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Literature Review

Energy cost of 60 minute Zumba in healthy adult females

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Abstract

This paper reviews the literature which has investigated the physiological responses and energy cost of aerobic fitness type exercises. The paper essentially targeted studies which recruited young healthy adults consisting predominantly of women. Results revealed that the exercise intensity attained in most of the studies (for example, popmobility, Curves, Zumba) were 50% to 80% of $\dot{V}O_2\text{max}$ and 60% to 95% of maximum heart rate (HRmax) which are within the guidelines of the American College of Sports Medicine (ACSM) recommendations for promoting cardiovascular fitness. However, some other fitness exercises like yoga, Pilates and NIA (Neuromuscular Integrative Activity) technique did not meet these recommendations. Benefits were also noted in terms of weight management with majority of the studies resulting in an energy expenditure greater than 300 kcals per workout session which is also within the ACSM recommended guidelines for attainment and maintenance of weight loss.

Future studies should employ larger sample sizes and be conducted on the male population. In addition, to achieve more significant results or greater benefits, future research on aerobic fitness type exercises should be conducted for longer duration and investigations performed on differences between group and individual sessions.

Contents Page

	Abstract	1
1.	Introduction	3
2.	Review of literature	5
2.1	Studies conducted on aerobic fitness exercise	5
2.2	Studies conducted on Zumba	17
3	Methodological issues	20
3.1	Sample size	20
3.2	Subject selection	20
3.3	Practice session and familiarization	21
3.4	Measurement technique	21
4.	Summary and Conclusions	23
	References	25

1. Introduction

Physical inactivity is a critical public health issue (United States Department of Health and Human Services [USDHHS], 2008) which is responsible for approximately 3.2 million deaths globally and is described as the fourth major cause of death worldwide (WHO, 2013). The present increase in physical inactivity could be attributed to the advancement of technology in society today or individual choices (Devlin, 2012). On the other hand, engaging in regular physical activity and exercise have been shown to diminish the possibility of being affected with stroke, coronary heart disease, type 2 diabetes and some cancers such as breast and colon cancers (USDHHS, 2008), to improve physical and mental health (ACSM, 2011) and to have a positive impact on weight management (USDHHS, 2008).

Thus, it is necessary to engage in physical activity to achieve a healthier lifestyle (Department of Health, 2011). The American College of Sports Medicine (ACSM) recommends 150 minutes of moderate intensity exercise per week between 40 to 85% $\dot{V}O_2\text{max}$ or 64 to 94% HRmax at 300 kcals per workout to achieve health benefits and to maintain healthy weight (ACSM, 2010). Furthermore, the ACSM (2011) notes that the choice of aerobic activities (such as dancing, swimming and running) is essential for a healthy lifestyle.

Aerobic dance, a type of aerobic exercise, is a combination of choreographed routines which incorporates upper and lower body muscles precipitating exercising the whole body (Foster

1975; Buermann 2012) and its origin can be credited to Jacki Sorensen in 1969 (Monroe, 2007) . Zumba is a latin inspired aerobic dance founded by celebrity fitness trainer Alberto Perez (Beto) in the mid 1990's. It is the world's largest and most successful dance fitness program and is currently performed by fourteen million people in 151 countries worldwide (Zumba fitness, 2013).

This paper aims to review the evidence on the cardiovascular and health benefits of aerobic fitness exercises and thus provide the general public with knowledgeable information regarding the benefits of aerobic fitness exercise to health with a focus on Zumba fitness program.

2. Review of literature

2.1 Studies conducted on aerobic fitness exercise

The origin of aerobic exercise has been credited to Dr Kenneth Cooper, a physician of the United States Armed Forces who published a book called “Aerobics” in 1968 (Duncan, 2004). Its popularity spread worldwide as awareness of the positive cardiovascular effects of aerobic fitness exercises increased (Berlin & Colditz, 1990; Sternfield, 1992; USDHHS, 1996; USDHHS, 2008). Based on the prescript of Cooper’s book, a dance instructor, Jacki Sorensen (1969) created some dance routines and thus, dance aerobics was born. Aerobic fitness classes and dance aerobics have remained increasingly popular as an alternative to traditional training activities or exercise; therefore, it would seem important to ascertain its possible benefits to cardiovascular fitness and health (Foster, 1975). In 1975, Foster conducted an investigation to determine the intensity at which participants’ exercised during an aerobic dance; results of the study revealed an intensity of 77% of $\dot{V}O_2\text{max}$ suggesting that an aerobic dance session could improve cardiovascular fitness. This was one of the first experiments published on aerobic dance fitness classes. Another study by Milburn and Butts (1983) investigated exercise responses to seven weeks of aerobic dance training compared to jogging. Results revealed that both exercises improved cardiovascular responses with a 10% increase in oxygen consumption ($\dot{V}O_2$) of individuals who participated in aerobic dance and an 8% increase in $\dot{V}O_2$ in those who jogged. Since then, various studies (table 1) have been conducted on the physiological responses or energy cost of different aerobic fitness classes. Their efficiency in improving cardiovascular fitness was categorised according to ACSM recommended guidelines. Several of these studies have shown that these aerobic fitness classes meet the ACSM criteria for

improving cardio respiratory fitness popmobility (Grant et al. 1993), step aerobics (Sutherland, Wilson, Aitchison, & Grant, 1998), quidance (Buermann, 2012), cardiokickboxing (Immel & Porcari, 1999), bootcamp (Porcari, Hendrickson, & Foster, 2008), hooping (Holthusen, 2010), Curves (Greany & Porcari, 2005) and Zumba (Luetzgen, Foster, Doberstein, Mikat, & Porcari, 2011; Otto et al. 2011). Alternatively, research conducted on other fitness classes such as Pilates (Spilde & Porcari, 2005), Yoga (Boehde & Porcari, 2005) do not meet the aforementioned criteria. A brief summary of these studies will be given below and chapter 3 will focus on a critique of the methodology employed. Also, a summary of research studies performed on aerobic fitness classes can be seen in table 1.

Table 1. Summary of aerobic studies assessing exercise intensity and energy expenditure

Authors	Participants	Type of activity/Study time	Measurement technique	Results (Exercise intensity and energy expenditure)	Conclusion
Grant et al. (1993)	10 females 19-22 yrs	Popmobility 20 minutes	RPE – 6-20 Borg scale	75.6% of HRR 76.4% of $\dot{V}O_2\text{max}$ 236 ± 8.4 kcals	Met ACSM guidelines for improving CV fitness
Sutherland et al. (1998)	10 females 20-24 years	Step aerobics 40 minutes	HR – polar4000 portable heart rate monitor $\dot{V}O_2$ - douglas bag RPE – 6-20 Borg scale	6 inch – 70±7.5 % HRmax, 45.6 ±6.6% $\dot{V}O_2\text{max}$ 8 inch – 75±4.7 % HRmax, 51.6 ±4.7% $\dot{V}O_2\text{max}$ 10 inch –79 ±5.5 % HRmax 56.2 ±7.3% $\dot{V}O_2\text{max}$	Met ACSM guidelines for improving CV fitness
Immel & Porcari (1999)	15 females 21-46 yrs	Kickboxing 35minutes	HR – polar XL heart rate monitor $\dot{V}O_2$ - KBI-C portable analyser (open circuit spirometry) RPE – 6-20 Borg scale	86% of HRmax 73% of $\dot{V}O_2\text{max}$ 351 kcals 7.4 ± .76 METS	Met ACSM guidelines for improving CV fitness and controlling weight

Authors	Participants	Type of activity/Study time	Measurement technique	Results (Exercise intensity and energy expenditure)	Conclusion
Boehde, & Porcari (2005)	15 females	Yoga 50 minutes	Information not provided	Beginner 48±3.4%HRmax, 24% ± 4.1 $\dot{V}O_2$ max 155 ± 39kcal Power 62 ± 5.4 HRmax 46 ± 4.8% $\dot{V}O_2$ max 237± 2.0 kcal	Did not meet ACSM guidelines for improving CV fitness
Greany, & Porcari (2005)	15 women 26-55 yrs	Curves 30minutes	HR – polar heart rate monitor $\dot{V}O_2$ -portable metabolic analyzer	75% of HRmax 60% $\dot{V}O_2$ max 184 ± 23.5 kcal	Met ACSM guidelines for improving CV fitness
Spilde, & Porcari (2005)	15 women 18-26 years	Pilates 50minutes	RPE – 6-20 Borg scale	Beginner 54 ± 3.6% HRmax 28% ± 4.3 $\dot{V}O_2$ max 175 ±43.5 kcal Advanced 62 ± 4 HRmax 43 ± 5.3% $\dot{V}O_2$ max 254± 38.8 kcal	Did not meet ACSM guidelines for improving CV fitness

