® class. A single sample t test with a significance level of .05 was used to determine if there was a significant difference between the METs of the Zumba® class and 6 METS, the ACSM's definition of vigorous physical activity.

Hypothesis

The following null hypothesis will be tested by this study:

1. There will be no significant difference between the METs of the Zumba® class and the ACSM's definition of vigorous physical activity of 6 METS.

Definition of Terms

For the purpose of clarification, the following definitions and/or explanations of terms were established for use throughout the study:

1. Zumba®: an exercise format that contains international music and dance rhythms choreographed based on song sections in a unique manner to create an aerobic dance class (Zumba® Fitness, 2010)
2. Aerobic dance: an exercise class format where dance movements are choreographed by instructors to the beat of specialized music (Angelis, Vinciguerra, Gasbarri, & Pacitti, 1998).

3. Cardiovascular or cardiorespiratory fitness: the ability of the heart, lungs, and vessels of the cardiovascular system to supply the body with oxygen so that energy output can be continued at a desired workload (McArdle, Katch, & Katch, 2010).
4. Energy expenditure: the body's fuel cost while performing work and expressed as kilocalorie expenditure or oxygen consumption.
5. Kilocalories (kcal): the amount of work or energy equal to the amount of heat required to raise the temperature of 1 kg of water 1°C and a quantification of energy used during an activity.
6. Oxygen consumption (VO_2): the consumption rate of a certain volume of oxygen (O_2) (Brooke, Fahey, & Baldwin, 2005).
7. Metabolic equivalent (MET): one metabolic equivalent is equal to 3.5 ml of oxygen per kg of body weight per min or the amount of oxygen consumed while sitting at rest (Sidney & Blumchen, 1990).

Assumptions

The study will be conducted based on the following assumption:

1. The $K4b_2$ Cosmed is a valid and reliable instrument for measuring metabolic data.
2. Five kcal per 1 L of oxygen consumed represents a valid method of calculating energy expenditure.
3. The participants understood and could perform the choreography after three familiarization sessions.

4. The experimental Zumba® class was reflective of a normal class.

Limitations

The study was subject to the following limitations:

1. The results may not be able to apply to populations other than college aged females.
2. The results may not be able to apply to participants in Zumba® classes taught by other instructors.
3. Exercise history and dietary intake may influence results.
4. The songs played during the experimental class may vary in other Zumba® classes.
5. Choreography was created for the experimental class and followed the Zumba® formula.

Significance of the Study

Participation in regular exercise is strongly encouraged for maintenance or improvement in various components of health and fitness (Grant, Davidson, Aitchison, & Wilson, 1998). Physical activity has been established as a critical component in health and weight management (ACSM, 2009). A sedentary lifestyle can lead to obesity and an increased risk of developing numerous chronic diseases as well as premature death (Haskell et al., 2007).

The ACSM states that aerobic fitness can be improved and health benefits received with 20-60 min of moderate to vigorous exercise on 3-5 days per week at 50-

85% VO_2max, 60-95% HRmax, or 3-6 METS (ACSM, 2009). Aerobic dance classes are a popular method used to meet these criteria and have been reported to be effective in improving fitness (Grant et al., 1993). However, the physiological responses of the latest aerobic dance trend, Zumba®, have not been studied to establish it as an acceptable mode of improving or maintaining aerobic fitness. Therefore, an investigation of the energy expenditure of a Zumba® class would provide valuable information for participants looking to meet the ACSM criteria for health benefits or weight control.

CHAPTER II

REVIEW OF LITERATURE

Recently, Zumba® has emerged as a global movement in fitness, being ranked by the ACSM as #9 in the Top Twenty Fitness Trends for 2012 (ACSM, 2011). Since it is a relatively new fitness activity, there is minimal research on Zumba®, though it is introduced as a fun and effective way to improve cardiovascular fitness and control body weight. There are a number of studies on this aerobic format that can serve as valuable resources to understanding Zumba®.

Cardiorespiratory Improvements

To improve the cardiorespiratory system, aerobic or endurance type exercises are prescribed. According to Brooks, Fahey, & Baldwin (2005), for an exercise to be considered aerobic, it must use the majority of the body's muscle mass in a rhythmical manner. The ACSM recommends that adults, 18-65 years of age, participate in a minimum of 30 min per day of moderate intensity (3-5.9 METS) exercise for 5 days per week or 20 min of vigorous intensity (≥ 6 METS) exercise for 3 days per week to improve and maintain aerobic fitness and health (ACSM, 2009). Benefits of engaging in regular exercise include decreasing risk of stroke, type II diabetes, cardiovascular disease, high blood pressure, and certain cancers, while improving lipoprotein profile, managing weight, and increasing quality of life (Donnelly et al., 2009). The Aerobics Center Longitudinal Study revealed that mortality rates were 60% lower in those with moderate, compared to low, aerobic fitness levels who participated in moderate intensity physical activity (Stofan, DiPeitro, Davis, Kohl, & Blair, 1998).

McArdle, Katch, & Katch (2010) recognize four exercise factors that affect changes in an individual's cardiorespiratory fitness levels: exercise intensity, exercise duration, exercise frequency and initial fitness level. Relative training intensity can be described in various ways, including as a percentage of VO_2max, as a percentage of HRmax, and energy expenditure (kcals). Exercise duration refers to the training volume or total work accomplished, and exercise frequency is how often the training occurs (McArdle et al., 2010). An individual's initial fitness level can be determined through measuring pretraining VO_2max (Kohrt et al., 1991). The following sections will expand upon these four factors and their effects on cardiorespiratory fitness.

Exercise Intensity

Measuring energy expenditure, percentage of HRmax, percentage of VO_2max, and MET levels are effective tools for determining exercise intensity in cardiorespiratory exercises; thus, each is recognized as a legitimate approach to providing a prescription in exercise intensity (ACSM, 1998). Changes in these variables express transformations in the cardiorespiratory system in response to exercise. When directly measuring HRmax and VO_2max is not practical, estimating maximal intensity is also acceptable (ACSM 1998).

If HRmax cannot be measured through direct testing, there are formulas to estimate HRmax. The most common calculation predicts HRmax based on age with the equation HRmax = 220 – age (years). As noted by Londeree & Moeschberger (1982), there can be deviations of 10 beats per minute (bpm) among individuals using this equation. A longitudinal study of the relationship between HRmax and age suggests the previous formula underestimates HRmax value in individuals over 40 years and overestimates it in those under the age of 40 years (Gellis et al., 2007). The benefit of this formula is that it is independent of variables such as sex, race, and body mass index (BMI).

An individual's HRmax does not change through training in the same way VO_2max does, making it a reliable reference point for training intensity. Resting and submaximal HR can be altered with an exercise program. After training, submaximal HR will be lower at the same absolute workload than before exercise (Brooks, Fahey, & Baldwin, 2005). Hofmann et al. (1994), who studied HR responses to exercise, further noted the usefulness in using exercise HR and a percentage of HRmax to establish exercise intensity.

Improvements in aerobic fitness are generally achieved when an individual works at an intensity defined by a percentage of maximum capacity, such as percent HRmax, percent VO_2max or percent METmax. The suggested intensity ranges for eliciting cardiorespiratory improvements are 50-85% VO_2max, 65-90% HRmax or 3 to $\geq$ 6 METS as recommended by the ACSM's 2011 position stand (American College of Sports Medicine, 2011). Moderate intensity levels are defined as 40-60% VO_2 reserve (VO_2R) and vigorous intensity exercise is considered is ≥ 60% VO_2R, both with increases in HR and breathing (ACSM, 2009).

The progressive overload training principle states that training at higher than normal exercise frequencies, intensities and durations is required to produce a physiological response (McArdle et al., 2010). Garber et al. (2011) demonstrated that aerobic exercise below the minimal intensity levels of 40% VO_2max and 55% HRmax will be insufficient to challenge the cardiorespiratory system and fail to produce the desired physiological results. It is commonly accepted that greater results from training will be observed in intensities on the higher end of this range, with an estimated upper limit of 90% VO_2max or 95% HRmax (McArdle et al., 2010).

Metabolic equivalent units or METs are routinely used as an index of energy expenditure of various activities in straightforward and practical terms. One MET is defined as a VO2 of 3.5 ml/kg/min or the amount of oxygen an individual would consume sitting at rest (ACSM, 2009). From this, the energy cost of physical activities can be expressed as a multiple of 1 MET or the resting metabolic rate. Light intensity exercise is considered to be 1-2.9 METs and less than that needed to improve cardiorespiratory endurance in healthy individuals (Sidney & Blumchen, 1990). However this intensity could be appropriate for sedentary individuals beginning an exercise routine. Activities that demand an energy expenditure of 3-5.9 METs are classified as moderate intensity and are suitable training stimulus for healthy individuals

(Sidney & Blumchen, 1990). Vigorous or high intensity exercise is identified as ≥ 6 METs (ACSM, 2009).

The often-cited recommendation of 70% HRmax as a training threshold for aerobic improvements represents a general guideline for effective yet comfortable exercise (Karvonen, Kentala, & Mustala, 1957). Aerobic training typically yields cardiorespiratory benefits of 5-25% VO_2max if 50-70% HRmax is maintained during exercise sessions (McArdle et al., 2010).

Based on results from several studies, training intensity is critical to maintaining improvements in VO_2max in comparison to frequency and duration (Hickson et al., 1984; Hickson et al., 1982; Hickson & Rosenkoetter, 1981). Over the course of three studies, participants exercised at recommended levels of training intensity, frequency, and duration to stimulate increases in VO_2max. One training component was then decreased while the others stayed the same in order to observe changes in VO_2max values. Hickson et al. (1984) tested the effects of reducing exercise intensity by having 12 male and female participants cycle or run 6 days/week, 40 min/session, at ~80% VO_2max for 10 weeks, resulting in 11-20% VO_2max increases. For the next 5 weeks, exercise frequency and duration remained constant, but seven participants reduced their training intensity by one-third and the remaining six reduced intensity by two-thirds. Both groups showed a significant decrease in VO_2max after reducing intensity, with a 21% loss in VO_2max in the one-third reduction group and a 30% VO_2max loss in the two-thirds reduction group. Hickson & Rosenkoetter (1981) noticed no significant change in VO_2max after training frequency was reduced from 6 days/week for 10 weeks to either 2 or 4 days/week for 5 weeks with duration and intensity continuing unchanged. When training duration was decreased from 40 min/session for 10 weeks to either 26 min/session or 13 min/session, no significant change in VO_2max was observed (Hickson et al., 1982). The results of these three studies demonstrate that training intensity is the main factor in preserving VO_2max increases. Additionally, the results from Hickson et al. (1984) suggest continuing to train at an intensity of at least ~70% VO_2max is necessary for maintaining changes.

Exercise Duration

In regard to exercise duration, a dose response may exist. Church et al. (2007) studied training volume and duration in inactive women and found, at low intensities, 3-5 min bouts of exercise could elicit small benefits, but 20-30 min sessions produced larger improvements in cardiorespiratory fitness. The ACSM guidelines recommend durations of 20-60 min depending on the intensity of exercise (ACSM, 2009). Higher intensities require a smaller duration of 20 min while lower intensities necessitate higher durations of 30-60 min for aerobic improvements.

Exercise Frequency

According to the ACSM, a frequency of 3-5 days per week will deliver cardiorespiratory improvements relating to health and well-being. For novice exercisers, 3 days of activity per week is advised, with the intention of increasing the frequency as fitness improves. For active individuals, exercising 3 days at vigorous intensity or 5 days at moderate intensity is necessary. Pollock et al. (1977) state that frequency is of less importance than intensity and duration. This conclusion is supported by Fox et al. (1975), who found similar changes in VO_2max in individuals exercising 2 or 5 days/week at the same intensity level.

Based on results from the Hickson studies, training intensity is critical to maintaining improvements in VO_2max in comparison to frequency and duration (Hickson& Rosenkoetter, 1981; Hickson, Kanakis, Davis, Moore, & Rich, 1982; Hickson, Foster, Pollock, Galassi, & Rich, 1984). Over the course of three studies, participants exercised at recommended levels of training intensity, frequency, and duration to stimulate increases in VO_2max. One training component was then decreased while the others stayed the same in order to observe changes in VO_2max values. Hickson et al. (1984) tested the effects of reducing exercise intensity by having 12 male and female participants cycle or run 6 days/week, 40 min/session, at ~80% VO_2max for 10 weeks, resulting in 11-20% VO_2max increases. For the next 5 weeks, exercise frequency and duration remained constant, but seven participants reduced their training intensity by one-third and the remaining six reduced intensity by two-thirds. Both groups had a significant decrease in VO_2max after reducing intensity, with a 21% loss in VO_2max in the one-third reduction group and a 30% VO_2max loss in the two-thirds reduction group. Hickson & Rosenkoetter (1981) noticed no significant change in VO_2max after training frequency was reduced from 6 days/week for 10 weeks to either 2 or 4 days/week for 5 weeks with duration and intensity continuing unchanged. When training duration was decreased from 40 min/session for 10 weeks to either 26 min/session or 13 min/session, no significant change in VO_2max was observed (Hickson et al., 1982). The results of these three studies demonstrate that training intensity is the main factor in preserving VO_2max increases. Additionally, the results from Hickson et al. (1984) suggest continuing to train at an intensity of at least ~70% VO_2max is necessary for maintaining changes.

