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Enjoyment Levels of Irish Women Performing Continuous Moderate Intensity Exercise Versus High Intensity Interval Exercise

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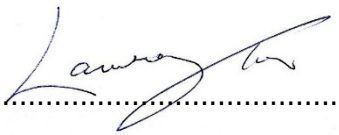
Declaration

This work is original and has not been previously submitted in support of a Degree, qualification or other course.

Signed  .....

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Abbreviations and Acronyms

ACSM - American College of Sports Medicine

ANOVA - Analysis of Variance

BMI - Body Mass Index

CSO - Central Statistics Office

CST - Chester Step Test

CVD - Cardiovascular Disease

EE - Energy Expenditure

GXT - Graded Exercise Test

HIIT - High Intensity Interval Training

HR - Heart Rate

HRmax - Maximal Heart Rate

MCT - Moderate Continuous Exercise

MD - Weighted Mean Difference

MET - Metabolic Equivelant

NCD - Non-Communicable Disease

NCRI - National Cancer Registry Ireland

$\dot{V}O_2max$ - Aerobic Capacity

$\dot{V}O_2peak$ - Peak Oxygen Consumption

OR - Odds Ratio

PA - Physical Activity

PACES - Physical Activity Enjoyment Scale

PRET - Perceptually Regulated Exercise Test

RCP - Respiratory Compensation Point

RCT - Randomized Controlled Trial

RPE - Rating of Perceived Exertion

SB - Sedentary Behaviour

SLAN - Survey of Lifestyles, Attitudes and Nutrition

T2D - Type 2 Diabetes

VT - Ventilatory Threshold

WHO - World Health Organisation

University of Chester

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Literature Review

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Abstract

PA and exercise are widely recognised as being important for enhancing positive health and reducing risk of chronic illness. PA has been observed to be linked with chronic illnesses specific to women including breast and ovarian cancers. In Ireland, the incidence of both these types of cancers are increasing with 31% of women achieving only a low level of daily PA. Guidelines have been developed outlining the amount and types of exercise individuals should engage in to in order to attain health benefits, which can be carried out in the form of either HIIT or MCT. The Irish guidelines stand as a public health message which is more easily understood by the general public. Despite this, a number of barriers are often reported such as lack of time as preventing individuals from meeting the recommended guidelines. Type and intensity of exercise has been seen to impact upon exercise adoption and adherence, along with psychological parameters including enjoyment. HIIT has been observed to be perceived as being more enjoyable than MCT by males. Determining whether HIIT or MCT is found to be more enjoyable for females could help improve health promotion strategies which are PA based.

Introduction

Physical Activity (PA) and exercise are widely recognised as being important for reduced risk of a range of chronic illnesses and promoting health (Chien, Chen, Hsu, Su, & Lee, 2009; Minder et al. 2014; Hallal et al. 2012). For women, it has been observed that risk of all-cause mortality is reduced due to increased PA from HR=0.67 95%CI: 0.58-0.76 for very low weekly PA to HR=0.53 95%CI: 0.45-0.62 for moderate to high level of PA weekly (Brown et al. 2012). A study by Minder et al. (2014) of 2269 males aged 44±9years and 531 females aged 41±9years assessed the relationship between PA level, fitness and cardiometabolic risk. Fitness level was subsequently found to be significantly ($p<0.001$) correlated with a number of cardiometabolic risk factors including BMI ($r=-0.438$) waist circumference ($r=-0.422$). Significantly greater odds of hypertension (OR=2.79 95%CI: 1.75, 4.43; $p<0.001$), metabolic syndrome (OR=1.76 95%CI: 1.13, 2.75; $p=0.012$) and obesity (OR=2.39 95%CI: 1.56, 3.68; $p<0.001$) were also observed demonstrating the importance of PA and fitness level for health promotion. It has also been observed that low levels PA is also linked with female specific illness such as ovarian cancer (Moorman, Jones, Akushevich, & Schildkraut, 2011). In Ireland, there were 376 new cases of ovarian cancer diagnosed in 2012 (National Cancer Registry Ireland, 2015). It has been observed that 31% of Irish women achieve only a low level of weekly PA (Morgan et al. 2008). Guidelines outlining the intensity and quantity of PA to promote the health of individuals have been developed (Department of Health and Children, & Health Service Executive, 2009). This activity can be continuous moderate intensity or high intensity interval training (American College of Sports Medicine, 2011). Although, individuals report that barriers such as lack of time and lack of facilities prevent them from partaking in PA (Downes, 2015). Type and intensity of exercise have also been found to impact upon PA participation (Rhodes, Warburton, & Murray, 2009). Enjoyment of PA has been