Authors	Participants	Type of activity/Study time	Measurement technique	Results (Exercise intensity and energy expenditure)	Conclusion
Konemann, Battista, Porcari (2008)	13 females	NIA technique 55 minutes	$\dot{V}O_2$ -Cosmed k_4b^2 analyzer	57% HRmax 32% $\dot{V}O_{2max}$	Did not meet ACSM guidelines for improving CV fitness
Porcari Hendrickson & Foster (2008)	6 men, 6 women 19-29 yrs	Boot camp workout 40 minutes	$\dot{V}O_2$ -portable oxygen analyzer RPE –6-20 Borg scale	77% HRmax 62% $\dot{V}O_{2max}$ 400 kcals	Met ACSM guidelines for improving CV fitness
Holthusen & Porcari (2010)	16 females 16-59 yrs	Hooping 30mins	HR – polar telemetric unit $\dot{V}O_2$ -portable metabolic analyzer RPE – 6-20 Borg scale	84% of HRmax 210 ± 43.3 kcals	Met ACSM guidelines for improving CV fitness
Luetngen & Foster (2011)	19 females 18-22 yrs	Zumba 40 min	HR – telemetry $\dot{V}O_2$ - open circuit spirometry RPE- 0-10 Borg scale	64% $\dot{V}O_{2max}$ 378 ± 108 kcals	Met ACSM guidelines for improving CV fitness and controlling weight
Otto et al. (2011)	15 females 19-23 yrs	Zumba 24 mins	$\dot{V}O_2$ - portable metabolic equipment	6.6 to 7.3 METS	Met ACSM guidelines for improving CV fitness

Authors	Participants	Type of activity/Study time	Measurement technique	Results (Exercise intensity and energy expenditure)	Conclusion
Buermann (2012)	20 females 18-25yrs	Qidance 52min	HR – radiotelemetry $\dot{V}O_2$ - open circuit spirometry RPE- 6-20 Borg scale	68 – 95% of HRmax 47 – 91% of $\dot{V}O_{2max}$ 433 ± 76.0 kcals	Met ACSM guidelines for improving CV fitness and controlling weight

The research of Grant and colleagues (1993) investigated the physiological responses to a pop mobility aerobic session which recruited ten female participants ranging in age from 19 to 22 years old. A pop mobility session can be described as an aerobic session consisting of 25 minutes of aerobic activities, five minutes of endurance exercises and five minutes of flexibility exercises (Buermann, 2012). Participants completed a maximum oxygen uptake ($\dot{V}O_2\text{max}$) treadmill test to attain $\dot{V}O_2\text{max}$ and maximum heart rate (HRmax) values. Their heart rates (HR) and $\dot{V}O_2$ were measured throughout the session. Results from the study revealed that the participants exercised at an average intensity of 76.4% of $\dot{V}O_2\text{max}$, 75.6% of heart rate reserve (HRR) and expended an average of 236 kilocalories (kcal). Thus, Grant et al. (1993) concluded that a pop mobility session meets the ACSM guidelines for recommended intensity of exercise and is thus, useful in acquiring positive cardiovascular benefits. Also, Sutherland et al. (1998) explored the potential of step aerobics in improving cardio respiratory fitness. Ten females of average age 22 ± 2.2 years with previous experience of step aerobics participated in the study. They completed step routines at step heights six (6) inches, eight (8) inches and ten (10) inches. Before engaging in an exercise trial, participants completed a maximal incremental treadmill test to ascertain their $\dot{V}O_2\text{max}$ and HRmax values. Results of the study revealed that the average intensity for the six inch step was $70 \pm 7.5\%$ HRmax and $45.6 \pm 6.6\%$ $\dot{V}O_2\text{max}$, for the eight inch step values were $75 \pm 4.7\%$ HRmax, $51.6 \pm 4.7\%$ $\dot{V}O_2\text{max}$, and for the ten inch step, $79 \pm 5.5\%$ HRmax and $56.2 \pm 7.3\%$ $\dot{V}O_2\text{max}$. Therefore, findings from this study proffer that engaging in step aerobics can be beneficial in improving cardio respiratory fitness.

Another study which produced similar results was the research of Immel and Porcari (1999) on the physiological responses to cardio kickboxing in fifteen (15) healthy females. A Cardio kickboxing class is similar to an aerobics, step aerobics or spinning class with an instructor directing the class with verbal cues and demonstrations of techniques (ACE, 1999). Participants completed a $\dot{V}O_2\text{max}$ incremental treadmill test using the Bruce protocol and data was collected during the Cardio kickboxing session using a KBI-C aero sport metabolic analyser. The results of the study demonstrated that subjects exercised at an average intensity of 86% of HRmax, 73% of $\dot{V}O_2\text{max}$ and expended 351kcal which is equivalent to $7.4 \pm .76$ METS per workout. Immel and Porcari (1999) duly presented that the intensity during a cardio kickboxing session was sufficient to improve cardiovascular fitness.

In 2005, the American Council on Exercise commissioned Greany and Porcari to ascertain the exercise intensity and energy expenditure achieved in a Curves session. Curves is typically a 30 minute exercise session with a 25 minute circuit comprising of 30 seconds of resistance training and 30 seconds of stationary jogging or walking on springy boards culminating with 5 minutes of stretching (Anders, 2005). It is the world's largest fitness franchise with over 8,500 locations around the world and is very popular among women (Anders, 2005). The study recruited 15 females from Curves locations in La Crosse of age range 26 to 55 years. Incremental $\dot{V}O_2\text{max}$ treadmill tests were performed to ascertain participants' individual fitness levels. During the session, calories expended and oxygen consumption ($\dot{V}O_2$) were measured using a portable metabolic analyser and heart rate and RPE by polar heart rate monitor and Borg scale respectively. Results revealed a 30 minute Curves workout burns 184 kcal and exercise intensity

of 75% of HRmax and 60% of $\dot{V}O_2$ max. Findings from the study affirm that exercise intensity of a Curves workout is within ACSM recommendations for improving cardiovascular fitness.

A thriving fitness program in the United States known as Hooping, is a trendy adaptation of the hula hoops (Holthusen, Porcari, Foster, Doberstein & Anders, 2011). Its advocates/ enthusiasts claimed an energy expenditure of 600 kcals per hour with an average hooping session lasting approximately 60 minutes in length (Holthusen, Porcari, Foster, Doberstein & Anders, 2011). Consequently, Holthusen (2010) sought to investigate the exercise intensity and caloric expenditure of hooping. Typically, a hooping fitness class incorporates the use of hoops weighing one to four pounds and 37 to 45 inches wide and is performed to dance music. Sixteen (16) healthy females aged between 16 to 59 years who were familiar with hooping were recruited for the study. The participants' had familiarisation sessions using a hooping video prior to research testing then hooped to a 30 minute video. Oxygen consumption ($\dot{V}O_2$), heart rate (HR) and ratings of perceived exertion (RPE) were recorded throughout the session. The results revealed that the participants exercised at 84% of HRmax and expended 210 ± 43.3 kcal per workout (30- minute session, values are represented as mean \pm SD). Consequently, researchers noted that the intensity of a hooping session lies within the exercise intensity recommendations of the ACSM affirming the potential of hooping towards contributing positive cardiovascular benefits. Simultaneously, the 210 kcals expended during the 30 minute session suggests that hooping will have some benefits in weight management

Similar findings were apparent from a study by Porcari, Hendrickson, & Foster (2008) which investigated the exercise intensity of a boot camp session. Boot camp is a fitness exercise led by

an instructor where participants engage in drill like routines such as push ups, kicks and punches (Buermann, 2012). The study involved six men and six women between ages 19 to 29 years. Results revealed exercise intensity for a 40-minute session to be $81 \pm 14.3\%$ of HRmax, $62 \pm 4.24\%$ of $\dot{V}O_2\text{max}$ and energy expenditure of 300 ± 74 kcals.

Furthermore, Buermann (2012) sought to determine the exercise intensity and energy expenditure achieved in a 52- minute Qidance session. Qidance is an aerobic dance fitness program which uses pre choreographed styles to engage participants in an energetic workout (ACE, 2013). The results of the study revealed that average exercise intensity for the session was 69% of HRmax, $82 \pm 7.5\%$ of $\dot{V}O_2\text{max}$ and energy expenditure 433 ± 76.0 kcals (values are mean \pm SD).

In contrast to the aforementioned studies, which demonstrate that the above fitness exercises meet the ACSM standard guidelines/ recommendations for improving cardio respiratory fitness, some other studies (Konemann, Battista, & Porcari 2008; Boehde & Porcari, 2005; Spilde & Porcari, 2005) indicate that some fitness exercises did not meet the ACSM recommendations for improving cardiovascular fitness.