Initial Fitness Level

The magnitude of aerobic fitness improvements following exercise training is dependent upon the original fitness level of the individual. Those who are initially unfit are likely to have greater responses to the same exercise training stimuli than those who are already active and inversely, individuals who are already active require higher amounts of training to stimulate responses to exercise (Blair & Connelly, 1996). According to the ACSM's 2011 Position Stand, if an individual is not capable of engaging in the ACSM's minimal exercise recommendations, benefits can still be received from activity below the recommendations (2011). While an average individual can achieve improvements of 20% VO_2max by training at high intensity levels, participants with low initial fitness levels have shown larger changes of 50% VO_2max over a period of 12 weeks, exercising 3-4 days/week (Branch, Pate, & Bourque, 2000). Midgley, McNaughton, & Wilkinson (2006) analyzed training intensities in runners and determined that moderately trained athletes required a stimulus of 70-80% VO_2max to improve their VO_2max levels whereas highly trained runners needed to exercise at intensities of 95-100% VO_2max for increases. This further supports the idea that the minimum exercise intensity for improving aerobic fitness can vary depending on initial fitness level.

Maintaining Cardiovascular Improvements

Maintaining the benefits of aerobic exercise is also of considerable importance to researchers and the general public. It has been documented that the intensity of exercise is the main factor in upholding VO_2max improvements (Hickson et al., 1985). The participants in the Hickson studies saw improvements of 20-25% VO_2max after exercising 40 min, 6 days per week for 10 weeks, at 80-90% VO_2max (Hickson et al., 1982; Hickson & Rosenkoetter, 1981; Hickson et al., 1985). The cardiorespiratory fitness of the participants remained unchanged after decreasing exercise frequency to 2 or 4 days per week when intensity and duration remained the same (Hickson & Rosenkoetter, 1981). The subsequent study followed the same initial exercise prescription by keeping the same frequency and intensity, but reducing the duration to either 26 or 13 min and noted the participants preserved their VO_2max increases (Hickson et al., 1982). In Hickson and colleagues' (1985) next study, intensity was reduced, causing a significant decrease in VO_2max. This series of research verifies intensity needs to be kept constant to maintain the benefits of aerobic fitness though duration and frequency may be reduced.

Energy Expenditure

Donnelly et al. (2009) suggest that an effective exercise program should include aerobic training with a target caloric expenditure of approximately 1200-2000 kcal per week. This caloric deficit is sufficient to provide weight loss and inhibit weight gain greater than 3% (Donnelly et al., 2009). A combination of moderate and vigorous intensity exercises can be employed to achieve the 1200-2000 kcal per week volume.

To reduce the risk of developing adverse health conditions, an expenditure of 1000 kcals per week is required. The finding in the Harvard Alumni study confirms that 1000 kcals per week of moderate intensity activity is related to a reduced risk of cardiovascular disease and premature mortality (Lee & Paffenbarger, 2000). Church, Earnest, Skinner, and Blair (2007) noted significant decreases in risk for cardiovascular problems and mortality in exercise quantities of one-half of the previously recommended expenditure. They also noted that exercising 75 min per week and expending 500 kcal per week can significantly improve cardiovascular fitness in inactive, overweight, middle-aged women (Church, Earnest, Skinner, & Blair, 2007). The equation of 5 kcals used per 1 L of O_2 consumed during exercise estimates the caloric requirements of a given activity (McArdle at al., 2010). This caloric cost can fluctuate tremendously between different activities.

Adherence to Exercise Programs

Though the benefits of the ACSM’s guidelines of frequency, intensity, and duration are largely broadcast, Rhodes, Warburton, and Murray (2009) noted that this information has negligible effects on adherence to an exercise program. Individuals can accomplish ACSM's recommendations for exercise using many different modes, which is why choice, preference, and enjoyment is taken into consideration in an exercise prescription (Williams, 2008). Some studies indicate that how enjoyable a person perceives an activity to be may influence future exercise choice (Marcus, Williams, & Dubbert, 2006; Williams, 2008). Wankel (1993) studied the relationship of exercise enjoyment to adherence and found greater rates of implementing and continuing an enjoyable activity. Limited evidence proposes additional adherence if the exercise environment has entertaining distractions such as music, television, scenery, or an instructor to allow the participant to disassociate from the activity (Annesi, 2001; Masters & Ogles, 1998).

While fitness and health benefits can be derived from both moderate to vigorous intensity exercise, there is a greater likelihood of adherence to moderate intensity activities rather than vigorous (Warburton, & Murray, 2009). Individuals who regularly engage in physical activity have a higher tolerance for vigorous activity whereas sedentary individuals respond positively to self-paced, moderate intensity exercise (Anton et al., 2005; Ekkekakis, Hall, & Petruzzello, 2005). The ACSM advises initially prescribing moderate intensity exercise to beginners to promote adherence with the objective of increasing to vigorous exercise (Garber et al., 2001).

Group Fitness Classes

"Aerobics" and group fitness have become popular additions to studios, gyms, and fitness facilities worldwide to promote health and fitness. There have been a large number of original classes used as exercise since the creation of the aerobic class concept by Dr. Kenneth Cooper. Zumba® is one example of an innovative exercise class format developed to promote health and fitness.

A Zumba® class is generally comprised of Latin American rhythms, such as Meringue, Cumbia, Salsa, etc; elements from other exercise classes have played an important role in forming this exercise style. Footwork and movements from established group fitness classes such as kickboxing, step aerobics, and especially dance aerobics, can all be found in Zumba® choreography. Due to the rise in popularity of these group fitness activities, researchers have become interested in determining whether the new trends meet the criteria recommended by the ACSM guidelines.

Physiological Responses to Les Mills™ Programs

Les Mills™ is a company that has developed 10 group fitness programs employed at over 14,000 clubs in 80 counties and is considered the creator of "the world's most popular group fitness classes" (Les Mills™, 2011). The benefit of Les Mills™ programming is that it provides gyms with instructor certification courses, prechoreographed routines, music, and group fitness resources. Facilities can join Les Mills™ to ensure safe and effective group fitness classes and receive new choreography, music, and instructor education every 3 months. Four of the most frequently used group fitness programs are BODYATTACK™, BODYCOMBAT™, BODYSTEP™, and RPM™. BODYATTACK™ combines sports-inspired and strength movements, and BODYCOMBAT™ is a martial arts-based workout involving striking, punching, and kicking (Les Mills™, 2011). BODYSTEP™ is comprised of movements over, around, and on a height adjustable step, and RPM™ is a spin cycle class consisting of flats, hills, mountains, and time trials (Les Mills™, 2011). BODYATTACK™ and BODYCOMBAT are considered by Les Mills™ to be high intensity classes expending an average of 735 ± 103.2 kcal and 737 ± 82.2 kcal per class, respectively, whereas the intensity of BODYSTEP™ and RPM™ are classified as moderate to high and using 620 ± 64.8 kcal and 675 ± 92.8 kcal per class, respectively, in moderately trained men and women (2011).

Lythe & Pfitzinger (2000) found slightly lower caloric expenditures when testing 15 participants on the same four programs. The average VO_2 for RPM™, BODYATTACK™, BODYCOMBAT™, and BODYSTEP™ was 31.6 ± 4.8 ml/kg/min and mean HR responses ranging from 73.9 ± 9.7% (BODYCOMBAT™ and BODYATTACK™) to 78.7 ± 7.3% (RPM™) HRmax, categorizing the classes as moderate to high intensity. VO_2max was not measured, however, it can be deduced that the intensity of the classes was above ACSM's minimum recommendations of 50% VO_2max. Heart rate of seven BODYCOMBAT™ participants was also evaluated during a study by Ferrari & Guglielmo (2006), and they observed a higher mean value of 86 ± 8.4% HRmax. Large differences in BODYCOMBAT™ responses between the two studies can possibly be attributed to small sample sizes with varying experience levels of the participants; still both studies indicated BODYCOMBAT™ is a moderate to high intensity group fitness format.

The Les Mills™ classes were evaluated for energy expenditure and compared to two running speeds by Rixon, Rehor, and Bemben (2006). BODYCOMBAT™, BODYSTEP™, and RPM™ produced responses of 9.7 ± 2.0 kcal/min, 9.6 ± 1.8 kcal/min, and 9.9 ± 1.9 kcal/min respectively. It was also noted that the energy cost of all three modes were equal to jogging at speeds of 5-5.2 mph.

Lythe and Pftizinger also calculated caloric expenditure in all four Les Mills™ classes (2009). Energy expenditure was 462.8 kcal, 555.6 kcal, 631.0 kcal, and 582.1 kcal for a 50 min BODYCOMBAT™, BODYSTEP™, BODYATTACK™, and RPM™ class, respectively (Lythe & Pftizinger, 2000). All values are less than Les Mill's™ reports, indicating that the company potentially overestimated the caloric requirements for the classes. Despite the differences between the company's claim and research data, each format could still be a useful component in an exercise program.

Physiological Responses to Cardio Kickboxing

Though the Les Mills™ company creates quality aerobic classes, many facilities choose not to adopt this brand and instead implement other group fitness programs. Kickboxing, a blend of martial arts and aerobics, is also a popular group fitness class that is believed to elicit a substantial training effect and energy expenditure. Immel (1999) found that a 35-40 min kickboxing session elicited average responses of 70% VO_2max

and 86% HRmax. Stricevic, Okazaki, & Tanner (1980) also noted than a karate class produced HRs above 80% HRmax. A similar group fitness format, taekwondo, was found to have higher energy expenditures during a 45 min class than noncompetitive singles tennis, but comparable amounts to that of running at a speed of 7 mph, boxing, and judo and intensities ranging from 68-72% VO_2max and 88-92% HRmax (Toskovic, Blessing, & Williford, 2002). Ergun et al. (2006) studied 18 women participating in a 22 min kickboxing routine and discovered the class mean was 49 ± 10% VO_2R and 7 kcal/min expended. The values were lower than the previous research, but still fell within the bottom range of the ACSM's guidelines. It can be concluded that most kickboxing group fitness formats meet the ACSM's recommendations for weight loss and enhancing cardiorespiratory fitness.

Physiological Responses to Step Aerobics

Step or bench aerobics is a group fitness format that incorporates choreographed movements involving a participant-selected bench height of 6, 8, 10, or 12 in. for the purpose of increasing aerobic fitness (Garrick & Requa, 1988). Sutherland, Wilson, Aitchison, and Grant (1999) studied VO_2 and HR responses in 10 women using 6, 8, and 10 in. benches in a 40 min step aerobics class. Mean percent VO_2max values of 45.6 ± 6.6%, 51.6 ± 3.9%, and 56.2 ± 7.3% and mean %HRR values of 57.2 ± 8.5%, 63.6 ± 6.0%, and 70.1 ± 7.7% in the three heights, respectively. Olson, Williford, Blessing, and Greathouse, (1991) similarly indicate that VO_2 responses significantly increased with the height of the step when the cardiovascular effects of the 6, 8, 10, and 12 in. bench height were measured in a choreographed step class, with bench height being the only difference in the routine. Their results show that mean VO_2 values were the lowest when the step was 6 in. (28.4 ± 5.4 ml/kg/min) and highest with a 12 in. step (37.3 ± 5.1 ml/kg/min). Additional literature agrees that the step height the participant selects for the class is a factor in the metabolic demand of the activity (Scharff-Olson, Williford, Blessing, & Brown, 1996). All three studies indicate step aerobics provided enough aerobic demand to classify the activity as able to improve fitness; however, in first study the 6 in. bench height VO_2 response was below the ACSM's recommendation that an activity elicit a minimum intensity of 50%VO_2max.

Laukkanen et al. (2001) and Clapp and Little (1994) both investigated the physiological effects of previous step aerobics experience during an exercise bout. There was a significant difference in the cardiorespiratory responses of 36 instructors and 53 participants during an aerobic step performance (62 ± 2% VO_2max and 76 ± 1% VO_2max, respectively) suggesting that the participants worked at a higher intensity than the instructor (Clapp & Little, 1994). Analogous results were discovered by Laukkanen et al. (2001) when they found physiological responses varied between groups who participated in a step class < 2 days per week or ≥ 4 days per week when comparing light, moderate, and heavy intensity classes. There were significant increases between the classes ranging from 74-89% HRmax. Though there is a disconnect between instructor and participant HR responses, both groups achieved enough stimuli to reach ACSM's requirements for improving cardiorespiratory fitness.