observed to impact upon PA participation (Currie, 2012). Males have reported an enjoyment score of 88±6 for high intensity interval training which was significantly higher ($p=0.004$) than the enjoyment score of 61±12 reported for continuous moderate intensity exercise (Bartlett, Close, MacLaren, Gregson, Drust, & Morton, 2011). Determining which of these intensities women find more enjoyable may positively impact upon exercise adherence.

Physical Activity and Health

Physical Activity, Morbidity and Mortality

A recent review of literature by Gill, Celis -Morales & Ghouri (2014), observed that a high level of fitness was associated with reductions of approximately 40-45% in all-cause mortality, approximately 50-60% in cardiovascular disease (CVD) mortality, and approximately 50-70% in mortality as a result of Type 2 Diabetes (T2D) compared to a low level of fitness in cohort studies. It was also observed that Sedentary Behaviour (SB) was associated with an increased risk of CVD, T2D and metabolic syndrome with 35% of adults worldwide not achieving recognised PA guidelines. It was also concluded that inactivity is responsible for 9% of mortality globally, equating to 5.3million deaths annually. Strong links have also been found between PA level, mortality and disease risk regardless of other risk factors such as obesity (Loprinzi & Pariser, 2014; Martins et al. 2015; Richard, Martin, Wanner, Eichholzer & Rohrmann, 2015).

Physical Activity and Disease in Women

A review of epidemiological literature by Loprinzi, Cardinal, Smit and Winters-Stone (2012), examined the relationship between PA and breast cancer. A total of 76 studies were reviewed of which 72 had only women as a sample. This included 28 prospective cohort studies, 5 retrospective cohort studies and 43 case-controlled studies. If a significant inverse association was found with PA and breast cancer risk, a protective effect was concluded. This was the case for 53% of the studies reviewed. Of the remainder, 37% reported a non-significant protective effect and only 10% finding no association between PA and breast cancer risk. Of the studies which reported a protective effect, an average 36% decreased risk was found. The intensity of activity was also found to impact on the reduction in risk with a reduction of 26% observed for vigorous activity and a reduction of 13% observed for moderate activity. The case–

controlled studies were found to report a greater reduction in breast cancer risk of 35% than that of cohort studies of 21%. These findings can be considered stronger than that of the cohort studies due to the controls in the study design (Thomas, Nelson & Silverman, 2010). This subsequently adds strength to the conclusion that PA reduces the risk of breast cancer (Loprinzi, Cardinal, Smit &Winters-Stone, 2012).

A study by Xi et al. (2014), examined the relationship between PA and breast cancer in a sample of 839 breast cancer patients aged 48.97±11.57 years and 863 healthy controls aged 49.23±11.76 years. PA was measured via an interview recalling PA participation over a 10 year period, this was converted to Metabolic Equivalent (MET) hours performed weekly (MET⋆hours.wk^{-1}). After adjusting for confounding factors, participants who had participated in <3 MET⋆hours.week^{-1} were at significantly higher ($p<0.001$) risk of breast cancer (OR=1.55 95%CI: 1.13-2.12), as were those achieved 3 to <18 MET⋆hours.week^{-1} (OR=3.08 95%CI: 2.25-4.22). This demonstrates the positive impact of PA on disease risk particularly for females, however a recall of PA over an extended period such as in this study may not be accurate and may weaken the findings (Polgar & Thomas, 2013).