One of these studies was the research of Konemann, Battista and Porcari (2008) on the physiological responses to NIA technique. NIA (Neuromuscular Integrative Activity) is an aerobic fitness program which focuses on improving health via physical, emotional and spiritual means (NiaSharing, 2008). Typically, a NIA class or session lasts 55 minutes and consists of nine techniques -Tai Chi, Tae Kwon Do, Aikido, jazz dance, modern dance, Duncan dance, Yoga, Alexander Technique and Teachings of Moshe Feldenkrais (NIA, 2011). The study involved

participants working out to a 55-minute NIA video. Results indicated that subjects exercised at 57%HRmax, 32% $\dot{V}O_2$ max and expended 165kcal per 55-minute workout. Thus, the NIA technique did not meet the recommendations of ACSM in improving cardiovascular fitness.

Additionally, Boehde and Porcari (2005) investigated the physiological effects of Yoga. Yoga is an exercise which uses strength, flexibility and breathing to promote health and wellbeing (National Health Service (NHS), 2013). The subjects in this study participated in two different 50- minute Yoga sessions- beginners' level and advanced level sessions. The participants exercised at an intensity of $48 \pm 3.4\%$ HRmax, $24 \pm 4.10\%$ $\dot{V}O_2$ max for the beginner's level and 62 ± 4 HRmax, $46 \pm 4.8\%$ $\dot{V}O_2$ max for the advanced level. The energy expenditure of the 50- minute video session was 155 ± 39 kcals (beginners level) and 237 ± 2 kcals [advanced level](values are expressed means \pm SD). The results of the study intimated that exercise intensity of a yoga session did not meet the ACSM recommendations for improving cardiovascular fitness.

Similar findings were apparent from another study (Spilde & Porcari, 2005) which investigated the physiological responses to 50-minute Pilates video sessions. Pilates is a fitness programme which incorporates stretching and strengthening exercises to improve muscle strength, flexibility, balance and posture (NHS, 2013).Results from the study revealed that the energy intensity of the beginner and advanced 50- minute video session was $54 \pm 3.6\%$ HRmax, $28 \pm 4.3\%$ $\dot{V}O_2$ max and 62 ± 4 HRmax, $43 \pm 5.3\%$ $\dot{V}O_2$ max respectively(values are expressed means \pm SD). Energy expenditure was 175 ± 43.5 kcals (beginners level) and 254 ± 38.8 kcals (advanced level, values are expressed means \pm SD). Consequently, these results did not meet the ACSM

recommendations for exercise intensity hence indicating Pilates was not effective at improving cardiovascular fitness. However, these fitness classes (NIA, Yoga and Pilates) have been purported to improve balance and flexibility in individuals (Johnson, Larsen, Ozawa, Wilson, & Kennedy 2007; Hakim, Kotroba, Cours, Teel, & Leininger, 2010).

The differences in the results of the above studies might be explained by the difference in the duration of the exercise activity or in the equipment used in collecting data. However, it was interesting to note that the studies which did not meet the ACSM recommendations were all 50 minutes and longer in duration (Boehde & Porcari, 2005; Spilde & Porcari, 2005; Konemann, Battista & Porcari, 2008) compared to some of the others (which met the ACSM recommendations) of shorter time durations (Greany & Porcari, 2005; Holtusen, 2010). In addition to that, it was noted that the participants in some of the studies (Immel & Porcari, 1999; Greany & Porcari, 2005; Porcari, Hendrickson, Foster, 2008; Holthusen, 2010) wore metabolic equipment to measure cardio respiratory parameters during the exercise trials while in other studies (Buermann, 2012), the parameters were derived from values attained at the maximal treadmill test.

Generally, most of these studies were performed between 30mins to 52mins. Some can be considered a relatively short duration and it could be assumed that adequate energy will not be expended within such a short time. For instance, this could suggest that participating in a pop mobility session for a longer duration would correspond to expending more energy. Alternatively, it could be surmised that because a session only lasted for a short duration, the participant had put in their best and were not exhausted rapidly.

2.2 Studies conducted on Zumba

Zumba is the world's largest and most successful dance fitness program (Zumba fitness, 2013). It is rated 9th on the American Council of Exercise fitness trends to watch in 2012 (Thompson, 2011) and is currently used by fourteen million people in 185 countries worldwide (Zumba fitness, 2013).

Zumba is a latin inspired aerobic dance with a strong latin influence with a fusion of rythms which are merengue, salsa, cumbia, reggaeton, mambo, chachacha, soca, bhangra, belly dance, flamenco, hip hop, tango and samba. Zumba was founded by celebrity fitness trainer Alberto Perez (Beto) in the mid 1990's. It was born on a certain day when Beto arrived to teach at his aerobic class and realized that he had forgotten his music. He had to improvise with the salsa and merengue tapes he had in his car. He danced to the music as if he was in the club and his class loved it and it became the most popular class offered at his gym. Thus, Zumba was born. Originally, Zumba was popular for its latin inspired dance steps of salsa, flamenco, merengue and samba but recently there has been a lot of incorporation of music from around the world such as indian harmonies, country, funk, rock and roll and African reggaeton.

Beto claims that Zumba has no set rules and it is typically an enjoyable workout where the movement of the body matches the rhythm of the music, allowing a less structured style of exercise class hence the phrase – 'ditch the workout, join the party'.

The difference between Zumba and the other aerobic dance programs is that in Zumba, the repetition is not counted over the music but an individual is encouraged to enjoy the music and move to the beat. Therefore, it is geared at having fun whilst working to achieve improved cardiovascular fitness, muscular endurance, balance and coordination. Only two published studies (Luetttgen, Foster, Doberstein, Mikat & Porcari, 2011, Otto et al. 2011) have been carried out on the potential benefits of Zumba. However, with its burgeoning popularity, more research is necessary.

The American Council of Exercise, in 2011 commissioned John Porcari and colleagues to conduct a study to determine the exercise intensity and energy expenditure achieved in a Zumba session (effectiveness or fitness benefits of Zumba). The study was conducted at the University of Wisconsin, La Crosse campus. 19 healthy females who were familiar with Zumba participated in the study. Prior to the exercise testing, a maximal treadmill test was conducted to determine the $\dot{V}O_2$ and HR measurement of the participants. A linear regression equation was developed for HR - $\dot{V}O_2$ values. This equation was subsequently used to determine $\dot{V}O_2$ values from the heart rate measurements obtained during the Zumba session.

During the session, heart rates were measured using a telemetric heart rate monitor and Borg scale for RPE. Results revealed that the average exercise intensity during the session was $79 \pm 7\%$ HRmax, $66 \pm 10.5\%$ $\dot{V}O_{2max}$ and energy expended 378 ± 108 kcals and energy cost is 8.8 ± 1.8 METS (values are expressed as means \pm SD). The researchers reported that all the participant's parameters met ACSM recommendations. Hence, they concluded that Zumba is an activity which could improve cardio respiratory fitness. Also, the caloric expenditure during this

40 minute Zumba session is in line with the ACSM recommendations for weight loss. Consequently, these would suggest that Zumba has possible benefits in weight management. However, the researchers suggested further research hypothesizing that longer sessions would equate to greater energy expenditure.

Another study (Otto et al. 2011) was conducted at the Adelphi University and produced similar results even though values were less than the La Crosse study. The purpose of the study was to determine energy cost and cardio respiratory benefits in a 24 minute Zumba session. Fifteen (15) subjects who were familiar with Zumba exercise participated in the study. The participants completed a familiarization session with testing protocol (where the participants practised the routines) using a Zumba DVD and exercise testing performed a day after. Heart rate and $\dot{V}O_2$ were measured throughout the session using telemetric heart rate monitor and open circuit spirometry (metabolic analysers were worn by the participants). Results revealed an energy cost of 6.6 to 7.3 METS for the duration of the session. This corresponds to an expenditure of 378 kcals thus agreeing with the research of Luetngen, Foster, Doberstein, Mikat & Porcari (2011). Hence, recommendations were made for further studies with suggestions that participating in a Zumba session for a longer period would amount to greater energy expenditure and participation in a group class based session would make an individual work harder compared with working individually with a DVD (Otto et al. 2011).

3. Methodological issues

Reviewing the above studies, a number of questionable issues arise concerning the small sample size, subject selection and different equipment used in testing of oxygen consumption.

3.1 Sample size

The sample sizes of the studies were small (less than 20 participants) and no clear report of a power calculation was documented on any of the studies (table 1). Small sample sizes could be an important limitation of a study as they limit reliability and validity of results. No drop outs were reported in all of the studies, so it was assumed that all participants completed all tests. However, it could be that drop outs were not documented, and thus results did not incorporate participants who did not complete the tests, which could affect the results.

3.2 Participant selection

A random selection of subjects was performed in all the studies increasing the likelihood that the data collected was representative of the study population. In addition, these fitness exercises are popular among women (Sherwood & Jeffery, 2000) and so the studies typically recruited women (Luettgen, Foster, Doberstein, Mikat & Porcari, 2011; Buemann, 2012; Immel & Porcari, 1999; Sutherland et al. 1998; Grant et al. 1993; Greany & Porcari, 2005). However, this does not necessarily mean that the male population is exempted from these exercises as there is evidence indicating male participation in aerobic fitness type exercises (Porcari, Hendrickson & Foster, 2008; Ewa Wigaens et al. 1980). Consequently, there is need for further investigations on research including the male population.