Aerobic Dance Classes

Aerobic dance was officially recognized as an acceptable form of activity by Dr. Kenneth Cooper in 1982 (Cooper, 1982). Since then, physiological benefits of aerobic dance have been extensively examined.

Physiological Responses to High Impact Aerobic Dance

Foster (1975) collected VO_2 data on an Aerobic Dance, Inc. workshop hosted by founder Jacki Sorenson at the University of Texas. Foster showed the class, which consisted of women ages 20-38 years, elicited an average VO_2 of 28-32 ml/kg/min which was representative of 77% of the participant's VO_2max and approximately the same VO_2 required to run a 12 min mile. It was determined that the first widespread aerobic dance class created by Aerobic Dance, Inc., was an acceptable type of cardiorespiratory activity for improving aerobic fitness. Rockefeller & Burke (1979) further demonstrated participation in an aerobic dance program is of sufficient intensity to increase cardiovascular endurance. Twenty-one college aged women participated in a 40 min aerobic dance program that incorporated Sorenson's class design 3 days per week for 10 weeks. At the end of the 10 week period, VO_2max, $V_E$max, maximal working capacity, and submaximal HR all significantly improved. Additionally, an estimated 289.3 kcals were expended during the last aerobic dance session and the participants were working at an approximate intensity of 63% VO_2max with a mean HR of 163 bpm. The results reveal aerobic dance is a favorable means of producing cardiovascular fitness improvements.

Though the dynamics of aerobic dance have changed since being studied by Sorenson (1979) and Cooper (1982), it is still being performed and studied in university students. Popmobility is an aerobic dance style that involves 20 min of aerobics, 5 min of muscular endurance exercises, and 5 min of flexibility exercises combined in a 30 min workout. Grant et al. (1993) investigated the intensity of a Popmobility session in 10 women, 21.2 ± 1.5 years old. The mean intensity of the 20 min aerobic section ranged from 67.7-82.6% of VO_2max and 59.1-75.6% HRR. A mean total caloric expenditure of 236.6 ± 28.4 kcal was observed. Other studies have produced average VO_2 values of comparable intensities (80.3, 78.14, and 70% VO_2max) to Popmobility (Claremount et al., 1986; Igbanugo & Gutn, 1978; Williford, Scharff-Olson, & Blessing, 1989). Grant et al. (1993) concluded the intensity level of the aerobic dance class can increase cardiorespiratory fitness based on the ACSM guidelines.

Angelis et al. (1998) studied 30 women during a session of Aerobic Dance (AD), a fitness dance class style through International Dance Exercise Associate (IDEA) that consists of rhythmic intensities varying from low impact (120 bpm) to a combination of low to high impact (140 bpm) throughout a single session. Heart rate and VO_2 were monitored during the 55 min class and peak values reported were 92.8 ± 7.8% HRmax and 99.5 ± 12.4% VO_2max. The AD values presented were higher than most previous aerobic dance class studies (Grant et al., 1993; Parker, Hurley, Hanlon, & Vaccaro, 1989; Rockefeller & Burke, 1979; Williford et al., 1989). This could be attributed to participants prematurely terminating the cycle ergometer VO_2max test since they were not familiar or comfortable with the exercise mode, which would overestimate values derived from the AD class. The authors concluded AD is labeled a high intensity activity and best suited for fit and trained individuals. They also stated AD would be an inappropriate mode for unfit or sedentary participants due to its high intensity and the demanding nature of the class.

Physiological Responses to Low Impact Aerobic Dance

The positive effects of an aerobic dance class are well documented, but the large aerobic demand and high impact choreography were not suitable for all populations and the need for low impact variations were necessary. Low impact dance aerobics requires one foot to remain in contact with the floor at all times whereas high impact aerobics can involve "flight phases" with skipping, jumping, and callisthenic movements (Richard & Veatch, 1990). Richard and Veatch (1990) recorded peak impact force, mean loading rate, and mean impact impulse during five high impact front knee lifts and five low impact front knee lifts, a common movement in an aerobic dance class.

When low impact aerobic dance classes began flooding group fitness studios, the question arose as to whether the intensity of aerobic dance is enough to elicit a training effect. Otto et al. (1986) studied the metabolic demand of high and low impact dance. Music selection and duration were identical in both classes, and the only variation was whether high or low impact choreography was performed. The average VO_2 in the low impact dance was 25.1 ± 3.9 ml/kg/min and 31.4 ± 5.1 ml/kg/min in the high impact option. Low impact dance produced a mean HR of 166 ± 15 bpm and 177 ± 12 bpm by high impact. Though the metabolic challenge of the low impact class was less than the high impact class, the intensity levels were still adequate enough to result in aerobic fitness improvements.

Grant et al. (1998) furthered this research by comparing the physiological responses of 10 women in a high impact (HIP) class and low impact (LIP) Popmobility class. High impact Popmobility produced values within ACSM's guidelines for improving aerobic endurance at a mean of 64.7 ± 8.2% VO_2max and 76.6 ± 6% HRmax, demonstrating the intensity of the activity can deliver a training effect. Low impact Popmobility was at the lower end of ACSM's range of acceptable values at 51.9 ± 9.1% VO_2max and 71.6 ± 7% HRmax. While the intensity of LIP is clearly not as high as HIP, and lower than previously reported Popmobility values, it is an adequate mode for maintaining or improving cardiorespiratory fitness in sedentary or overweight individuals (Grant et al., 1998).

Comparison of Other Aerobic Activities and Aerobic Dance Classes

The physiological responses of two fitness dance tests to a step test in 10 women were compared by Bell and Bassey (1994). The 15-20 min dance tests were divided into a high impact, with additional arm and jumping variations provided, or a low impact option. The dances were both choreographed into progressively harder sequences for 15-20 mins and the step test was also a graded exercise test of matching duration. The low impact dance elicited a mean HR of 134.6 ± 14.6 bpm at 68.10 ± 6.87% HRmax with a mean VO_2 of 21.86 ± 3.52 ml/kg/min. HR in the high impact dance surpassed HRmax by having a mean response of 160.2 ± 15.45 bpm at 81.0 ± 7.53% HRmax and mean VO_2 of 29.33 ± 5.22 ml/kg/min. At an equal HR, there were no significant differences in VO_2 between the step and dance tests. The data indicates the addition of arm and ballistic movements can raise the HR to potentially unsafe limits in individuals unaccustomed to physical activity. Though in participants who regularly engage in exercise, both dance classes are effective modes of cardiovascular exercise.

With many studies demonstrating aerobic dance classes are capable of improving cardiovascular functioning, Milburn and Butts (1983) compared physiological changes in aerobic dance to different types of exercises. Forty-six college women exercised 4 days per week, for 7 weeks, for 30 min, at 83-84 ± 5% HRmax in either a dance or treadmill jogging group. As a result of the exercise program, both groups significantly increased VO_2max and maximal running times with no significant difference between the two groups. The dancer's VO_2max values improved from 35.4 ± 2.8 ml/kg/min to 39.0 ± 2.0 ml/kg/min and maximal running time from 410 ± 71 s to 495 ± 45 s. VO_2max increased from 36.4 ± 2.1 ml/kg/min to 39.4 ± 2.6 ml/kg/min and running time from 451 ± 39 s to 516 ± 64 s. Thus, when performed at similar intensities, frequencies, and durations, both exercise programs produce comparable cardiorespiratory responses.

Similar to the above study, Shimamoto et al. (1998) showed a 3 month low impact aerobic dance intervention is equal to jogging or cycling by significantly improving aerobic capacity in middle aged, mildly obese women. Sixty women were divided into a low impact aerobic dance or cycling and jogging treatment groups where they exercised for 60 min, 2-3 days per week, at an RPE of 12-14. At the conclusion of 3 months, the dance group increased VO_2max by 4.7 ml/kg/min. Similarly, the jog and cycle group increased 4.4 ml/kg/min VO_2max.

Conclusion

In a review of literature, Williford et al. (1989) supported aerobic dance as a legitimate mode of training to maintain or improve cardiorespiratory fitness. Aerobic dance programs have been demonstrated to produce VO_2 increases of 5-41% VO_2max when practiced for a duration of 7-16 weeks and frequency of 2-4 times per week. As already indicated, the intensity of an aerobic dance class varies greatly between formats, with some styles employing high impact, others low impact, and some mixing the movements throughout a session. The amount of large muscle activity, lower body impact, and music tempo can all have an influence on class intensity and therefore energy expenditure.

Table 1

Zumba® Class Playlist

Song Title	**Artist**	**Rhythm**	**Duration (min)**
Turn up the Music	Chris Brown	Warm Up Part I	3:49
Bailando Sexy	Wisin & Yandel	Warm Up Part II/Reggaeton	3:15
Shawty Got Moves	Get Cool	Hip Hop/Salsa	3:15
Fire Burnin'	Sean Kingston	Hip Hop	4:03
Sobrevivire	Azucar Morena	Flamenco	3:48
Blanco	Pitbull	Reggaeton	3:24
Danza Kuduro	Don Omar & Lucenzo	Meringue	3:19
Gimmie Gimmie Gimmie	Beenie Man	Hip Hop	3:04
El Vacilon	Zumba® Fitness	Meringue	4:00
Drop It On Me	Ricky Martin	Salsa	3:55
Na De Na	Angel y Khriz, Gocho & John Eric	Reggaeton	3:23
Muevelo	Los Super Reyes	Cumbia	3:55
Jump	Rupee	Meringue	3:37
Prrrum	Consculluela feat. Wisin & Yandel	Reggaeton	4:00
El Amor	Tito El Bambino	Cool Down Part I/Salsa	4:07
Zumba Lluvia	Zumba® Fitness	Cool Down Part II/Stretch	4:11

CHAPTER III

METHODS

To better understand the physiological responses of college aged women to Zumba®, cardiovascular and metabolic data were analyzed during a 58.6 min Zumba® class. Heart rate, oxygen consumption, and caloric expenditure responses were measured in this study.

Participants

Thirty nonsmoking females, age 18-30 years were recruited to participate in this study. Participants were volunteers from students enrolled in KINS 1311: Personal Fitness or experienced attendees of Zumba® classes held at Texas Woman's University's Fitness and Recreation center.

Prior to the study, participants completed a Physical Activity Readiness Questionnaire (PAR-Q) and provided written consent (Appendix B and Appendix C). Only individuals that were categorized as low risk according to the ACSM guidelines were recruited. Low risk is defined as individuals 55 years of age and under, who have fewer than two coronary risk factors, including high blood pressure, high blood cholesterol, smoking, diabetes, obesity, sedentary lifestyle, family history of coronary heart disease, and who do not have signs, symptoms, or known coronary, pulmonary, or metabolic disease. Approval from the Texas Woman's University Institutional Review Board was obtained prior to the study (Appendix A).

Procedures

Anthropometric Measurements

Height and body weight were measured prior to the Zumba® class. Body weight was measured to the nearest 0.1 kg and obtained while the participant stood on a Tanita BWB-800 Digital Scale (Tanita Corportation of America, Inc., Arlington Heights, IL) with no shoes. Height was measured using a portable stadiometer to the nearest 0.1 cm and obtained while the participants were barefoot and looking straight forward.

Preliminary Procedures

Participants filled out the PAR-Q and signed the informed consent after the methods and purpose of the study was explained. Participants were required to attend a minimum of three familiarization Zumba® classes identical to the test session to become accustomed to the instructor, music, and choreography. Data was not collected on the participants during their familiarization Zumba® classes. Prior to the testing day, participants were asked to avoid any major physical activity in the preceding 24 hours, and avoid heavy meals and caffeine drinks or supplements 2-3 hours before entering the group fitness studio.

On the day of data collection, participants reported to the group fitness studio half an hour prior to the class to review the objectives and procedures of the study and be fitted with the $K4b_2$ Cosmed unit. A face mask was securely fitted to each participant to ensure no gas escape could occur. The $K4b_2$ was held to each participant using a harness which was adjusted to allow more minimal obstruction of movement. A sphygmomanometer and blood pressure cuff were used to measure resting blood pressure while the participants sat in a chair. Resting kcal, kcal/min, HR, VO_2, and METs data were collected from the seated position for a period of 15 min.