PA has been also been linked to ovarian cancer (Moorman, Jones, Akushevich, & Schildkraut, 2011). A recent case-control study examined the impact of PA on the risk of ovarian cancer in a sample of 500 ovarian cancer patients aged 59.07±5.68 years and 500 controls aged 59.71±6.46years (Lee, Su, Pasalich, Wong, & Binns, 2013). Data was collected via a 45 minute interview in the presence of the participants' next of kin to reduce error. Information was gathered on the amount and type of activity the participants had undertaken in the 5 years prior to the interview. Activities were categorized as strenuous sports, vigorous work and moderate activity which were also given MET values while SB was assessed separately (Strenuous Sports=7.5MET,

Vigorous Activity=6.0MET, Moderate Activity=4.5MET). The information on these activities was then quantified into MET•hours to compare the groups objectively. The weekly MET•hours spent undertaking each activity for each group and significant differences between the groups can be found in **Table 1**. The Odds Ratio (OR) of ovarian cancer risk for the length of time spent undertaking each activity with significance values can be found in **Table 2**.

Table 1. Mean Weekly MET•hours Spent in Activities (Source: Lee, Su, Pasalich, Wong, & Binns, 2013)

	Case	Control	*P*
Strenuous Sports	0.63 ±2.3	0.99 ±2.8	0.03
Moderate Activity	12.93 ±12.2	14.84 ±11.5	0.01
Total PA	16.21 ±14.1	18.84 ±13.0	<0.01

Table 2. Adjusted Odds Ratio (95% Confidence Interval) for Ovarian Cancer Risk and Physical Activity (Source: Lee, Su, Pasalich, Wong, & Binns, 2013)

	Duration (MET•hours)	OR	95% CI	*P for trend*
Strenuous Sports	<6	0.58	0.38-0.88	0.01
	≥6	0.4	0.11-1.44	
Moderate Activity	<11.5	0.14	0.01-1.53	0.02
	≥11.5	0.10	0.01-1.06	
Total PA	12-22	0.82	0.60-1.11	0.02
	≥23	0.49	0.35-0.68	

What is of particular interest here is the total time spent in PA. As can be seen in **Table 1**, The ovarian cancer patients had spent significantly ($p<0.01$) less time being physically active weekly than their control counterparts, providing an initial grounding

for the conclusion that PA reduces the risk of ovarian cancer. The further analysis of the findings strengthens this with a significant trend (p=0.02) of a reduction in the risk of ovarian cancer observed with increased time spent in PA weekly while accounting for confounding factors such as age, smoking and BMI as seen in **Table 2**. This shows the importance of PA for the promotion of health of women

Physical Activity Levels and Disease Incidence in Ireland

According to the World Health Organisation (WHO), 27000 deaths occurred in Ireland in 2014 (WHO, 2015). Of these, 32% were caused by CVD, 30% by cancer, 2% by diabetes and 17% by other Non-comminicable Diseases (NCD). According to the most recent Survey of Lifestyle, Attitudes and Nutrition in Ireland (SLAN), 38% of Irish adults report living with a chronic illness or NCD (Morgan et al. 2008). This suggests that promotion of physical activity in Ireland is important for the whole population to reduce risk of mortality improve overall health. Data from the Central Statistics office in Ireland (CSO) states that in 2009, there were 15364 newly diagnosed cases of all types of cancer in Irish women (CSO, 2015). Of these 2740 were breast cancer, and 297 were ovarian cancer. The National Cancer Registry Ireland (NCRI) states that in 2012, the number of newly diagnosed cases of breast cancer in women had risen to 2860, and to 376 newly diagnosed cases of ovarian cancer (NCRI, 2015). SLAN also states that 31% of Irish women achieve only low levels of daily PA, classified as ≤5000steps daily, whereas only 26% of men fall into this category further demonstrating the importance of promoting PA in Irish women (Loprinzi, & Lee, 2014; Morgan et al. 2008).