Evidence of convenience sampling was noted as most participants in the different studies (table 1) were from a university campus except in the study of Immel and Porcari (1999) and Greany and Porcari (2005) in which subjects were recruited from a martial arts studio and local Curves location in La Crosse respectively.

3.3 Practice session and familiarisation

Most of the studies (Grant et al. 1993; Luetzgen, Foster, Doberstein, Mikat & Porcari, 2011) recruited participants who were familiar with the routines and in those who were not they were given videos to watch and practice. While research suggests that individuals' familiar with the choreography or routines used show higher training effects (Dishman, Sallis & Orenstein, 1985), evidence (Ziemba et al. 2003) exists supporting the lack of positive training effects with a familiarisation of exercise protocols.

3.4 Measurement technique

Most of the studies ensured participants performed incremental maximal exercise testing on a treadmill prior to the research trial testing.

Buermann (2012) used a HR - $\dot{V}O_2$ relationship from the maximal treadmill test to determine exercise intensity and energy expenditure during research trial.

During the research trial, heart rate measurements were conducted by telemetry (Luetzgen, Foster, Doberstein, Mikat & Porcari, 2011; Buermann, 2012; Holthusen, 2010) or a polar heart rate monitor (Sutherland et al. 1998; Immel & Porcari, 1999; Greany & Porcari, 2005; Grant et al. 1993). Measurements of maximal oxygen uptake was done by portable metabolic analyzers

(Immel & Porcari, 1999; Porcari, Hendrickson, & Foster, 2008; Konemann, Battista, & Porcari, 2008; Holtusen, 2010; Greany and Porcari, 2005) and rating of perceived exertion was measured using both the 6-20 Borg scale (Porcari, Hendrickson and Foster, 2008; Jordan and Holthusen, 2010; Buerrmann, 2012; Immel & Porcari, 1999), and the 0-10 Borg scale (Luetzgen, Foster, Doberstein, Mikat & Porcari, 2011). However, some of the studies did not mention equipment used in measuring certain parameters, for example, the heartrate measurement (Porcari, Hendrickson, & Foster, 2008; Konemann, Battista, & Porcari, 2008).

The studies all measured what they set out to measure thus proving that they were valid research (Aveyard, 2010). The aims were to determine the physiological responses or energy cost to the various fitness programmes. They were evaluated to ascertain if they measured up to the ACSM standards for improving cardiovascular fitness. A number of the studies did (Immel & Porcari, 1999; Holthusen, 2010; Greany & Porcari, 2005; Buermann, 2012; Grant et al. (1993) did while others did not (Konemann, Battista, & Porcari 2008; Boehde & Porcari, 2005; Spilde & Porcari, 2005).

4 Summary and Conclusion

Since no information was provided by researchers in the studies (table 1) which executed a $\dot{V}O_{2\max}$ test regarding the attainment of a true $\dot{V}O_{2\max}$ value, it is presumed that true $\dot{V}O_{2\max}$ was achieved. Attainment of $\dot{V}O_{2\max}$ is characterized by the achievement of a plateau in $\dot{V}O_2$ notwithstanding increasing intensity of exercise (Astrand & Rodahl, 1986). It is important to note that the absence of a plateau in $\dot{V}O_2$ does not necessarily mean that participants were exercising submaximally (Wasserman, Hansen, Sue, Whipp & Stringer, 2005). However, if a $\dot{V}O_{2\max}$ is not achieved, peak $\dot{V}O_2$ indicates the highest $\dot{V}O_2$ achieved during maximal exercise testing (Armstrong & Wellsman, 1994).

Most of the studies' determination of exercise intensities were based on heart rate measurements even though some (Immel & Porcari, 1999; Porcari, Hendrickson, & Foster, 2008; Sutherland, Wilson, Aitchison, & Grant, 1998; Grant et al. 1993; Luetzgen, Foster, Doberstein, Mikat, & Porcari, 2011) reported their RPE values as well. It could be speculated that the heart rate measurements and $\dot{V}O_2$ values derived during the trials are more accurate in determining intensity because the concentration of participants in performing the routines correctly might diminish their perception of how hard they are working and thus, they might underestimate their actual intensity values using the RPE. However, it should be noted that the RPE is regarded as a valid tool for monitoring and prescribing exercise intensity (Scherr et al. 2013).

Interestingly, a number of these studies (table 1) were conducted on small sample populations, thus, there is a requirement for further research with larger sample size. Additionally, they

were performed on female populations. Even though it is speculated that aerobic fitness type exercise is more common among the female population, still, it would be interesting to determine what the physiological responses to these exercises would represent in the male population.

Furthermore, a number of the studies involved participants who were familiar with the exercise routines or choreography, probably in order to get better results. It would be assumed that recruiting participants who are not familiar with routines would produce very different results. Also, longer sessions would probably yield quite different results as recommended by Luetttgen and colleagues (2011). Another indication for future research could be in the investigation of the energy cost and physiological responses to aerobic fitness exercises performed in a group compared to performing the same exercises individually.

Consequently, in relation to aerobic fitness type exercise studies, it is evident that these exercises are more common among young and middle aged women. Additionally, these exercises meet the ACSM recommendations for improving cardiovascular fitness and have benefits in weight management. Therefore, it should be recommended as a means of increasing physical activity especially in the sedentary population or in individuals who do not like sports or structured exercise.

In Conclusion, promoting physical activity through increased awareness of aerobic fitness exercises which are a fun way to exercise in groups can go a long way in promoting health and curbing early mortality rates.

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Department of Clinical Sciences

MSc in Exercise and Nutrition Science

Research Paper

Energy expenditure and physiological responses to 60 minute Zumba aerobic sessions (group class versus home) in healthy adult females

Word count:

Key words: maximum oxygen consumption, cardiovascular fitness, ACSM guidelines, regression equation

Content Page

Acknowledgements	iii
Rationale for journal selection	iv
List of figures	v
Abstract	vi
1. Introduction	1
2. Methods	2
2.1 Participants	2
2.2 Exercise protocol	3
2.2.1 Zumba sessions	3
2.2.2 Maximal treadmill test	4
2.3 Statistical Analysis	6
3. Results	7
3.1 Physiological characteristics	7
3.2 Heart rate responses for trials	7
3.3 Oxygen consumption ($\dot{V}O_2$) for trials	8
3.4 Energy expenditure for trials	9
4. Discussion	11
4.1 Recommendations for further research	16
5. Conclusion	16
References	17

Appendices	22
Appendix 1: Ethical approval letter	22
Appendix 2: Participant information sheet	24
Appendix 3: Health screen form	26
Appendix 4: Consent form	27
Appendix 5: RPE scale	28
Appendix 6: Data collection sheets for Zumba sessions	29
Appendix 7: Statistical tests	30
Appendix 8: Data Collection sheet for $\dot{V}O_2$ max test	32
Appendix 9: Protocol for $\dot{V}O_2$ max test	33

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Rationale for journal selection

A suitable journal for the publication of this study would be the Journal of Sports Sciences and Medicine. It is an electronic journal with the primary purpose of supplying information on current research, review papers, reports and editorials on subject matters relating to sports and exercise. It provides information to a wide range of readers through modern media making it more accessible and endearing to the general public. In addition, one of the studies conducted on Zumba was published in this journal. Thus, this paper would contribute to existing knowledge on the physiological benefits of Zumba exercise and create awareness on the energy cost of participating in group Zumba or alone.

The current study will be written in the format as required by the chosen journal.

LIST OF FIGURES

Pages

Figure 1. Percentage maximum heart rate during Zumba group and home based sessions	8
Figure 2. Percentage maximum oxygen consumption during Zumba group and home based sessions	9
Figure 3. Energy expenditure during Zumba group and home based sessions	10
Figure 4. Percentage maximum heart rate of aerobic studies	12

ABSTRACT

Objectives The purpose of this study was to determine (i) the maximum oxygen consumption and energy expenditure of young adult females during 60 minute Zumba sessions (group class and home based), (ii) that a Zumba session is a safe fitness activity which meets the ACSM recommendations and (iii) to identify any differences in energy cost of participating in a group Zumba session compared to a session performed at home.

Methods Fifteen healthy adult females from the University of Chester participated in this study. They performed two Zumba sessions during which their heart rates and ratings of perceived exertion were measured at five minute intervals. Each participant also performed a maximal oxygen consumption test and a linear regression equation was used to determine their $\dot{V}O_2$ from the heart rate measurements obtained during the Zumba session. Data was analysed using Paired t tests to determine differences in %HRmax, METS and caloric expenditure values across trials (group versus home based sessions) and Wilcoxon's test for $\dot{V}O_{2max}$ across trials.