Zumba® Class

All Zumba® class tests were performed in a group fitness studio located in the Fitness and Recreation Center or Pioneer Hall on the Texas Woman's University campus. To control for any inter-instructor variability, a single certified Zumba® instructor directed the same Zumba® choreography and music. The Zumba® session was performed in a standard class setting identical to the three familiarization classes.

The class duration was 58.6 min and composed of 16 Latin American and hip hop songs corresponding to a specific set of choreography (Table 1). Participants followed the movements of the instructor, but were allowed to modify the position, range, and impact of each movement as well as make adjustments to the choreography according to their preference.

The first two songs performed were warm up rhythms, lasting a combined duration of 7 min. The first two songs consisted of basic steps and choreography patterns. The middle 14 songs were considered the aerobic phase with the complexity of the movements and footwork increasing progressively throughout the 14 songs. The aerobic phase lasted for 43.4 min and was divided into three segments each lasting 14.5 min. The last two songs were the cool down songs and had a duration 8.2 min. In the second to last song the speed of movements was taken to half time. The final song consisted of only static stretches. All songs were choreographed to follow the Zumba® formula.

Measurements

Throughout the Zumba® class, MET levels, kcal, HR, VO_2, VCO_2, V_E, and RER were recorded on a breath-by-breath analysis using a portable telemetric apparatus ($K4b_2$, Cosmed, Rome, Italy). This consisted of a harness worn on the chest on which an oxygen-analyzer-transmitter (13 x 9 x 4 cm) was fixed on the participant's back and a battery (13 x 9 x 2 cm) on the front, for a total mass of 800 g. An oro-nasal mask with a turbine for measurements of ventilator flow rate was fixed on the participant's face. Gas samples were streamed to a mico-mixing chamber for analysis and a receiver unit recorded the data.

Data was transmitted in real time from the $K4b_2$ unit to a computer located at the back of the group fitness studio. All variables were viewed breath-by-breath on the $K4b_2$ computer program starting with the rest period and ending with the last cool down song. The beginning and end of the rest period, warm up, aerobic phase, and cool down were indicated on the computer program using the "marker" feature. The three 14.5 min segments that the aerobic phase was divided into were also noted via the marker feature.

Prior to testing, the $K4b_2$ Cosmed flow meter was calibrated with a 3-L syringe, and the oxygen analyzer was calibrated with a known gas mixture (16% O_2 and 4% CO_2) and environmental air (20.93% O_2 and 0.03% CO_2).

Data Analysis

Mean values for caloric expenditure, HR, VO_2, VCO_2, V_E, METs and RER were determined for the whole Zumba® class and for each of the three main phases: warm up, aerobic phase, and cool down. The metabolic and cardiorespiratory data for each of the three 14.5 min aerobic segments within the aerobic phase were averaged. Mean caloric expenditure, HR, VO_2, and METs were also calculated for the 15 min rest period before the Zumba® class.

Descriptive statistics were calculated to provide means, standard deviations, and ranges for height, weight, and age. A one sample t test was used to determine if there was a significant difference between the METs of the Zumba® class and 6 METs, the ACSM's definition of vigorous physical activity. Significance level was set at $p \leq .05$. A repeated measures ANOVA will be used to determine if there is a significant difference between kcal/min, METs, VO_2, HR and %HRmax in the three phases (warm up, aerobic, cool down) of the Zumba® class. A repeated measures ANOVA will also be used to determine if there is a significant difference between kcal, kcal/min, METs, VO_2, HR and %HRmax in the three segments of the aerobic phase. Significance level was set at $p \leq .05$ and a Bonferroni post-hoc test was used.

CHAPTER IV

RESULTS

The purpose of this study was to determine the energy expenditure throughout a 58.6 min Zumba® class. Participants attended three familiarization Zumba® classes identical to the Zumba® class where data was collected. A $K4b_2$ Cosmed unit was secured to each participant during the 58.6 min Zumba® class and variables of caloric expenditure, kcal/min, HR, VO_2, and METs were recorded. A single sample t test with a significance level of .05 was used to determine if there was a significant difference between the METs of the Zumba® class and the ACSM's definition of vigorous physical activity of 6 METs.

Participant Descriptions

Thirty female participants took part in this study. Mean ± standard deviation (SD) for age, weight, height, and age-predicted HRmax can be seen in Table 2. All participants were female volunteers enrolled in KINS 1311, Personal Fitness, or regularly attended Zumba® classes held at Texas Woman's University Fitness and Recreation Center. Participants completed a PAR-Q prior to acceptance and were cleared of any medical problems which would preclude them from participation in the study.

Table 2

Characteristics of Participants

Characteristic	**Mean**	±	**SD**
Age (years)	23.7	±	3.8
Weight (kg)	71.0	±	14.5
Height (cm)	165.1	±	20.5
Age-predicted HRmax (b/min)	196	±	4

n = 30

Analysis of Data

Following three familiarization Zumba® classes, participants performed a Zumba® class where data was collected. The 58.6 min Zumba® class was divided into a 7 min warm up phase, 43.4 min aerobic phase, and 8.2 min cool down phase. Metabolic and cardiorespiratory data was collected using a $K4b_2$ Cosmed unit that the participants wore during the 58.6 min Zumba® class. Data for all phases, segments and the 15 min rest period were averaged.

Mean values for caloric expenditure, HR, METs, and VO_2 for the full 58.6 min Zumba® class and three main phases of the Zumba® class, the warm up, aerobic phase, and cool down, are presented in Table 3. All values were higher in the aerobic phase than the warm up and cool down phases.

Table 3

Mean Values (± SD) for the Full Zumba® Class and Three Phases of the Zumba® Class

	METs	**Caloric Expenditure (kcals)**	**Calorie Expenditure per Minute (kcals/min)**	**HR (bpm)**	**% age-predicted HRmax**	**VO_2 (ml/kg/min)**	**VO_2 (L/min)**
Warm up phase	5.6 ± 1.9	48.1 ± 14.6	6.8 ± 2.1	148 ± 25	75.2 ± 12.6	20.2 ± 7.0	1.4 ± 0.4
Aerobic phase	5.9 ± 1.9	310.6 ± 81.8	7.2 ± 1.9	164 ± 12*	83.7 ± 6.1*	21.0 ± 6.8	1.5 ± 0.4
Cool down phase	4.2 ± 1.4ǂ	41.0 ± 11.4	5.0 ± 1.3ǂ	139 ± 20	71.0 ± 10.4	14.7 ± 4.9ǂ	1.0 ± 0.3ǂ
Full Zumba® Class	5.7 ± 1.8	401.4 ± 103.6	6.9 ± 1.8	153 ± 16	78.0 ± 8.0	20.0 ± 6.3	1.4 ± 0.4

*denotes a significant difference ($p < .05$) between the aerobic phase and both the cool down and warm up phases

ǂdenotes a significant difference ($p < .05$) between the cool down phase and both the warm up and aerobic phases

Repeated Measures ANOVA for each phase revealed significant differences for the HR and %HRmax during the aerobic phase and both the warm up phase and cool down phase. The cool down phase for the METs, caloric expenditure, relative VO_2 and absolute VO_2 were significantly lower than the warm up phase and aerobic phase.

The aerobic phase was further divided into three aerobic segments. The mean values for caloric expenditure per minute, HR, METs, and VO_2 for the segments can be found in Table 4.

Table 4

Mean Values (± SD) for the Three Aerobic Phase Segments

Aerobic Phase	**METs**	**Caloric Expenditure (kcals)**	**Calorie Expenditure per Minute (kcals/min)**	**HR (bpm)**	**% age-predicted HRmax**	**VO_2 (ml/kg/min)**	**VO_2 (L/min)**
Segment 1 (14.3 min)	6.7 ± 1.9*	114.7 ± 27.3*	8.0 ± 1.9*	165 ± 14	84.1 ± 6.9	23.4 ± 7.0*	1.6 ± 0.3*
Segment 2 (14.3 min)	5.9 ± 2.0*	103.2 ± 28.6*	7.1 ± 2.0*	164 ± 12	83.8 ± 5.8	20.9 ± 6.9 *	1.4 ± 0.4 *
Segment 3 (14.3 min)	5.3 ± 2.0*	92.6 ± 28.0 *	6.4 ± 2.0*	162 ± 11*	82.4 ± 5.7*	18.9 ± 7.1*	1.3 ± 0.4 *

* denotes a significant difference ($p < .05$) than the other two segments.

Repeated Measures ANOVA for each segment revealed significant differences for the METs, caloric expenditure, relative VO_2 and absolute VO_2 between all three segments of the aerobic phase. The HR and %HRmax for segment 3 was significantly lower than segment 1 and segment 2.

The mean caloric expenditure and mean METs during the different phases of the Zumba® class for all participants are illustrated in Fig. 1 and Fig. 2. The dashed line in Fig. 2 represents the ACSM's definition of vigorous physical activity of 6 METs. One sample t-test indicated a significant difference between 6 METs and segment 3 of the aerobic phase and the cool down phase (Figure 2). The warm up phase, segment 1 and segment 2 of the aerobic phase were not significantly different from 6 METs.

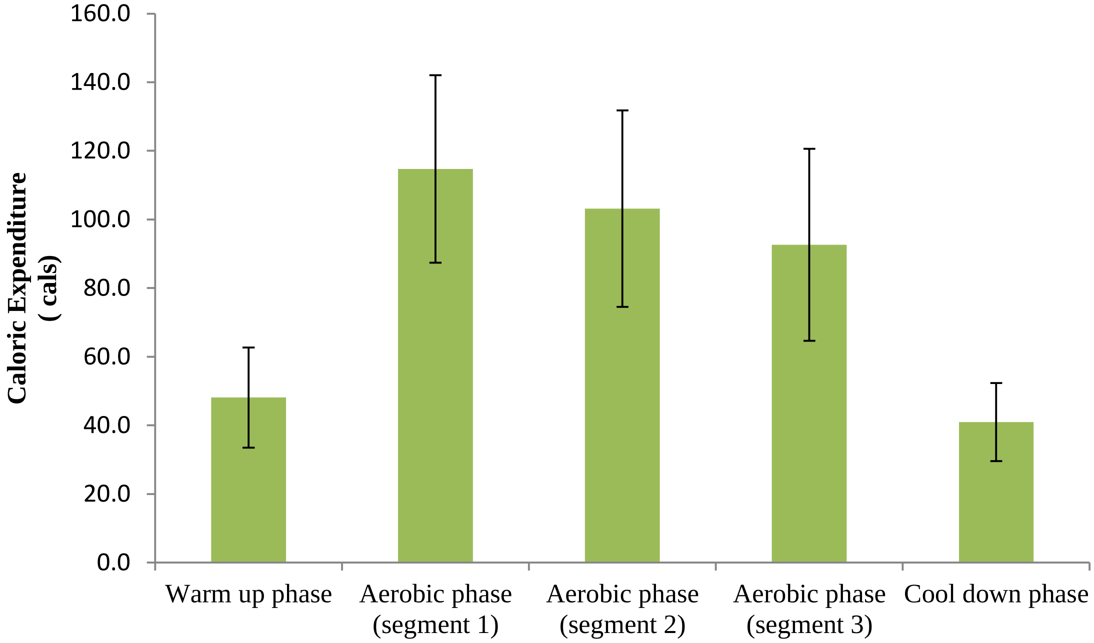

Figure 1. Mean kcals expended at the different phases of the Zumba® class. n = 30; 48.1 ± 14.6 kcals during the warm up phase; 114.7 ± 27.3 kcals during segment 1 of the aerobic phase; 103.2 ± 28.6 kcals during segment 2 of the aerobic phase; 92.6 ± 28.0 kcals during segment 3 of the aerobic phase; 41.0 ± 11.4 kcals during the cool down phase; values expressed ± standard deviation.