Guidelines for Physical Activity

American College of Sports Medicine Physical Activity Guidelines

As PA participation is important, guidelines on levels of PA for health benefits have been developed (Gill, Celis -Morales, & Ghouri, 2014; Loprinzi, & Pariser, 2014). The American College of Sports Medicine (ACSM) regularly issues guidelines outlining the frequency, intensity duration and type of activity individuals should engage in to attain health benefits (Thompson, Gordon, & Pescatello, 2010). The ACSM advise that individuals participate in a total volume of ≥500-100MET·min weekly consisting of 30-60minutes of moderate intensity activity on 5 or more days, or 150minutes weekly (ACSM, 2011). This can also be achieved through 20-60minutes of vigorous intensity activity on 3 or more days, or 75minutes weekly. A combination of moderate and vigorous intensity activity will also achieve this recommendation. Exercise intensity is classified by physiological and perceptual measures by the ACSM. Moderate intensity in classified as 64-76% of an individual's maximum Heart Rate (HRmax), 46-63% of an individual's aerobic capacity ($\dot{V}O_2$max) or reporting 12-13 on the Borg Rating of Perceived Exertion (RPE). Vigorous intensity in classified as 77-95% of an individual's HRmax, 64-90% of an individual's $\dot{V}O_2$max, or reporting an RPE of 14-17. RPE provides a means of monitoring intensity when using physiological methods are not possible (Chen, Fan & Moe, 2002).

Moderate Continuous Intensity and High Intensity Interval Training

Both moderate and vigorous intensity activity are recognised as being beneficial for positive health (Nilsson, Westheim, & Risberg, 2008; Stensvold et al. 2010; Tjønna et al. 2009). Vigorous intensity activity is not sustainable for a prolonged period of time and is often performed in the form of High Intensity Interval Training (HIIT) involving bouts of vigorous activity interspersed with periods of active or passive recovery

(Gibala, 2009). A Randomised Controlled Trial (RCT) by Moholdt et al. (2009), examined the effects of both HIIT and Moderate Continuous Exercise (MCT) in a sample of 59 patients who had undergone a coronary bypass. Participants were randomly assigned to perform either MCT or HIIT. The MCT group were aged 62.0±7.6years and performed walking exercise at 70% HRmax for 46minutes. The HIIT group were aged 60.2±7.6years and performed four repetitions of 4minutes at 90% HRmax with 3minutes of active recovery at 70% HRmax. The HIIT sessions also included an 8minute warm up and 5minute cool down. Both groups performed these isoenergetic protocols 5days weekly for 4weeks. Both groups gained a significant increase ($p<0.001$) in $\dot{V}O_2max$ (MCT- Pre: 27.1±4.5ml.kg^{-1}.min^{-1}, Post: 30.4±5.5ml.kg^{-1}.min^{-1}; HIIT- Pre: 26.2±5.2ml.kg^{-1}.min^{-1}, Post: 28.5±5.6ml.kg^{-1}.min^{-1}). Both groups also experienced significant improvements ($p<0.05$) in one minute Heart Rate (HR) recovery (MCT- Pre: 19.6±6.8bpm, Post: 22.5±7.6bpm; HIIT- Pre: 20.3±9.4bpm, Post: 25.4±8.4bpm). The MCT group attained a significant ($p<0.05$) improvement in Resting HR from 68.6±8.4bpm to 66.4±8.7bpm. The HIIT group also achieved a significantly reduced ($p<0.01$) resting HR from 68.8±9.5bpm to 63.9±8.8bpm.