Results The results revealed that values were significantly higher ($p < 0.05$) for % $\dot{V}O_{2max}$ (mean \pm SD: 59.1 ± 19.2 % $\dot{V}O_{2max}$ versus 49.8 ± 16.9 % $\dot{V}O_{2max}$), HRmax (68.7 ± 13 % HRmax versus 60.8 ± 8.2 % HRmax) and energy expenditure (363 ± 98.1 kcals versus 310 ± 94.5 kcals) in the group sessions compared with the home based sessions respectively.

Conclusion Both home and group Zumba sessions meet ACSM recommended guidelines for cardiovascular fitness. They also elicit exercise intensities that fall within the recommended guidelines for 'moderate' levels of intensity, constituting Zumba as a safe fitness activity. Furthermore, higher values of exercise intensity and energy expenditure obtained in group sessions suggest that more energy is expended when performing Zumba in a group.

1. Introduction

Physical inactivity and its accompanying health problems is a critical public health issue worldwide. The American College of Sports Medicine (ACSM, 2010) and World Health Organisation (WHO, 2013) have specific guidelines advising the amount of physical activity necessary to improve health. However, a survey (Sjöström M et al. 2006) of some countries in Europe (for example, England, Germany, Denmark, Sweden and Portugal) reveal that only one-third of the adult population meet these recommendations (Cavill, Kahlmeier, & Racioppi, 2006; Craig, Mindell, & Hirani 2009). Common cited reasons for not engaging in regular physical activity are lack of time, motivation and confidence (Biddle & Mutrie, 2008). Perhaps attitude towards physical activity would change if people were encouraged to participate in activities they enjoy (Cavill, Kahlmeier, & Racioppi, 2006; Williams, 2008). Aerobic dance, introduced in the 1960's, is an activity which was recognized by numerous individuals especially women as a fun way to exercise/ alternative to structured exercise; and has remained popular till date (Wang, 2011). A relatively new aerobic dance class which is thriving globally is Zumba, a latin inspired aerobic dance which was founded by celebrity fitness trainer Alberto Perez (Beto) in the mid 1990's. In 2013, the Zumba fitness website (<http://www.zumba.com>) discloses that Zumba is the world's largest and most successful dance fitness program and is currently used by fourteen million people in 185 countries worldwide. However, only two studies (Luetgen, Foster, Doberstein, Mikat, & Porcari, 2011; Otto et al. 2011) have been conducted on its physiological benefits and their results revealed that Zumba met the ACSM recommended

guidelines for improving cardiovascular fitness and maintaining health and recommendations. Given the growing popularity of Zumba, the current study aims to satisfy the recommendations for further research which were that longer Zumba sessions would result in greater energy expenditure. Also, as lack of time and confidence have been indicated as some of the reasons preventing active gym attendance or participation thus, individuals turn to exercising at home, hence this study also sought to investigate any differences in exercise intensity or energy expenditure between home based and group based Zumba sessions.

2. METHODS

2.1 Participants

15 healthy adult females, age 26 ± 3.2 years, body mass 59.19 ± 12.5 kg, height 1.62 ± 0.1 m, $\dot{V}O_2\text{max}$ 36.9 ± 8.8 ml/kg/min and HRmax 194 ± 3.2 bpm volunteered to participate in the study. Sample size was representative of sample size of previous Zumba study. All participants were from the University of Chester. The inclusion criteria were that they were healthy females and aged 18 to 40 years. Exclusion criteria included being in a pregnant state, a history of cardiopulmonary disease, back and joint pain/injury, recent fracture, and taking drugs to stabilize heart rate or drugs for acid reflux. Ethical approval was obtained from the Faculty of Applied Sciences Research Ethics Committee at the University of Chester (Appendix 1). Prior to the beginning of the study, participant information sheet (appendix 2) which explained the protocol was given to the participants. They completed health screening forms (appendix 3) and gave written informed consents (appendix 4).

2.2 Exercise protocol

A repeated measures design was employed in which the subjects participated in two Zumba sessions. One of the sessions was a 60 minute Zumba group session conducted by an instructor which took place at the University fitness gymnasium and the second, an individual session in the participants' home using a Zumba DVD lasting 60 minutes. Participation in these sessions were performed in a randomized manner to offset learning effect. Following the completion of these Zumba sessions, the participants performed an incremental maximal treadmill test.

2.2.1 Zumba sessions

Before each session began, the participants' blood pressure and heart rates were measured using a digital sphygmomanometer (Omron, Matsusaka Company Limited, Japan) and polar heart rate monitor (Polar Electro, Oy, Finland) respectively. During the Zumba sessions, the participants' heart rates and ratings of perceived exertion (RPE) were taken at five minute intervals using the polar heart rate monitor (Polar Electro, Oy, Finland) and 6-20 Borg's scale (Borg, 1998) (appendix 5) respectively.

For the individual session, the participants' were given an instruction sheet (appendix 6) to follow and a clock, heart rate monitor (Polar Electro, Oy, Finland), RPE scale (6-20 Borg's scale) and sphygmomanometer (Omron, Matsusaka Company Limited, Japan) to record data. The dvd used was the Zumba exhilarate dvd (ZumbaFitness, LLC). The researcher was not present during the testing so as to avoid watching the participants and affecting results.

2.2.2 Maximal treadmill test ($\dot{V}O_2$ max test protocol)

The participants reported to the Human Performance laboratory for the incremental, maximal treadmill test after abstaining from tobacco (three hours), caffeine (12 hours), alcohol (24 hours) and vigorous exercise (48 hours) before each testing session. This was because these have been reported to affect performance (Cox et al. 2002). All the maximal treadmill tests were performed on the same treadmill (HP Cosmos, Nussdorf- Traunstein, Germany) in the University of Chester Human Performance laboratory. Sessions were conducted on the same time of the day even though on different days to reduce differences in physiological responses and exercise performance (Atkinson & Reilly, 1996; Reilly, 2007). Before testing began, participants' height and weight were measured using a wall mounted stadiometer (Holtain, Crymych, Dyfed, United Kingdom) and Seca scale (Seca, Hamburg, Germany) respectively. These data and participant's age were then imputed into the breath by breath online gas analysing system (cosmed s.r.l., Rome, Italy). The test consisted of an incremental protocol (appendix 9) to exhaustion starting with a speed of 1.7mph and a gradient of 10% with an increase of 0.8mph and 2% gradient every three minutes until the participant reached volitional exhaustion or test termination criteria was attained. The heart rate and ratings of perceived exertion was recorded into a data sheet (appendix 8) at the end of each stage. Test termination criteria were: (i) respiratory exchange ratio (RER) was greater than 1.15 (ii) heart rate was within 10% of maximum heart rate (iii) blood lactate was greater than 1 (iv) presence of a $\dot{V}O_2$ plateau. However, in situations where no plateau was observed, the $\dot{V}O_2$ peak was taken as the $\dot{V}O_2$ max (Howley et al. 1995). The participants were encouraged by the researcher to give their maximum effort throughout the testing session.

A linear regression equation was developed from this test and this equation used to predict the $\dot{V}O_2$ (ml/kg/min) values of the participants' from the heart rate measurements taken during the Zumba sessions. Energy expenditure was calculated from the predicted $\dot{V}O_2$ assuming an expenditure of 5 kcal for every 1 litre of O_2 consumed (Gaesser & Poole, 1996). This was conducted in accordance with the work of Luetttgen (2011).

During the maximal treadmill test, pulmonary gas exchange was recorded continuously with an integrated cardiopulmonary breath by breath online gas analysing system (cosmed s.r.l., Rome, Italy). Participants wore a suitable facemask (Hans Rudolf, Kansas City, USA) connected to a sensor consisting of a flow turbine and gas sampling tube. Before each testing session, the gas analyser was calibrated with gases of known oxygen (O_2) and carbondioxide (CO_2) concentrations. Cardio respiratory parameters like pulmonary $\dot{V}O_2$, CO_2 production ($\dot{V}CO_2$), and expired minute ventilation were measured continuously with an on-line gas analysing system (cosmed s.r.l., Rome, Italy) and averaged every 30s in accordance with the work of Morris (2012). Blood lactate was measured (Lactate Pro, Arkray, Japan) immediately after cessation of test.

During the incremental exercise the highest $\dot{V}O_2$ value recorded during any single 30-s interval was taken as the $\dot{V}O_{2max}$.

2.3 Statistical Analysis

Data analysis was performed using SPSS software version 20 and statistical significance was set at $p < 0.05$. All data are presented as mean \pm standard deviation (SD) and data was assessed for normal distribution using the Shapiro-Wilk's statistics. In instances where a test of normal distribution (using Shapiro-Wilk's statistics) was passed, Paired T test (table 3-5: appendix 7) was conducted to compare differences between % HRmax, METS and caloric expenditure values across trials (group and home based Zumba sessions). Wilcoxon's test (table 6) was conducted for the $\dot{V}O_{2\max}$ across trials because the test of normality was not passed.