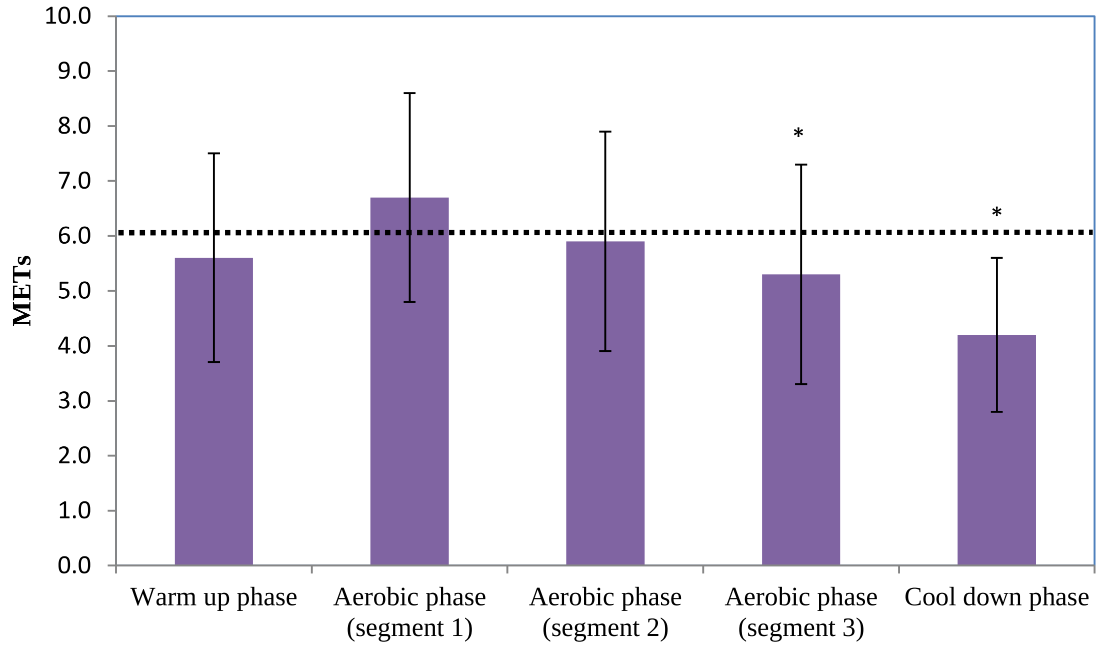

Figure 2. Mean METs during the different phases of the Zumba® class. n = 30; 5.6 ± 1.9 METs during the warm up phase; 6.7 ± 1.9 METs during segment 1 of the aerobic phase; 5.9 ± 2.0 METs during segment 2 of the aerobic phase; 5.3 ± 2.0 METs during segment 3 of the aerobic phase; 4.2 ± 1.4 METs during the cool down phase; the dashed line represents the ACSM's definition of vigorous physical activity of 6 METs; values expressed ± standard deviation. * denotes a significant difference ($p < .05$) between the class section and 6 METs.

CHAPTER V

SUMMARY, DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

This study was undertaken to determine the energy expenditure and physiological effects of a 58.6 min Zumba® class and compare the average METs of the Zumba® class to the ACSM's definition of vigorous activity of 6 METs. The null hypothesis stated that there would be no significant difference between the Zumba® class and 6 METs.

Summary

Participation in regular exercise is strongly encouraged for maintaining or improving various components of health and fitness (Grant, Davidson, Aitchison, & Wilson, 1998). Physical activity has been established as a critical component in health and weight management (ACSM, 2009). A sedentary lifestyle can lead to obesity and an increased risk of developing numerous chronic diseases as well as premature death (Haskell et al., 2007).

The ACSM states that aerobic fitness can be improved and health benefits received from 20-60 min of moderate to vigorous exercise on 3-5 days per week at 50-85% VO_2max, 60-95% HRmax, or 3-6 METs (ACSM, 2013). Aerobic dance classes and group fitness classes are a popular methods used to meet these criteria and have been reported to be effective in improving fitness (Grant et al., 1993). Zumba® is a group exercise format that incorporates aerobic dance components and has claimed to be an appropriate physical activity to be included in an exercise prescription for improving cardiorespiratory fitness. The purpose of this study was to determine the energy expenditure of a 58.6 min Zumba® class and compare the average MET level of the Zumba® class to the ACSM's definition of vigorous activity of 6 METs.

Thirty female participants took part in this study. All participants were female volunteers enrolled in KINS 1311: Personal Fitness or regularly attended Zumba® classes held at Texas Woman's University Fitness and Recreation center. Prior to data collections, all participants attended three Zumba® classes to become familiar with the format and choreography of the routines presented by the instructor.

The Zumba® session where data was collected was performed in a standard class setting identical to the three familiarization classes. The Zumba® class duration was 58.6 min, and was composed of 16 Latin American and hip hop songs corresponding to a specific set of choreography. The Zumba® class was divided into a warm up phase, aerobic phase, and cool down phase. Throughout the Zumba® class, METs, caloric expenditure, kcal/min, HR, and VO_2 were recorded using a K4b2 Cosmed unit that the participant wore during the class. A one sample t test with a significance level of .05 was used to determine if there was a significant difference between the METs of the Zumba® class and 6 METs, the ACSM's definition of vigorous physical activity. Based upon the findings of this study, the investigator was able to accept the following null hypothesis:

1. There will be no significant difference between the METs of the Zumba® class and the ACSM's definition of vigorous physical activity of 6 METs.

Discussion

Group Exercise Class Design

Ideal shifts in exercise intensity throughout a group fitness class consists of a gradual rising of intensity from the warm up phase to the aerobic phase, followed by the levels returning to a similar point as the warm up during the cool down phase. Figure 1 and Figure 2 illustrate the relatively bell curve shape of the mean caloric expenditure and METs of the participants in the Zumba® class. However, only HR and %HRmax follow this pattern with the aerobic phase being significantly different than both the warm up and cool down phase indicating an increase in intensity during the aerobic phase in comparison to the warm up and cool down phases (Table 3).

There was a significant difference between the cool down phase and both the warm up and aerobic phase with METs, caloric expenditure per minute, and VO_2 responses (Table 3). This signifies similar intensity levels in the warm up and aerobic phases and a decrease in intensity in the cool down phase which does not follow the intensity pattern of the ideal group fitness class design. When the aerobic phase is divided up into the three segments, it appears the Zumba® class intensity starts to decrease in segment 3 rather than the cool down (Figure 2 and Table 4). The significant differences between the VO_2 and METs for all three aerobic segments and the significant difference between the HR and %HRmax for segment 3 and both segments 1 and 2 demonstrate a declining intensity level before the cool down phase is reached (Table 4). One possible explanation for this premature decrease in intensity is that the participants have a low fitness level and may have started to fatigue during the aerobic phase. Even though the participants were accustomed to a 58.6 min Zumba® class, they might have started to decrease the intensity of the choreography and movements before the cool down phase.

METs

The ACSM set the following intensity classifications for cardiorespiratory exercises: light intensity at 2.0-2.9 METs, moderate intensity at 3.0-5.9 METs, and vigorous intensity at $\geq$ 6.0 METs (ACSM, 2013). The moderate to vigorous intensity levels are recommended by the ACSM for developing and maintaining cardiorespiratory fitness (ACSM, 2013). The mean METs of the full 58.6 min Zumba® class was 5.7 ± 1.8 METs, categorizing the activity as moderate intensity. The mean METs of the aerobic phase of the Zumba® class was higher at 5.9 ± 1.9 METs though still considered moderate intensity. It should be noted that the METs of both the full Zumba® class and the aerobic phase are approaching the vigorous intensity level. Out of 30 total participants, two of the participants' METs would be classified as light intensity, 17 participants fell into the moderate intensity category, and 11 participants averaged 6 METs or above and were working at vigorous intensity levels. While the mean METs of the full Zumba® class classify the activity as moderate intensity, many participants still achieved vigorous intensity levels; therefore Zumba® might be considered vigorous exercise for some people.

In comparison to Jette, Sidney, & Blumchen (1990) who analyzed METs of various recreational activities and found aerobic dancing between 3.9-6.0 METs depending on if it was considered high (6.0 METs) or low impact dance (3.9 METs), Zumba® would be similar to the high impact aerobic dance class. The mean METs of Zumba® were comparable to Ainsworth et al.'s (1993) findings in the Compendium of Physical Activities of 5.0 METs for low impact aerobic dancing but lower than the reported 7.0 METs for high impact aerobic dancing. This would classify the Zumba® class as having equivalent exercise intensity to a low impact aerobic dance class. Jette, Sidney, & Blumchen (1990) and Ainsworth et al. (1993) present different METs values for low and high impact aerobic dance making an association to Zumba® difficult. It should be noted both studies compiled their results from previously published articles all of which used different methods to collect data. Therefore, the mean MET values reported might not reflect the true energy cost of the exercise and limit the accuracy of the comparison.

While the Zumba® class exhibited a lower intensity level than high impact aerobic dance according to the Compendium of Physical Activity, there are several activities that have a lower energy cost than Zumba® (Ainsworth et al., 1993). Stationary bicycling at 50-100 W is considered light to moderate effort and expends 3.0-

5.0 METs, lower than the 5.7 ± 1.8 METs of the Zumba® class (Ainsworth et al., 1993). Walking for exercise at 3 km/h, 5 km/h, and 7 km/h has a metabolic cost of 1.8 METs, 3.2 METs, and 5.3 METS, respectively, all of which are below the intensity level of the Zumba® class (Jette, Sidney, & Blumchen, 1990). The METs of the Zumba® class are also greater than METs of 4.0 for hatha yoga and water aerobics or water calisthenics (Ainsworth et al., 1993).

VO_2 and HR Responses

The mean values for oxygen consumption and heart rate during the Zumba® class were lower than previously documented research on aerobic dance classes (Angelis, Vinciguerra, Gasbarri, & Pacitti, 1998; Foster, 1975; Rockefeller & Burke, 1979). The mean VO_2 and HR for the full Zumba® class were 20.0 ± 6.3 ml/kg/min and 153.2 ± 16 bpm, corresponding to 78.0 ± 8.0% age-predicted HRmax. Based on the VO_2 and HR responses in Foster's (1975) and Rockefeller and Burke's (1979) studies, they both concluded the aerobic dance classes were of sufficient intensity to elicit improvements in cardiorespiratory fitness; however, since the mean VO_2 and HR of the Zumba® class was lower, it can be concluded the intensity of Zumba® would not stimulate the same response. When the VO_2 and HR for the three phases were compared to another aerobic dance study that also divided up the class into a warm up, aerobic/stimulus phase, and cool down, mean VO_2 and HR values for the three phases of the Zumba® class were still considerably lower than that study (Angelis et al., 1998). Angelis et al. (1998) found mean VO_2 responses of 19.7 ± 3.9 ml/kg/min for the warm up phase, 34.4 ± 5.3 ml/kg/min for the aerobic/stimulus phase, and 16.1 ± 4.3 ml/kg/min for the cool down phase for an aerobic dance class, all values which were higher than the three phases of the Zumba® class. In comparison to low impact versus high impact aerobic dance studies, the Zumba® class had a lower VO_2 and HR response than both formats, further demonstrating an intensity level below that of low impact aerobic dance which produced a mean HR of 166 ± 15 bpm and mean VO2 of 25.1 ± 3.9 ml/kg/min (Otto et al., 1986). However, the Zumba® class elicited greater mean HR responses than both high impact and low impact popmobility full classes which showed participants working at 71.6 ± 7% HRmax during the low impact popmobility class and 76.6 ± 6% HRmax during the high impact popmobility class (Grant et al., 1998). This could be attributed to popmobility formats containing strength training and flexibility components within the class, lowering the mean HR for the full class.

The ACSM (2009) recommends exercise intensity should be moderate to vigorous at 40-85% VO_2max or 60-95% HRmax for improving cardiorespiratory fitness. Results of previous studies are within this guideline with a mean VO_2max of 51-82% and mean HRmax of 69-93% in a combination of low impact and high impact aerobic dance classes, with the high impact aerobic dance classes yielding the top percentages and the low impact aerobic dance classes making up the lower percentages (Angelis et al., 1998; Claremount et al., 1986; Foster, 1975; Grant et al., 1993; Igbanugo & Gutn, 1978;

Rockefeller & Burke, 1979; Weber, 1974; Williford, Scharff-Olson, & Blessing, 1989). Using the equation HRmax(bpm) = 220 – age (yrs), the mean percentage of HRmax for the full Zumba® class was estimated to be 78.0 ± 8.0%. This percentage falls within the ACSM's range for moderate to vigorous intensity exercise as well as the accepted training threshold for cardiorespiratory improvements of 70% HRmax (ACSM, 2013; Karvonen, Kentala, & Mustala, 1975). Given that the present study did not measure VO_2max or HRmax, the percentages of either cannot be calculated; however, since the VO_2 values for the Zumba® class were less than the low impact aerobic dance classes, it can be inferred the Zumba® class would have a smaller %VO_2max than low impact aerobic dance and fall at the bottom end of the moderate intensity range.

Energy Expenditure

Using a combination of moderate and vigorous intensity activity, an exercise prescription should aim to achieve an energy expenditure of approximately 1000-2000 kcals per week to provide health benefits and weight control (Donnelly et al., 2009; Lee & Paffenbarger, 2000). Additionally, if a change in body composition is desired, the ACSM recommends an energy expenditure of 300-500 kcals per exercise session (ACSM, 1990). The caloric cost of the Zumba® class does meet the minimum energy requirements suggested by the ACSM and with a mean energy expenditure of 401.4 ± 103.3 kcals per Zumba® class and average class duration of 58.6 mins, attending 3-5

Zumba® classes per week would be necessary to maintain or improve cardiorespiratory fitness (ACSM, 2013).