A meta-analysis conducted by Smart, Dieberg, and Giallauria (2013), investigated the results of 13 RCT which examined the effects of HIIT and MCT in heart failure patients. All study groups were matched for age and gender, with all bar one using cycling as an exercise mode, but using walking instead. It was observed that the Weighted Mean Difference (MD) in $\dot{V}O_2peak$ was significantly in favour of HIIT compared to controls (MD= 1.58ml.kg^{-1}.min^{-1} 95%CI: 1.13, -2.04; $p<0.00001$). This was also observed for MD in $\dot{V}O_2peak$ of HIIT compared to MCT (MD= 1.04ml.kg^{-1}.min^{-1} 95%CI: 0.42, -1.66; $p<0.009$). It was also observed that change in $\dot{V}O_2peak$ was also significantly positively correlated (r-0.48, p=0.05) with weekly Energy Expenditure (EE). This links

with the recommendation of a total volume of activity as described in the ACSM guidelines (ACSM, 2011).

Physical Activity Guidelines for Ireland

Ireland has a set of physical activity guidelines published by the government as a public health message similar to that of the ACSM giving recommendations on the frequency, intensity, duration and type of activity which is beneficial for positive health (Department of Health and Children, & Health Service Executive, 2009). These guidelines, recommend individuals should aim to achieve at least 30minutes of moderate intensity activity 5days weekly or 150minutes weekly. Although, unlike the ACSM, these do not give recommendations for vigorous intensity activity. This may be due to the ACSM guidelines being more recent than that of the Irish guidelines (ACSM, 2011). In spite of this the Irish guidelines give both descriptions, and examples of moderate and vigorous intensity activity (Department of Health and Children, & Health Service Executive, 2009). Moderate intensity activity is described as activity which increases breathing and HR but a conversation can be maintained, such as a brisk walk. Vigorous intensity activity is described as activity where breathing becomes heavy, sweating occurs and a conversation cannot be maintained, such as during active sports and skipping. Although these give individuals specific examples of types of activities, the description of moderate and vigorous intensities are perceptual and therefore subjective (Ogden, 2012). This may be considered a flaw in the Irish guidelines, however the link between the ACSM and Irish guidelines in this regard could be RPE.

Physiological Intensity and RPE

Although RPE is a perceptual measurement and thus subjective, it is widely recognised as being a valid means of measuring exercise intensity (Coquart et al.

2009; Coquart et al. 2012; Esfon, 2009). A study by Morris, Lamb, Cotterrell, and Buckley (2009), examined the validity and reliability of the use of RPE to predict maximal exercise capacity while performing cycling ergometry. A sample of 23 participants aged 31±9.9years completed 5 exercise trials, one Graded Exercise Test (GXT) to exhaustion and four discontinuous submaximal Perceptually Regulated Exercise Tests (PRET). Participants regulated the exercise themselves by altering the resistance on the cycle ergometer at intensities of 9,11,13,15 and 17 on the RPE scale. Two of the trials involved 2minute bouts of exercise with 3minutes of active recovery, the other two trials had the same amount of active recovery with 3minute bouts of exercise, which were all performed in random order. Data relating to HR and resistance was hidden from the participants during the trials. Using a linear regression analysis, participants' aerobic capacity was predicted from the four exercise trials. No significant differences ($p>0.05$) were found between the participants' $\dot{V}O_2max$ from the GXT (41.5±8.0ml.kg^{-1}.min^{-1}) or that predicted via any of the four trials (2Minute Trial A: 38.9±10.7ml.kg^{-1}.min^{-1}, 2Minute Trial B: 40.2±9.6 ml.kg^{-1}.min-1, 3Minute Trial A: 40.5±10.4ml.kg^{-1}.min^{-1}, 3Minute Trial B: 41.3±9.9ml.kg^{-1}.min^{-1}). Limits of Agreement (LoA) analysis were also performed to assess the validity and reliability of using a PRET to predict $\dot{V}O_2max$. Using the full range of 9-17 on the RPE scale yielded the greatest LoA for all four trials for both validity (2Minute Trial A: −2.6±10.1ml.kg^{-1}.min^{-1}, 2Minute Trial B: −1.3±7.4ml.kg^{-1}.min-1, 3Minute Trial A: −1.0±9.2ml.kg^{-1}.min^{-1}, 3Minute Trial B: −0.2±7.2ml.kg^{-1}.min^{-1}), and for reliability (2Minute Bout: −1.3±9.2ml.kg^{-1}.min^{-1}, 3Minute Bout: −0.8±5.7ml.kg^{-1}.min^{-1}). An interclass correlation also showed a strong positive correlation between the GXT $\dot{V}O_2max$ and the 2minute bout trials ($r=0.90$) and 3minute trials ($r=0.96$). This shows that RPE is a consistent