Linear regression analyses were performed on individual heart rate data of each maximal treadmill test to predict $\dot{V}O_2$ during trials as was executed in previous studies (Luettgen, Foster, Doberstein, Mikat, & Porcari 2011; Buermann, 2012).

3. Results

3.1 Physiological characteristics

The 15 participants completed the two Zumba sessions and the incremental maximal treadmill test. Physiological responses are presented in table 1.

Table 1. Average physiological responses to 60 minute Zumba session

Variables	Mean \pm SD (group Zumba)	Mean
HR (bpm)	132.91 \pm 25.19	117.45 \pm 15.31
% HRmax	68.7 \pm 13	60.8 \pm 8.2
Predicted $\dot{V}O_2$ (ml/kg/min)	20.75 \pm 5.20	17.87 \pm 5.73
% $\dot{V}O_2$ max	59.1 \pm 19.2	49.8 \pm 16.9
METS	5.9 \pm 1.5	5.1 \pm 1.6
Kcal/min	6.06 \pm 1.64	5.17 \pm 1.58
Kcal/total	363 \pm 98.1	310 \pm 94.5
RPE	11 \pm 1.6	10 \pm 1.7

3.2 Heart rate response for trials

The average heart rate responses during the group Zumba session were 133 \pm 25.2 bpm which corresponded to 69 \pm 13 % HRmax while the responses for the home based session were 117 \pm 15.3 bpm which corresponded to 61 \pm 8.2 % HRmax. There was a significant difference ($p=0.015$) between both trials (Figure 1) and p was set at $p < 0.05$ (table 2 in appendix 7).

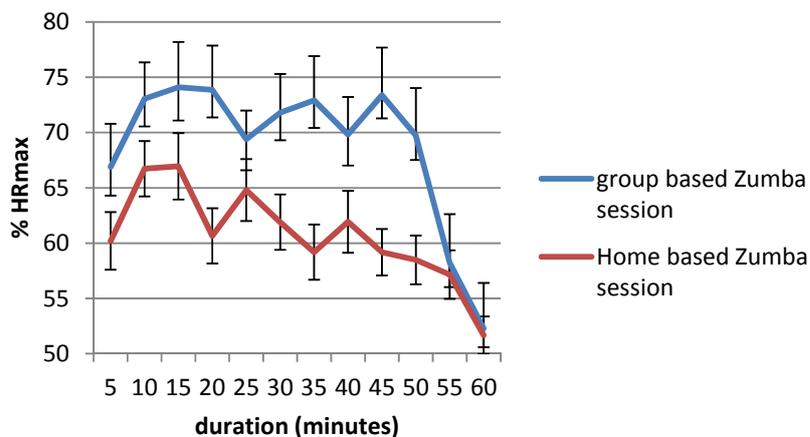


Figure 1. Graph of percentage maximum heart rate during Zumba group and home based sessions. There was a significant difference between both trials ($p = 0.015$).

3.3 Oxygen consumption ($\dot{V}O_2$) for trials

The average $\dot{V}O_2$ during the group Zumba session was 20.8 ± 5.2 ml/kg/min which corresponded to 59.1 ± 19.2 % $\dot{V}O_{2max}$ while the responses for the home based session were 17.9 ± 5.7 ml/kg/min which corresponded to 49.8 ± 16.9 % $\dot{V}O_{2max}$. There was a significant difference ($p=0.023$) between both trials (Figure 2) and p was set at $p < 0.05$ (table 5 in appendix 7).

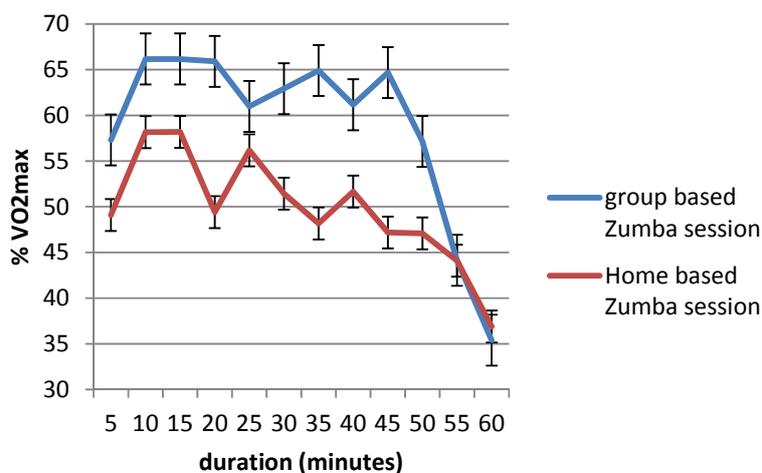


Figure 2. Graph of percentage maximum oxygen consumption during Zumba group and home based sessions. There was a significant difference between both trials ($p= 0.023$).

3.4 Energy expenditure for trials

For the 60- minute session, the average energy expenditure was 6.06 ± 1.6 kcals/min thus averaging 363 ± 98.1 kcal and the calories burned in the home based session was 5.17 ± 1.6 kcals/min thus averaging 310 ± 94.5 calories for the total session. Again, there was a significant difference ($p=0.017$) between both trials (Figure 3) and p was set at $p < 0.05$ (table 4 in appendix 7).

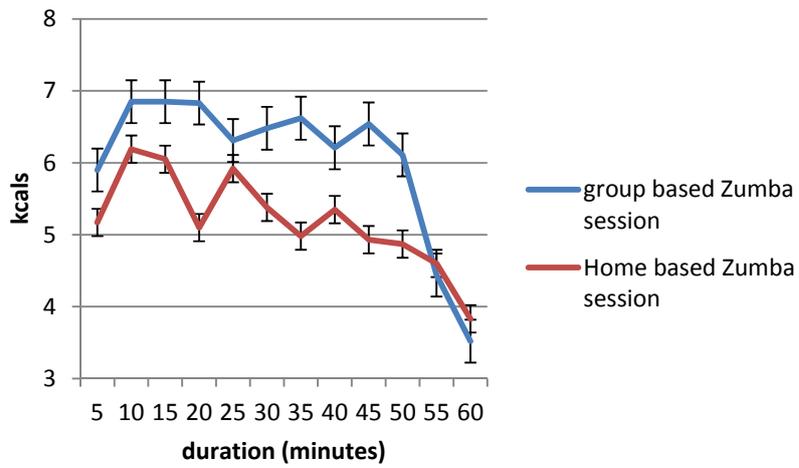


Figure 3. Energy expenditure during Zumba group and home based sessions. There was a significant difference between both trials p was set at $p < 0.05$.

4. Discussion

The American College of Sports Medicine (ACSM) recommends 150 minutes of moderate intensity exercise per week between 40-85 % $\dot{V}O_2$ max or 64-94 % HRmax at 300 kcals per workout to achieve health benefits and maintain a healthy weight (ACSM, 2010).

The purpose of this study was to determine that a 60 minute Zumba session would meet the ACSM recommended guidelines for improving cardiovascular fitness, and that the exercise intensity and caloric expenditure in a 60 minute group session would be significantly different from that in an individual (home based) session.

Findings from this study (Table 1) demonstrate that participating in a 60 minute Zumba session meets these ACSM guidelines. This confirms previous findings from other studies (Luetzgen, Foster, Doberstein, Mikat & Porcari, 2011; Otto et al. 2011) conducted on Zumba. These results are also in line with the findings of other research conducted on aerobic fitness exercises like Quidance (Buermann, 2012), Curves (Greany and Porcari, 2005) and cardio kickboxing (Immel and Porcari, 1999). However, results from research conducted on some fitness classes like NIA technique (Konemann, Battista & Porcari, 2008) and Pilates (Spilde & Porcari, 2005) demonstrated that the latter fitness exercises did not meet the ACSM recommended guidelines for improving cardiovascular fitness. The contrast in the findings of these studies could be attributed to the difference in aerobic requirements of the exercise techniques performed.