The mean caloric cost of the full Zumba® class was 401.4 ± 103.6 kcals with the majority of the energy expenditure occurring during the aerobic phase of the class at 310.6 ± 81.8 kcals. Other group fitness classes such as BODYATTACK™, BODYCOMBAT™, BODYSTEP™, and RPM™ all produced caloric responses which exceeded that of the Zumba® class (LessMills™, 2011; Lythe & Pftizinger, 2009; Rixon, Rehor, & Bemben, 2006). While it appears the Zumba® class energy expenditure is greater than that of Popmobility and Aerobic Dance, Inc., the duration of the aerobic dance section of both formats is less than that of the Zumba® class (Grant et al., 1993; Rockefeller & Burke, 1979). Popmobility reported an expenditure of 236.6 ± 28.4 kcals in the 20 min aerobic dance section which, in comparison to the 310.6 ± 81.8 kcals expended in the 43.4 min aerobic section of the Zumba® class, is certainly a higher rate of energy expenditure (Grant et al., 1993). Similarly, the Aerobic Dance, Inc. class expended 289.3 ± 45.1 kcals for the full class duration of 40 min, designating the caloric cost greater than that of 401.4 ± 103.3 kcals for the full 58.6 min Zumba® class (Rockefeller & Burke, 1979).

The full Zumba® class expended 6.9 ± 1.8 kcal/min with the aerobic phase requiring a cost of 7.2 ± 1.9 kcal/min. The values are less than the Les Mills™ classes of BODYCOMBAT™ and BODYSTEP™ which expended 9.7 ± 2.0 kcal/min and 9.6 ± 1.8

kcal/min, respectively (Rixon, Rehor, & Bemben, 2006). Ergun et al. (2006) recorded an energy cost of 7 kcal/min in a kickboxing group fitness class which is of similar intensity to both the full Zumba® class and the aerobic phase. A review of aerobic dance characterizes “low intensity” dance exercise by an expenditure of 4-5 kcal/min and “high intensity” dance exercise by a cost of 10-11 kcal/min (Williford, Scharff-Olson, & Blessing, 1989). The large difference in energy expenditure between the two is explained by less large muscle activity and a slower tempo music in “low intensity” dance requires less energy than the quicker tempo and large muscle groups used in “high intensity” dance (Williford, Scharff-Olson, & Blessing, 1989). According to this classification, the kcal/min of the Zumba® class falls mostly in the middle of “low intensity” and “high intensity” dance exercise; however, it is slightly closer to “low intensity”.

The results from the present study reveal a great deal of variability in energy expenditure between Zumba®, aerobic dance and other group fitness formats. Due to its lower total energy expenditure than other group fitness classes, Zumba® would need to be performed at a greater frequency to attain the fitness and health goals. Regular participation in Zumba® classes could still result in expending adequate calories to reduce the risk of chronic diseases, improve aerobic fitness, and decrease body fat. Furthermore, it should be understood that individual exercise classes involving aerobics as a component can differ in intensity which would change the energy expenditure for any given session.

Comparison to Aerobic Dance and Group Fitness Classes

It is questionable whether results from other studies can be genuinely juxtaposed to the Zumba® class. Differing protocols, styles, and core movements create great variability among group fitness and aerobic dance classes and make it difficult to compare values. While elements from other group fitness classes have provided a framework for Zumba®, this format has a unique exercise and dance technique that might not make it appropriate for comparing physiological responses to the group fitness or aerobic dance classes. There is also great variation in research design during data collection in previous studies. For example, some have participants dancing alone or in laboratory setting, dancing to a new routine, or following an unfamiliar instructor or videotape. All of those methods are very different than a normal group fitness class and their findings might not be reflective of the participant's true cardiorespiratory responses during their regular group fitness session. To improve upon these issues, the present study attempted to control the experimental conditions by allowing the participants to perform their typical Zumba® routine, in a standard class setting, and with their own instructor.

It should be noted that while Zumba® instructors are required to follow the Zumba® formula, they have the freedom to create their own song selection, playlist order and choreography. The variety in Zumba® makes every class unique and can cause the exercise intensity to change between classes and instructors. Variables that could affect the intensity include how comfortable the participant is with the dance, if the participant chooses a high impact or low impact version of a movement, and if the participant incorporates upper body or additional lower body steps into the choreography. Zumba® is described as a moderate intensity activity from this study, but based on which technique options and modifications each participant selects, some may be working at a low intensity or high intensity level. Therefore the results documented in this study might not be applicable to other Zumba® classes under different instruction since major components of the Zumba® class could change, influencing the intensity and caloric output. Even with the same instructor, the energy expenditure and intensity level the participant attains during one class might not be identical to the next session depending on the effort given by the participant.

Recommended Participant Population

Zumba® promotes its classes as being appealing to all fitness and age levels since the choreography is simple and movements are able to be adapted to the exercise requirements of each participant. As already mentioned, Zumba® appears to be a moderate intensity activity and analogous to low impact aerobic dance. With these factors in mind, a Zumba® class would be an appropriate exercise mode for the overweight, obese, beginner, sedentary, or deconditioned participant. According to Blair & Connelly (1996), greater responses to the same training stimuli will be seen in unfit rather than active individuals. With the intensity of a Zumba® class only reaching the lower limit to increase cardiorespiratory fitness, it might not be a suitable aerobic exercise to elicit improvements in trained or active individuals who are already accustomed to training at higher workloads. Therefore, improvements in cardiorespiratory fitness are more likely to be achieved by those with initially low fitness levels when participating in Zumba® classes. While improvements in VO_2max values may not be observed in more fit participants, Zumba® should still be considered an appropriate physical activity to prevent adverse health conditions such as heart disease, type 2 diabetes, hypertension, dyslipidemia, and stroke (Haskell et al., 2007).

Exercise Prescription Recommendations

The ACSM recommends moderate intensity exercise be performed for at least 5 days per week for 30 mins and 1000-2000 kcals per week expended through exercise to maintain or improve cardiorespiratory fitness and obtain health benefits (ACSM, 2013; Donnelly et al., 2009). Based on the mean MET levels, caloric expenditure, VO_2 and HR responses, Zumba® is classified as a moderate intensity activity and capable of meeting the ACSM's criteria if practiced for 60 min duration, 3-5 days per week. Taking three Zumba® classes per week would be the minimum recommended frequency and, depending on an individual's goals, increasing to 4-5 sessions might be more effective for fitness improvements or weight control.

Conclusion and Recommendations

In conclusion, the results of the present study showed no significant difference between 6 METs and the mean METs of a Zumba® class.

Recommendations for future studies may include:

1. Replicate this study, but include male participants.
2. Replicate this study using several different Zumba® instructors with a non-standardized playlist and choreography.
3. Replicate this study, but include a VO_2max test of all the participants.
4. Compare the physiological responses of the Zumba® to other exercises, activities, or group fitness classes.

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APPENDIX A

IRB Approval Letter

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378 FAX 940-898-4416
e-mail: IRB@twu.edu

April 3, 2013

Ms. Rebecca Rogers
3112 Redbud
Sherman, TX 75092

Dear Ms. Rogers:

Re: Physiological Responses to a 60-Minute Zumba® Class in College Age Females (Protocol #: 17276)

The above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and appears to meet our requirements for the protection of individuals' rights.

If applicable, agency approval letters must be submitted to the IRB upon receipt PRIOR to any data collection at that agency. A copy of the approved consent form with the IRB approval stamp is enclosed. Please use the consent form with the most recent approval date stamp when obtaining consent from your participants. A copy of the signed consent forms must be submitted with the request to close the study file at the completion of the study.

This approval is valid one year from March 1, 2013. Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

Sincerely,

Rhonda R Buckley

Dr. Rhonda Buckley, Chair
Institutional Review Board - Denton

cc. Dr. Charlotte Sanborn, Department of Kinesiology
Dr. Kyle Biggerstaff, Department of Kinesiology
Graduate School

APPENDIX B

Informed Consent

TEXAS WOMAN'S UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Title: Physiological Responses to a Zumba® Class in College Age Females

Investigator: Rebecca Rogers..rrogers2@twu.edu 903/815-9450
Advisor: Kyle Biggerstaff, Ph.D..kbiggerstaff@twu.edu 940/898-2596

Explanation and Purpose of the Research

You are being asked to participate in a research study for Ms. Rogers' thesis at Texas Woman's University. The purpose of this study will be to determine the physiological responses to a Zumba® class and analyze the difference between resting and Zumba® class heart rate, oxygen consumption and energy expenditure. You have been asked to participate in this study because you are female and attend Zumba® classes.

Description of Procedures

You will attend a minimum of three familiarization Zumba® classes at TWU Fitness and Recreation Center or Pioneer Hall which are identical to the test Zumba® class and will allow you to become familiar with the instructor, music, and choreography. Each familiarization Zumba® class will be 60-min long. You will complete a physical activity readiness questionnaire (PAR-Q) prior to the first familiarization Zumba® class. Anthropometric measurements of height and body weight will be performed in the exercise physiology laboratory in Pioneer Hall before the test Zumba® class. You will need to avoid heavy meals and caffeine drinks or supplements 2-3 hours before the familiarization Zumba® classes and test Zumba® class. A $K4b_2$ Cosmed unit and accelerometer will be used to collect data during the test which consists of a face mask and harness. The face mask will be securely fitted around you mouth area and the harness to your chest and back. The accelerometer will be hooked to the front of the harness. Once you have been equipped with the $K4b_2$ and the accelerometer, you will sit in a chair and rest for 15 min. You will then participate in a 60-min Zumba® class involving a warm-up, aerobic segment, and cool-down. You will be allowed to stop and rest at any point during the Zumba® class. When the Zumba® class is finished, the $K4b_2$ and accelerometer will be removed. The total time commitment will be approximately 285 min.

Potential Risks

You will be exposed to the following potential risks.

Risk of loss of Confidentiality – to minimize this risk, all data collected will be coded and participant's names will not be used. There is a potential risk of loss of confidentiality in all email, downloading, and internet transactions. The PI will keep all information in a file cabinet in a locked office that only the PI will have access to. All testing information will be treated as privileged and confidential. Other class attendees will be in the Zumba® class; therefore, loss of confidentiality will occur. The PI will avoid saying the participant's name, releasing any participant data or pointing out the participant during the Zumba® class.

Risk of embarrassment – to minimize this risk, the anthropometric measurements will be performed in a closed room in the exercise laboratory in Pioneer Hall with only the participant and the PI. All participants will have completed a minimum of three previous Zumba® classes to be familiar with the dance choreography, movements, and rhythms. Participants will be acquainted with the other class members due

____
Initials

TEXAS WOMAN'S UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Title: Physiological Responses to a Zumba® Class in College Age Females

Investigator: Rebecca Rogers..rrogers2@twu.edu 903/815-9450
Advisor: Kyle Biggerstaff, Ph.D..kbiggerstaff@twu.edu 940/898-2596

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______ Initials

APPENDIX C

Physical Readiness Activity Questionnaire (PAR-Q)

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE

Regular physical activity is fun and healthy, and increasingly more people are becoming more active every day. Being more active is very safe for most people. However, some people should check with their doctor before becoming much more physically active.

If you are planning to become more physically active than you are now, start by answering the following seven questions below. If you are between the ages of 15 and 69, these questions will tell you if you should check with you doctor before you start.

COMMON SENSE IS YOUR BEST GUIDE WHEN ANSWERING THESE QUESTIONS. PLEASE READ EACH CAREFULLY AND CIRCLE YES OR NO.

YES	NO	1. Has your doctor ever said that you have a heart condition and that you should only do physical activity as recommended by a doctor?
YES	NO	2. Do you feel pain in your chest when doing physical activity?
YES	NO	3. In the past month, have you had chest pain when not doing physical activity?
YES	NO	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
YES	NO	5. Do you have a bone of joint problem that could be made worse by a change in your physical activity?
YES	NO	6. Is your doctor currently prescribing drugs for your blood pressure or heart condition?
YES	NO	7. Do you know of any other reason why you should not do physical activity?

IF YOU ANSWERED YES TO ONE OF MORE QUESTIONS:
Talk to your doctor by phone or in person BEFORE becoming more physically active. Tell your doctor about this questionnaire and about which questions you answered yes to. You may be able to do any activity you want as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are deemed safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.

IF YOU HONESTLY ANSWERED NO TO ALL QUESTIONS:
You can be sure that you can start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.

I have read, understood, and completed this questionnaire. Any question I had was answered to my full satisfaction.