measure of intensity, demonstrating perceptual regulation of exercise intensity is linked strongly to physiological intensity, while also being valid and reliable.

A more recent study by some of the same authors had comparable findings. A sample of 18 participants aged 21.7±2.8years completed a Bruce protocol GXT only after completing three PRET on a treadmill ergometer (Morris, Lamb, Hayton, Cotterrel, & Buckley, 2010). The PRET involved three minute stages at an RPE of 9, 11, 13 and 15 as an upper limit to ensure safety of the participants. Participants began the PRET at a speed of 1.3km.hour^{-1} were allowed to adjust the speed and gradient of the treadmill to produce the aforementioned RPE values. Linear regression was also used to ascertain predicted $\dot{V}O_2$max for an RPE of 19 and 20. No significant differences ($p>0.05$) were found between criterion $\dot{V}O_2$max (48.0 ± 6.2ml.kg^{-1}.min^{-1}) and predicted $\dot{V}O_2$max for RPE19 as a maximum (Trial A: 48.8±10.8 ml.kg^{-1}.min^{-1}, Trial B: 48.2 ± 8.6 ml.kg^{-1}.min^{-1}, Trial C: 45.5 ± 7.8 ml.kg^{-1}.min^{-1}) or RPE20 as a maximum (Trial A: 49.9 ± 10.1 ml.kg^{-1}.min^{-1}, Trial B: 49.0 ± 8.1 ml.kg^{-1}.min^{-1}, Trial C: 47.4 ± 6.9 ml.kg^{-1}.min^{-1}). The closest LoA were thusly for RPE19, particularly for the first and second trials (Trial A: 0.8 ± 16.4 ml.kg^{-1}.min^{-1}, Trial B: 0.2 ± 10.3 ml.kg^{-1}.min^{-1}). The closest LoA for RPE20 was in the final trial (Trial C: -0.6 ± 7.1ml.kg^{-1}.min^{-1}). This further demonstrates the use of RPE as a perceptual method of regulating exercise intensity to be valid and reliable for a different mode of exercise. However, the authors conclude that a PRET on a treadmill to be more valid and reliable for predicting $\dot{V}O_2$max if the individual has had sufficient practice in regulating exercise in this way.

Thus it can be seen from the evidence that although the Irish PA guidelines provide a perceptual means of measuring intensity, this relates quite well to physiological exercise intensity and may be more comprehensible to the general public (Chen, Fan & Moe, 2002; Morris, Lamb, Hayton, Cotterrel, & Buckley, 2010).