A comparison of the exercise intensity based on heart rates of different types of aerobic dance classes is given in Figure 1 below

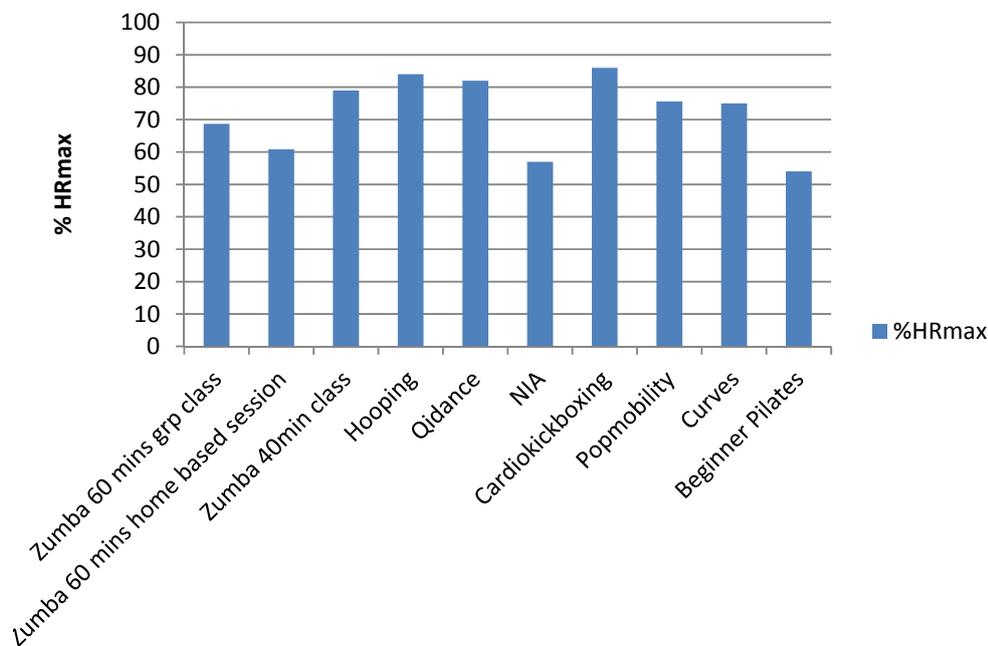


Figure 4. % HRmax of aerobic studies. Values are expressed as the mean

Values are adapted from various studies. Zumba 60 mins group (Okonkwo, 2013), Zumba 60 mins home (Okonkwo, 2013), Zumba 40mins class (Luetngen, 2011), Hooping (Holthusen, 2010), Qidance (Buermann, 2012), NIA (Konemann, Battista, & Porcari, 2008), Cardiokickboxing (Immel & Porcari, 1999), Popmobility (Grant et al. 1993), Curves (Greany & Porcari, 2005), Pilates (Spilde & Porcari, 2005).

Although aerobic classes like NIA technique and Pilates don't meet recommendations on improving fitness, other benefits attributed to them are improved balance, strength and flexibility (Johnson, Larsen, Ozawa, Wilson, & Kennedy 2007; Hakim, Kotroba, Cours, Teel, & Leininger, 2010). Despite the beginner's Pilates session falling below recommendations for improving cardiorespiratory fitness, it should be noted that the advanced class met the

recommendations. The researchers suggested that this could be due to increased muscular work entailed in executing some of the techniques or routines.

An important finding in the current study is that the intensity at which the participants worked was found to be higher in group session compared with the home based session. There were significant differences ($p < 0.05$) in exercise intensity based on %HRmax, % $\dot{V}O_2$ max and METS between both sessions (see appendix 7). This proved the hypothesis which suggested that participants' exercising in a group would work harder compared to participants' using a dvd at home. This is in line with research (Hertel, Kerr, & Messe, 2000; Feltz, Kerr, & Irwin, 2011; Irwin, Scorniaenchi, Kerr, Eisenmann, & Feltz, 2012; Osborn, Irwin, Skogsberg, & Feltz, 2012) which suggests that enhanced performance can be achieved by motivation gained through working in a group compared to working individually. In addition, it could be surmised that some participants have poor coordination and might have been working harder to get choreography right thus using physical and mental energy. However, looking at the results individually, it was noted that some participants (participants 1,2,3,8) based on their HR and $\dot{V}O_2$ values worked harder in the home based sessions. An explanation for this could be that these individuals were more familiar with the choreography or tunes used or they enjoyed dancing (Dishman, Sallis & Orenstein, 1985) hence the increased cardiovascular values. The rationale for higher cardiovascular values achieved due to familiarity of the choreography is nonetheless, arguable, as a study by Ziemba et al. (2003) suggests that familiarization with exercise protocols have no positive benefits on training effects.

The previous Zumba studies (Luetngen, Foster, Doberstein, Mikat & Porcari, 2011; Otto et al. 2011) consisted of sessions lasting 40 minutes or less. Luetngen and colleagues (2011) presented that participating in a 40-minute Zumba class would equate to burning an average of 9.5 kcal/min while the work of Otto and colleagues (2011) presented that participating in a 24 minute class would correspond to using 6.6 to 7.4kcal/min. It is noteworthy that the current study demonstrates that participation in longer Zumba classes does not necessarily amount to greater energy expenditure. The results report an average energy expenditure of 6.1kcal/min for the group session and 5.2 kcal/min in the individual sessions. The difference in the findings could be attributed to the difference in length of time of both studies and the fact that metabolic equipment worn by participants in the study by Otto et al. (2011) might have been cumbersome reducing performance and thus affected results. Although, participants in the current study wore no metabolic equipment but did not expend as much energy as those participants in the study by Luetngen and colleagues (2011). This could also be due to the fact that Luetngen and colleagues (2011) conducted their study on active participants (high fitness level) who were regular participants at a Zumba class in contrast to the present study which looked at participants with different levels of fitness and who were not familiar with the choreography. However, this study relates to real life situations where individuals can just step into a club and join the Zumba class. Furthermore, the total caloric expenditure for the group session was 363 ± 98.1 kcals while the home based session was 310 ± 94.5 kcals both above the ACSM recommendations for weight loss. Thus, substantiating the claims of the current study as to the benefits of Zumba to a weight loss programme.

It would be important to note however that the average RPE ratings during the group session was 11 ± 1.6 and 10 ± 1.7 for the individual session which corresponds to light exertion. This would suggest that the participants' perception was that they were performing light exercise. This further supports the position that Zumba exercise is a safe fitness exercise. The United States Department of Health and Human Services [USDHHS] (2008) recommend that moderate and low impact activity can be considered safe fitness activity for most individuals.

Results might have been more accurate if direct measurements of $\dot{V}O_2$ were performed using portable metabolic analysers instead of estimations from a linear regression equation. Evidence from studies (Arngrimsson, Stewart, Boranni, Skinner & Cureton, 2003; Reybrouk, Heigenhauser & Faulkner (1975) allude to some limitations of the HR - $\dot{V}O_2$ relationship.

The current study examines participants who are unfamiliar with the choreography or dance tunes used during the session. Perhaps the results might have been different if they were familiar with the tunes and choreography employed. However, this study was trying to differ from previous studies which investigated participants who were familiar with the choreography employed in their studies. Although, research by Ziemba et al. (2003) demonstrates that a lack of familiarization does not necessarily affect results negatively.

Additionally, the different instructors in both Zumba sessions of the class could be responsible for the different results based on the enthusiasm of the instructor. However, the same dance songs and choreography that were utilized in the group class were used in the home based sessions. Also, the study tried to be as comparable to real life situation as possible where an

individual who is a regular participant at a Zumba class would most likely use a Youtube version of Zumba or buy a dvd not instructed by his/her class instructor when exercising at home.

4.1 Recommendations for further research

Regarding the growing popularity of Zumba worldwide and the limited research available, there is wide range of areas for further study. Previous Zumba studies have revealed that Zumba session meets ACSM recommendations for improving cardiovascular treatment. The current study supports this finding and further reveals the exercise intensity and energy cost of participating in group sessions and home based sessions. Hence, future studies could investigate the difference between perceived and actual energy expenditure during Zumba sessions. The current study suggests that the difference in the instructor or dancing ability or pleasure of some individuals could be the reason for the participant working harder in the home based sessions than in the group sessions. It would be interesting to carry out a study to determine the energy expenditure of a number of Zumba sessions with different instructors.

5 Conclusion

Zumba exercise has been purported to be a fun way of exercising and is beneficial in improving cardiovascular fitness (Luetzgen, Foster, Doberstein, Mikat&Porcari, 2011). Thus, the present study supports this statement.

With evidence citing lack of time, interest or motivation as reasons why individuals, particularly women don't exercise regularly (Biddle & Muthrie, 2008). Evidence from this study suggests that sedentary females can partake in group Zumba exercises at a local club with friends as health benefits could be achieved. This is in line with the NICE guidelines on steps to take to attain active lifestyles.

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APPENDIX 1



Faculty of Applied Sciences

Research Ethics Committee

frec@chester.ac.uk

Nneka Maryann Okonkwo

7th June 2013

Dear Nneka,

Study title: Energy expenditure and physiological responses to group versus individual home based Zumba sessions in healthy adult females.

FREC reference: 798/13/NO/CSN

Version number: 1

Thank you for sending your application to the Faculty of Applied Sciences Research Ethics Committee for review.

I am pleased to confirm ethical approval for the above research, provided that you comply with the conditions set out in the attached document, and adhere to the processes described in your application form and supporting documentation.