Name: ____ Date: ________________________

Signature: ___________________________________ Witness:_____________________________

APPENDIX D

Zumba® Frequency Survey

Zumba® Frequency Survey

1. How many hours do you work out a week?
    a. <5
    b. 5-10
    c. 10-20
    d. >20

2. Does your workout involve attending Zumba® classes?
    a. Yes
    b. No

3. If you answered yes to question 2, how many hours do you spend attending Zumba® classes each week?
    a. 1-2
    b. 2-3
    c. 3-4
    d. <4

4. How long have you been attending Zumba® classes?
    a. >1 month
    b. 1-3 months
    c. 3-6 months
    d. 6-12 months
    e. 1-2 years
    f. >2 years

APPENDIX E

Data Collection Form

Data Collection Form

Participant ID: ________________________ Cosmed ID: ________

Familiarization 1 Date: ___________ Fam 2 Date: _________ Fam 3 Date: _________

Trial Date: _______________

Height (kg): ____________________
Weight (cm): ____________________
DOB and age: ____________________

Rest/Song #/Section	Time begins/ends	Notes

Resting HR: ______________ Recovery HR: ____________
Resting BP: ______________ Recovery BP: ____________

APPENDIX F

Raw Data

Raw Data – Demographics

Participant	Weight (kg)	Height (cm)	Age (yrs)	Age-predicted HRmax (bpm)
1	63	165	24	196
2	97	170	26	194
3	66	163	26	194
4	63	165	29	191
5	73	168	22	198
6	71	175	32	188
7	76	163	24	196
8	116	157	25	195
9	92	258	34	186
10	46	155	18	202
11	82	165	27	193
12	48	158	20	200
13	70	147	22	198
14	58	142	21	199
15	66	135	21	199
16	64	163	19	201
17	79	173	25	195
18	72	140	26	194
19	58	160	20	200
20	64	168	22	198
21	75	175	23	197
22	83	176	27	193
23	74	165	27	193
24	86	175	22	198
25	67	170	21	199
26	78	155	19	201
27	54	152	20	200
28	57	157	24	196
29	63	170	23	197
30	69	168	22	198
Mean	71	165	24	196
S. Dev	15	21	4	4

Raw Data – Caloric Expenditure (kcals)

Participants	Full Class	Warm Up Phase	Aerobic Phase	Cool Down Phase
1	346.1	47.8	263.6	34.5
2	336.5	35.2	262.6	38.7
3	271.1	30.9	196.2	43.9
4	247.9	33.5	188.7	25.7
5	367.3	48.2	285.8	34.0
6	427.2	53.2	328.7	44.6
7	424.4	58.0	319.3	47.5
8	322.6	16.3	283.6	22.7
9	233.0	35.9	173.8	23.5
10	425.9	53.2	330.3	42.5
11	544.4	67.2	415.5	60.0
12	413.9	54.8	304.9	46.5
13	573.7	70.0	428.6	49.3
14	450.7	56.7	350.4	42.7
15	591.3	69.7	476.3	55.0
16	379.1	46.8	290.1	42.0
17	442.0	61.2	326.2	54.6
18	459.5	46.5	383.8	29.2
19	359.3	52.2	269.0	37.8
20	249.6	38.5	181.8	29.4
21	593.8	81.5	442.9	70.0
22	398.4	37.2	288.5	37.7
23	412.0	49.4	329.9	33.6
24	487.4	49.5	394.8	44.2
25	309.1	25.4	251.8	33.2
26	469.7	53.8	368.1	48.6
27	384.3	40.2	307.8	38.0
28	538.1	61.0	421.0	57.5
29	237.0	28.5	183.4	25.1
30	347.0	41.0	269.6	37.0
Mean	401.4	48.1	310.6	41.0
S. Dev	103.6	14.6	81.8	11.4

Raw Data – Caloric Expenditure (kcals)

Participants	Aerobic Segment 1	Aerobic Segment 2	Aerobic Segment 3
1	98.0	97.7	68.1
2	98.3	89.0	75.3
3	81.6	57.6	57.0
4	68.0	61.9	58.8
5	106.1	94.7	83.6
6	125.1	104.6	99.6
7	128.6	106.6	80.0
8	102.8	94.5	86.2
9	71.1	56.0	46.7
10	125.0	104.4	100.6
11	153.7	133.2	126.2
12	111.3	101.1	111.2
13	159.4	140.3	132.4
14	132.3	111.7	103.8
15	156.6	168.9	153.8
16	112.5	96.4	81.3
17	132.4	112.5	81.4
18	142.1	134.0	107.1
19	101.0	86.7	81.3
20	73.0	55.2	54.3
21	150.4	148.8	142.5
22	103.8	99.2	87.3
23	121.8	119.2	89.4
24	151.5	127.3	116.2
25	90.0	84.3	77.5
26	128.7	123.2	117.5
27	106.1	94.7	83.6
28	142.4	140.7	139.1
29	69.4	63.6	51.8
30	99.2	86.9	84.3
Mean	114.7	103.2	92.6
S. Dev	27.3	28.6	28.0

Raw Data – Calorie Expenditure per Minute (kcal/min)

Participants	Full Class	Warm Up Phase	Aerobic Phase	Cool Down Phase
1	5.9	6.8	6.0	4.3
2	5.7	5.0	6.1	4.7
3	4.9	4.5	4.8	5.4
4	4.2	4.4	4.3	3.4
5	6.3	6.9	6.6	4.1
6	7.3	7.6	7.6	5.0
7	7.2	8.3	7.4	5.4
8	5.5	2.1	6.6	2.6
9	4.0	5.1	4.0	3.0
10	7.3	6.6	7.6	5.2
11	9.3	9.6	9.6	6.7
12	6.9	7.8	7.0	5.7
13	9.8	10.0	9.9	6.0
14	7.7	8.1	8.1	5.2
15	10.1	10.0	11.0	6.7
16	6.5	6.7	6.7	5.1
17	7.5	8.7	7.5	6.7
18	7.8	6.6	8.9	3.6
19	6.1	7.5	6.2	4.6
20	4.3	5.5	4.2	3.6
21	10.1	11.6	10.2	8.5
22	6.8	5.3	6.7	4.6
23	7.0	7.1	7.6	4.1
24	8.3	7.1	9.1	5.4
25	5.3	3.6	5.8	4.0
26	8.0	7.7	8.5	5.9
27	6.6	5.7	7.1	4.6
28	9.2	8.7	9.7	7.0
29	4.0	4.1	4.2	3.1
30	5.9	5.9	6.2	4.5
Mean	6.9	6.8	7.2	5.0
S. Dev	1.8	2.1	1.9	1.3

Raw Data – Calorie Expenditure per Minute (kcal/min)

Participants	Aerobic Segment 1	Aerobic Segment 2	Aerobic Segment 3
1	6.3	6.2	4.3
2	6.9	6.2	5.3
3	6.0	4.3	4.0
4	4.8	4.3	4.0
5	7.4	4.9	4.8
6	8.7	7.3	6.8
7	9.0	7.5	5.6
8	7.0	6.7	6.3
9	5.0	3.9	3.3
10	8.7	7.3	7.0
11	10.7	9.3	8.8
12	7.8	7.1	7.8
13	11.1	9.8	9.3
14	9.2	7.6	7.3
15	10.9	11.8	10.8
16	7.9	6.7	5.7
17	9.3	7.9	5.7
18	9.9	9.4	7.5
19	7.1	6.1	5.7
20	5.1	3.9	3.8
21	10.5	10.4	10.0
22	7.3	6.9	6.1
23	8.5	8.3	6.3
24	10.6	8.9	8.1
25	6.3	5.9	5.4
26	9.0	8.6	8.2
27	7.4	6.6	5.8
28	10.0	9.8	9.7
29	4.9	4.4	3.6
30	6.9	6.1	5.9
Mean	8.0	7.1	6.4
S. Dev	1.9	2.0	2.0

Raw Data – Heart Rate (bpm)

Participants	Full Class	Warm Up Phase	Aerobic Phase	Cool Down Phase
1	173	146	174	180
2	142	125	146	129
3	145	136	146	149
4	154	139	155	157
5	156	132	157	162
6	151	165	151	135
7	158	149	159	152
8	106	89	156	74
9	159	159	160	141
10	151	165	151	135
11	156	170	156	140
12	175	181	176	148
13	156	172	157	141
14	161	175	161	145
15	159	175	161	143
16	149	139	162	141
17	167	155	178	138
18	129	97	186	101
19	179	142	184	163
20	157	164	164	145
21	163	148	188	153
22	143	125	146	129
23	164	156	186	148
24	165	171	174	144
25	111	80	157	93
26	158	170	164	141
27	150	145	171	131
28	154	154	169	143
29	152	150	167	136
30	155	153	162	148
Mean	153	148	164	139
S. Dev	16	25	12	20

Raw Data – Heart Rate (bpm)

Participants	Aerobic Segment 1	Aerobic Segment 2	Aerobic Segment 3
1	163	173	163
2	145	149	143
3	147	143	146
4	150	155	160
5	151	157	161
6	151	152	150
7	162	160	155
8	150	162	156
9	157	164	159
10	151	152	150
11	156	157	155
12	165	175	165
13	158	157	157
14	161	162	160
15	161	160	160
16	169	162	159
17	182	180	175
18	193	178	182
19	190	183	180
20	169	164	160
21	190	188	185
22	148	146	145
23	190	186	185
24	177	175	172
25	164	158	152
26	167	165	163
27	177	174	167
28	170	168	167
29	173	167	157
30	168	162	157
Mean	165	164	162
S. Dev	14	12	11

Raw Data – VO_2 (ml/kg/min)

Participants	Full Class	Warm Up Phase	Aerobic Phase	Cool Down Phase
1	18.9	20.3	19.2	13.8
2	11.8	10.4	12.5	9.7
3	14.3	13.3	14.3	15.5
4	13.7	15.5	14.0	10.7
5	17.7	18.0	18.6	11.4
6	19.8	21.9	21.5	15.4
7	19.7	22.3	19.9	15.7
8	9.5	5.7	11.1	5.4
9	8.6	11.2	8.5	6.0
10	30.8	29.9	33.5	22.4
11	22.8	23.9	23.5	16.4
12	28.9	32.3	29.2	23.8
13	27.3	28.4	28.6	16.8
14	26.8	26.9	27.5	17.4
15	30.3	30.3	33.8	20.9
16	20.2	20.9	20.9	16.0
17	19.1	22.1	19.1	16.9
18	21.8	18.4	24.6	9.9
19	21.1	25.7	21.4	15.9
20	13.3	17.2	13.1	11.2
21	27.0	31.0	27.3	22.8
22	16.4	12.8	16.1	11.1
23	19.0	19.1	20.6	11.1
24	19.3	16.4	21.2	12.5
25	15.7	10.8	17.4	12.1
26	20.6	19.7	21.8	23.1
27	24.3	21.3	26.3	17.2
28	32.2	30.6	34.1	24.6
29	12.8	12.9	13.4	9.7
30	17.2	17.0	18.0	13.1
Mean	20.0	20.2	21.0	14.7
S. Dev	6.3	7.0	6.8	4.9

Raw Data – VO_2 (ml/kg/min)

Participants	Aerobic Segment 1	Aerobic Segment 2	Aerobic Segment 3
1	21.3	21.2	15.5
2	14.2	12.8	10.8
3	17.7	12.7	12.0
4	15.2	14.0	12.5
5	19.7	18.1	16.0
6	25.0	20.7	20.0
7	21.6	16.8	12.2
8	12.8	11.1	10.4
9	10.3	8.1	7.2
10	38.0	30.7	30.0
11	27.0	22.7	21.0
12	32.3	29.5	31.2
13	32.0	27.3	26.7
14	31.6	26.7	26.0
15	33.2	35.7	32.4
16	24.6	21.1	17.8
17	23.4	19.9	14.4
18	27.6	26.0	20.8
19	24.4	20.9	19.6
20	15.9	12.1	11.9
21	28.0	27.7	26.6
22	17.5	16.7	14.7
23	23.0	22.5	16.9
24	24.6	20.7	18.9
25	18.8	17.6	16.2
26	22.1	21.1	15.2
27	27.5	24.5	21.7
28	34.9	34.5	34.1
29	15.4	14.1	11.5
30	20.1	17.6	17.1
Mean	23.4	20.9	18.9
S. Dev	7.0	6.9	7.1

Raw Data – VO_2 (ml/min)