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Application Form	1	April 2013
Appendix 1 – C.V. for Lead Researcher	1	April 2013
Appendix 2 – Participant Information Sheet	1	April 2013
Appendix 3 – Health Screening Form	1	April 2013
Appendix 4 – Participant Consent Form	1	April 2013
Appendix 5 – Risk Assessment Form	1	April 2013
Appendix 6 – Borg’s RPE Scale	1	April 2013
Appendix 7 – Instructions for data collection during individual session (at home)	1	April 2013
Appendix 8 – Data collection sheet for group session	1	April 2013
Appendix 9 – List of References	1	April 2013
Response to FREC request for further information and clarification		June 2013
Appendix 4 – Participant Information Sheet	2	June 2013
Appendix 5 – Risk Assessment Form	2	June 2013

With the Committee’s best wishes for the success of this project.

Yours sincerely,

Dr. Stephen Fallows

Chair, Faculty Research Ethics Committee

Enclosures: Standard conditions of approval.

Cc. Supervisor/FREC Representative

APPENDIX 2



Participant Information Sheet

Energy expenditure and physiological responses to group versus individual home based Zumba sessions in healthy adult females

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

What is the purpose of the study?

The research is being undertaken on healthy young adult females. The aim is to determine if there is any difference between the intensity and energy expenditure during a one hour Zumba session performed in a class or an individual session at home using a dvd. The study will take place over 6 weeks; however it will only involve you for three to five days, in which time you are required to attend three testing sessions.

Why have I been chosen?

You have been chosen because you are a healthy female adult aged between 18 and 40 years.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect you in any way.

What will happen to me if I take part?

You will be required to attend three sessions – One of the sessions will be at the Human Performance Laboratory at the University of Chester which will involve you working to exhaustion using the rating of perceived exertion scale (a measurement of how hard it feels that you are exercising). The other two will be a group class (Zumba session) in the University of Chester fitness centre gymnasium and a Zumba session alone at home using the Zumba fitness dvd. In all testing sessions, the following measurements would be taken

- 1) Oxygen consumption and carbon dioxide production (for which you will be required to wear a mask).

- 2) Heart rate (for which you will be required to wear a belt around your waist).
- 3) Rating of perceived exertion (a measurement of how hard it feels while you are exercising).

Before each testing session your blood pressure will be measured. You will be required to abstain from the following prior to each testing session – vigorous exercise 48hrs, tobacco 3hrs, alcohol 24hrs and caffeine 12hrs.

What are the possible disadvantages and risks of taking part?

There are no disadvantages or risks foreseen in taking part in the study.

What are the possible benefits of taking part?

By taking part, you will get information about fitness level when you are working at your highest intensity.

What if something goes wrong?

If you wish to complain or have any concerns about any aspect of the way you have been approached or treated during the course of this study, please contact Professor Sarah Andrew, Dean of the Faculty of Applied Sciences, University of Chester, Parkgate Road, Chester, CH1 4BJ, 01244 513055.

Will my taking part in the study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential so that only the researcher carrying out the research will have access to such information.

What will happen to the results of the research study?

The results will be written up into a dissertation for my final project of my MSc. Individuals who participate will not be identified in any subsequent report or publication.

Who is organising the research?

The research is conducted as part of an MSc in Exercise and Nutrition Science within the Department of Clinical Sciences at the University of Chester. The study is organised with supervision from the department, by Nneka Okonkwo, an MSc student.

Who may I contact for further information?

If you would like more information about the research before you decide whether or not you would be willing to take part, please contact:

Nneka Okonkwo.

Thank you for your interest in this research.

APPENDIX 3

Pre-test Questionnaire/ Health Screening form

Energy expenditure and physiological responses to group versus individual home based Zumba sessions in healthy adult females

Researcher : Nneka Okonkwo

Name: _____

Contact number: _____ Date of birth: _____

In order to ensure that this study is as safe and accurate as possible, it is important that each potential participant is screened for any factors that may influence the study. Please circle your answer to the following questions:

1. Has your doctor ever said that you have a heart condition *and* that you should only perform physical activity recommended by a doctor? YES/NO
2. Do you feel pain in the chest when you perform physical activity? YES/NO
3. In the past month, have you had chest pain when you were not performing 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 bone or joint problems (e.g. back, knee or hip) 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. Are you pregnant, or have you been pregnant in the last six months? YES/NO
8. Have you injured your hip, knee or ankle joint in the last six months? YES/NO
9. Do you know of any other reason why you should not participate in physical activity? YES/NO

Thank you for taking your time to fill in this form.

APPENDIX 4



Title of Project: Energy expenditure and physiological responses to group versus individual home based sessions in healthy adult females

Name of Researcher: Nneka Okonkwo

Please initial box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.

3. I agree to take part in the above study.

Name of Participant

Date

Signature

Researcher

Date

Signature

1 for participant; 1 for researcher

APPENDIX 5

APPENDIX 6

DATA COLLECTION SHEET FOR ZUMBA SESSIONS

Materials needed - An analogue clock, Polar heart rate monitor, digital sphygmomanometer, 6-20 rating of perceived exertion(RPE) Borg scale

Procedure

1. Measure your blood pressure and heart rate using the digital sphygmomanometer prior to the beginning of the exercise. .
2. Put on the polar heart rate monitor and place the analogue clock and 6-20 Borg scale in front of you or a position that is clearly visible at any time..
3. Then put on dvd and begin exercise.
4. The heart rate and RPE measurements should be taken every five minutes so keep monitoring the clock while exercising.
5. At each five minute interval, record the heart rate and RPE measurements in the data sheet provided.
6. At the end of the exercise measure heart rate and blood pressure again.

APPENDIX 7

Table 2. Paired t test for %HRmax

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	% of HRmax(bpm) for groupzumba - % of HRmax(bpm) for home based zumba	7.88667	10.98180	2.83549	1.80515	13.96818	2.781	14	.015

Table 3. Paired t test for METS

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	metabolic equivalent achieved in group zumba class - metabolic equivalent achieved in homed based zumba	.79667	1.30409	.33671	.07449	1.51885	2.366	14	.033

Table 4. Paired t test for energy expenditure

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	energy expended during 1 hr group zumba session - energy expended during 1 hr home based zumba session	53.44000	76.25278	19.68838	11.21262	95.66738	2.714	14	.017

TABLE 5 Wilcoxon test statistics for % $\dot{V}O_2$ max.

		% maximum oxygen consumption in home based zumba session (ml/kg/min) - % maximum oxygen consumption in group zumba session (ml/kg/min)
Z		-2.272 ^b
Asymp. Sig. (2-tailed)		.023

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

APPENDIX 8

DATA COLLECTION SHEET FOR INCREMENTAL MAXIMAL TREADMILL ($\dot{V}O_2\text{max}$) TEST

Date..... Participant no..... Age..... Weight..... Height.....

Patient consent obtained Y/N Health screen completed Y/N Procedure explained Y/N

Resting blood pressure..... Resting heart rate..... Maximum heart rate.....

Resting blood lactate

TIME	STAGE	SPEED (mph)	% GRADE	HEART RATE	RATING OF PERCEIVED EXERTION
0-3	1	1.7	10		
3-6	2	2.5	12		
6-9	3	3.4	14		
9-12	4	4.2	16		
12-15	5	5.0	18		
15-18	6	5.8	20		
18-21	7	6.6	22		
21-24	8	7.4	24		
24-27	9	8.2	26		
27-30	10	9.0	28		

APPENDIX 9

PROTOCOL FOR $\dot{V}O_2$ max TEST

- Following appropriate screening using the health screening form (appendix 3) and once consent has been given, measurements of participants' height, weight, resting heart rate and blood pressure should be taken.
- Begin the test with a 5min warm up and familiarize participants with the exercise equipment to prepare them for the test.
- Participants should be fitted with a heart rate monitor to measure heart rate, the face mask connected to the gas analyzer to measure oxygen uptake and respiratory exchange ratio (RER). Borg scale and lactate monitor placed near participant for measurements of rating of perceived exertion (RPE) and blood lactate concentration respectively.
- During the test, heart rate, blood pressure and ratings of perceived exertion using the 6-20 Borg scale would be taken every three minutes
- First stage of test should be started at a speed of 1.7mph with a 10% gradient and then increase with a speed of 0.8mph at 2%grade respectively. Each stage should last for three minutes. Treadmill speed and incline should be increased every three minutes
- The participants' physical appearance and symptoms would be monitored throughout the test.
- The test would be discontinued when the test termination criteria is reached, the participant requests stopping the test or if any indication for stopping an exercise test are apparent
- A cool down should be performed by exercising at a low work rate that does not exceed the intensity of the first stage.
- During recovery, continue to monitor heart rate and physical appearance for at least 5 mins
- If the participant has signs of discomfort or if an emergency occurs, use a passive cool down with the client in a sitting or supine position.