Participants	Full Class	Warm Up Phase	Aerobic Phase	Cool Down Phase
1	1180	1376	1218	841
2	1149	1006	1211	945
3	965	886	961	1069
4	846	954	854	648
5	1254	1304	1369	886
6	1444	1508	1502	1009
7	1469	1646	1786	1151
8	1100	965	1303	859
9	997	1034	999	972
10	1454	1408	1532	1042
11	1844	1858	1912	1340
12	1381	1576	1418	1133
13	1954	1958	1952	1202
14	1534	1618	1622	1041
15	2004	1998	2204	1331
16	1294	1337	1340	1024
17	1509	1749	1507	1331
18	1568	1327	1773	712
19	1226	1491	1243	922
20	1052	1099	1040	1017
21	2027	2328	2046	1708
22	1360	1063	1332	920
23	1406	1410	1524	819
24	1663	1413	1823	1078
25	1055	726	1163	809
26	1603	1538	1700	1801
27	1312	1148	1422	927
28	1836	1743	1945	1403
29	809	813	847	613
30	1184	1173	1245	901
Mean	1369	1365	1446	995
S. Dev	350	410	380	268

Raw Data – VO_2 (ml/min)

Participants	Aerobic Segment 1	Aerobic Segment 2	Aerobic Segment 3
1	1373	1363	951
2	1375	1245	1053
3	1238	832	833
4	958	859	822
5	1493	1319	1166
6	1751	1460	1377
7	1643	1280	929
8	1453	1313	1094
9	985	973	948
10	1731	1460	1397
11	2151	1830	1777
12	1553	1418	1553
13	2211	1970	1857
14	1841	1570	1457
15	2191	2400	2177
16	1573	1348	1138
17	1851	1573	1138
18	1988	1875	1498
19	1413	1213	1137
20	1021	1072	1060
21	2103	2081	1992
22	1452	1387	1222
23	1703	1667	1251
24	2118	1781	1626
25	1259	1179	1084
26	1723	1644	1185
27	1483	1324	1170
28	1991	1968	1945
29	971	890	724
30	1387	1215	1179
Mean	1602	1436	1287
S. Dev	375	403	398

Raw Data – % age-predicted HRmax

Participants	Full Class	Warm Up Phase	Aerobic Phase	Cool Down Phase
1	88.0	74.3	89.0	91.6
2	73.2	64.3	75.1	66.7
3	74.8	69.8	75.0	76.8
4	80.5	72.8	81.2	81.9
5	78.7	66.5	79.1	81.6
6	80.2	88.0	80.4	71.8
7	80.4	76.0	81.2	77.7
8	54.6	45.8	80.0	37.9
9	85.4	85.7	86.1	75.9
10	74.6	81.9	74.8	66.8
11	80.7	88.3	80.9	72.5
12	87.3	90.3	88.2	73.8
13	78.9	86.8	79.5	71.3
14	80.8	88.1	81.0	72.9
15	80.0	87.8	80.9	71.8
16	73.9	69.2	80.5	70.3
17	85.8	79.3	91.4	70.9
18	66.7	49.9	95.7	51.9
19	89.7	71.2	92.1	81.3
20	79.2	82.6	82.9	73.4
21	82.6	75.3	95.5	77.6
22	74.1	65.0	75.8	66.8
23	84.9	80.9	96.6	76.5
24	83.2	86.2	88.0	72.7
25	55.7	40.2	78.9	46.6
26	78.5	84.8	81.7	70.2
27	74.8	72.5	85.6	65.3
28	78.6	78.4	86.0	72.9
29	77.1	75.9	85.0	69.1
30	78.0	77.5	81.8	74.8
Mean	78.0	75.2	83.7	71.0
S. Dev	8.0	12.6	6.1	10.4

Raw Data – % age-predicted HRmax

Participants	Aerobic Segment 1	Aerobic Segment 2	Aerobic Segment 3
1	83.1	88.3	83.1
2	74.9	76.6	73.9
3	75.9	73.8	75.3
4	78.7	80.9	83.6
5	76.1	79.1	81.5
6	80.5	80.7	80.0
7	82.5	81.8	79.2
8	77.0	82.9	80.0
9	84.2	88.4	85.3
10	74.9	75.1	74.5
11	81.0	81.2	80.5
12	82.5	87.5	82.5
13	79.6	79.5	79.2
14	81.1	81.3	80.6
15	80.7	80.5	80.2
16	84.2	80.5	79.0
17	93.3	92.3	89.9
18	99.3	91.5	93.7
19	95.1	91.4	89.9
20	85.2	82.6	80.9
21	96.6	95.5	94.0
22	76.8	75.7	74.9
23	98.3	96.4	96.0
24	89.5	88.3	87.0
25	82.4	79.6	76.5
26	83.0	82.2	81.3
27	88.4	87.1	83.7
28	86.9	85.7	85.1
29	87.9	84.6	79.7
30	84.9	82.0	79.5
Mean	84.1	83.8	82.4
S. Dev	6.9	5.8	5.7

Raw Data – METs

Participants	Full Class	Warm Up Phase	Aerobic Phase	Cool Down Phase
1	5.2	6.0	5.6	3.8
2	3.4	3.0	3.6	2.8
3	3.9	3.8	4.0	3.0
4	3.6	4.1	3.8	3.0
5	4.9	5.1	5.2	3.7
6	5.8	6.3	6.1	4.5
7	5.5	6.2	5.5	4.3
8	2.7	1.9	3.2	2.1
9	2.5	3.2	2.3	1.6
10	8.7	7.3	9.5	6.5
11	6.7	6.3	6.8	4.5
12	8.2	9.3	8.1	6.9
13	8.0	8.2	7.9	5.0
14	7.5	6.6	7.8	4.9
15	8.7	8.3	9.4	5.5
16	5.8	6.0	6.0	4.6
17	5.5	6.3	5.4	4.8
18	6.2	5.3	7.0	2.8
19	6.0	7.3	6.1	4.5
20	3.8	4.9	3.7	3.2
21	7.7	8.9	7.8	6.5
22	4.7	3.7	4.6	3.2
23	5.4	5.4	5.9	3.2
24	5.5	4.7	6.1	3.6
25	4.5	3.1	5.0	3.5
26	5.9	5.6	6.2	6.6
27	6.9	6.1	7.5	4.9
28	9.2	8.7	9.7	7.0
29	3.7	3.7	3.8	2.8
30	4.9	4.9	5.2	3.7
Mean	5.7	5.6	5.9	4.2
S. Dev	1.8	1.9	1.9	1.4

Raw Data – METs

Participants	Aerobic Segment 1	Aerobic Segment 2	Aerobic Segment 3
1	6.5	5.5	4.7
2	4.1	3.6	3.1
3	5.2	3.6	3.4
4	4.3	3.8	3.6
5	5.8	4.2	3.4
6	6.9	5.9	5.5
7	6.2	4.8	3.5
8	3.6	3.3	2.7
9	3.2	2.3	2.2
10	9.8	8.9	8.1
11	7.5	6.5	6.1
12	9.6	8.2	9.0
13	9.2	8.1	7.6
14	9.4	7.4	7.1
15	9.5	10.3	9.1
16	7.0	6.0	5.1
17	6.7	5.7	4.1
18	7.9	7.4	5.9
19	7.0	6.0	5.6
20	4.6	3.4	3.4
21	8.0	7.9	7.6
22	5.0	4.8	4.2
23	6.6	6.4	4.8
24	7.0	5.9	5.4
25	5.4	5.0	4.6
26	6.3	6.0	4.3
27	7.8	7.0	6.2
28	10.0	9.9	9.8
29	4.4	4.0	3.3
30	5.7	5.0	4.9
Mean	6.7	5.9	5.3
S. Dev	1.9	2.0	2.0

APPENDIX G

Pairwise Comparison Summary

Pairwise Comparisons for the Zumba® Class Phases (N = 30)

Variable	Phase	Phase	Mean Difference	Standard Error	Significance
METs	Warm Up	Aerobic	-.277	.180	.406
		Cool Down	1.477	.164	.000*
	Aerobic	Warm Up	.277	.180	.406
		Cool Down	1.753	.182	.000*
	Cool Down	Warm Up	-1.477	.164	.000*
		Aerobic	-1.753	.182	.000*
HR	Warm Up	Aerobic	-16.567	4.880	.006*
		Cool Down	8.067	3.610	.100
	Aerobic	Warm Up	16.567	4.880	.006*
		Cool Down	24.633	3.963	.000*
	Cool Down	Warm Up	-8.067	3.610	.100
		Aerobic	-24.633	3.963	.000*
%HRmax	Warm Up	Aerobic	-8.487	2.483	.006*
		Cool Down	4.133	1.831	.095
	Aerobic	Warm Up	8.487	2.483	.006*
		Cool Down	12.620	2.028	.000*
	Cool Down	Warm Up	-12.620	2.028	.000*
		Aerobic	-4.133	1.831	.095
Relative VO_2	Warm Up	Aerobic	-.827	.573	.479
		Cool Down	5.520	.602	.000*
	Aerobic	Warm Up	.827	.573	.479
		Cool Down	6.347	.651	.000*
	Cool Down	Warm Up	-5.520	.602	.000*
		Aerobic	-6.347	.651	.000*
Kcal/min	Warm Up	Aerobic	-.353	.240	.454
		Cool Down	1.863	.219	.000*
	Aerobic	Warm Up	.353	.240	.454
		Cool Down	2.217	.299	.000*
	Cool Down	Warm Up	-1.863	.219	.000*
		Aerobic	-2.217	.299	.000*
Absolute VO_2	Warm Up	Aerobic	-81.333	45.609	.255
		Cool Down	370.500	42.001	.000*
	Aerobic	Warm Up	81.333	45.609	.255
		Cool Down	451.833	44.861	.000*
	Cool Down	Warm Up	-370.500	42.001	.000*
		Aerobic	-451.833	44.861	.000*

.05 significance level; *indicates significant difference

Pairwise Comparisons for the Segments of the Aerobic Phase (N = 30)

Variable	Segment	Segment	Mean Difference	Standard Error	Significance
METs	1	2	.770	.106	.000*
		3	1.337	.126	.000*
	2	1	-.770	.106	.000*
		3	.567	.095	.000*
	3	1	-1.337	.126	.000*
		2	-.567	.095	.000*
kcals	1	2	11.577	1.568	.000*
		3	22.143	2.195	.000*
	2	1	-11.577	1.568	.000*
		3	10.567	1.776	.000*
	3	1	-22.143	2.195	.000*
		2	-10.567	1.776	.000*
HR	1	2	.700	1.065	1.000
		3	3.633	1.117	.009*
	2	1	-.700	1.065	1.000
		3	2.933	.711	.001*
	3	1	-3.633	1.117	.009*
		2	-2.933	.711	.001*
%HRmax	1	2	.383	.543	1.000
		3	1.800	.564	.010*
	2	1	-.383	.543	1.000
		3	1.417	.366	.002*
	3	1	-1.800	.564	.010*
		2	-1.417	.366	.002*
Relative VO_2	1	2	2.487	.365	.000*
		3	4.450	.423	.000*
	2	1	-2.487	.365	.000*
		3	1.963	.333	.000*
	3	1	-4.450	.423	.000*
		2	-1.963	.333	.000*
Kcal/min	1	2	.870	.123	.000*
		3	1.577	.159	.000*
	2	1	-.870	.123	.000*
		3	.707	.122	.000*
	3	1	-1.577	.159	.000*
		2	-.707	.122	.000*
Absolute VO_2	1	2	165.767	23.615	.000*
		3	315.400	31.379	.000*
	2	1	-165.767	23.615	.000*
		3	149.633	24.812	.000*
	3	1	-315.400	31.379	.000*
		2	-149.633	24.812	.000*

.05 significance level; *indicates significant difference

APPENDIX H

One Sample T-Test Summary

One Sample T-Test for Zumba® Class METs in Comparison to the ACSM's Definition of Vigorous Activity of 6 METs

	N	Mean	Standard Deviation	Standard Error Mean	t-statistic	df	Significance	Mean Difference
Warm Up Phase	30	5.6733	1.8992	.38015	-1.263	29	.217	-.48000
Aerobic Phase	30	5.9601	1.9226	.38365	-.530	29	.600	-.20333
Cool Down Phase	30	4.2332	1.4382	.27210	-7.191	29	.000*	-1.95667
Full Zumba® Class	30	5.5467	1.98663	.36271	-1.250	29	.221	-.45333

.05 significance level; *indicates significant difference

One Sample T-Test for the Aerobic Segment of the Zumba® Class METs in Comparison to the ACSM's Definition of Vigorous Activity of 6 METs

	N	Mean	Standard Deviation	Standard Error Mean	t-statistic	df	Significance	Mean Difference
Aerobic Segment 1	30	6.6733	1.93639	.39480	1.292	29	.207	.51000
Aerobic Segment 2	30	5.8933	2.00464	.39539	-.658	29	.516	-.26000
Aerobic Segment 3	30	5.2767	2.02649	.39310	-2.103	29	.044*	-.82667

.05 significance level; *indicates significant difference