Physical Activity Adoption and Adherence

Barriers to Physical Activity

Individuals often state that a number of barriers prevent them from partaking in regular PA, overcoming these is important for promoting PA and subsequently promoting health (Beighle & Morrow, 2014). Some of the main barriers often cited are lack of time, lack of facilities and environmental barriers (Adachi-Mejia et al. 2010; Cramp & Bray, 2011; Downes, 2015)

A study by Stutts (2002), examined the barriers and cues to becoming physically active of 137 adults. Within the sample, 82 participants were inactive and 80% of the sample were female. Barriers to PA and Perceived benefits of PA were measured using the Exercise Benefits/Barriers Scale. Internal barriers such as lack of time, lack of motivation, and boredom were rated as the top reasons for not becoming active for 73 of the participants. Physical limitations, such as illness was rated the top reason for 5 of the participants, and environmental barriers such as weather and lack of facilities rated the top reason by 2 participants. Interestingly, internal cues such as dissatisfaction with bodyweight and appearance, and prevention of health issues were referred to as a reason for PA involvement by 60% of those participants who were active. Also, environmental cues, such as availability of facilities was referred to as a cue to PA involvement by 20% of the active participants. This emphasises the importance of overcoming these barriers can aid in promoting PA (Beighle & Morrow, 2014).

A recent study of 1019 undergraduate students aged 18-21years in one public college in Australia and one private university in Malaysia examined PA participation and barriers using the Overcoming Barriers to Being Active Inventory (Wee Eng, Aumand, Ler Hui, & Chan Kai, 2013). Interestingly, lack of time was ranked 5th out of seven

subscales in the Inventory as being the main barrier to being active, whereas fear of injury, lack of skill, and social influence were ranked as the top three barriers to activity for both third level institutions. There was also no significant differences ($p>0.05$) between males and females in the results. This suggests that for younger people, psychological factors may play a greater role in PA participation (Higgins, Middleton, Winner, & Janelle, 2014; Robbins, Pender, & Kazanis, 2003).

Elements of the Guidelines Which Impact Physical Activity Participation

As previously mentioned, PA guidelines recommend levels of PA for health benefits in terms of frequency, intensity, duration and type of activity (ACSM, 2011). Type of exercise has been observed to impact participation (Parfitt, & Gledhill, 2004). A study of 26 recreationally active adults aged 33.2±6.0years examined positive and negative affect using the Positive and Negative Affect Scale in three conditions (Daley, & Maynard, 2003). Participants completed three conditions of 30minutes duration, one sitting watching a television programme as a control, one cycling at 75-80% HRmax and another exercising at 75-80% HRmax on their choice of either cycle, rower, stair-climb, ski or treadmill ergometers. At 15minutes into each session, positive affect was significantly lower ($p=0.01$) for no-choice cycling (2.6±0.96) than choice of activity (2.89±0.90) and watching television (2.92±0.72). The same significant ($p=0.01$) pattern emerged 5minutes post each session (No-choice cycling: 2.59±1.0, Choice of activity: 3.00±1.03, Watching television: 3.06±0.82). Negative affect was observed to be significantly higher ($p=0.05$) for no-choice cycling (1.970.91) than choice of activity (1.45±0.74) or watching television (1.40±0.65). Once again a similar significant ($p=0.01$) pattern emerged 5minutes post each session (No-choice cycling: 2.23±1.16, Choice of activity: 1.64±1.00, Watching television: 1.55±0.73). Therefore it can be seen how preference of type of exercise can impact upon an individual's perception of exercise and subsequently affect participation in PA (Daley, & Maynard, 2003).

A meta-analysis of 27 RCT by Rhodes, Warburton, and Murray, (2009), concluded that type of exercise had a trivial effect (d=0.1) on exercise adherence. Exercise intensity was found to have a trivial effect (d=0.02) on exercise adherence. This was found to be in favour of vigorous intensity over moderate intensity. Although, the authors explain that although the effect of exercise intensity was found to be trivial, often within studies analysed, mixed modes of exercise were used, such as jogging versus walking, or the intensity in some cases was light (50% $\dot{V}O_2max$) or a very high intensity (>80% HR Reserve) and therefore could skew their findings. The authors conclude that psychological factors may contribute to a greater extent to exercise and PA participation and adherence and thus these should be considered when using PA as a form of health promotion (Rhodes, Warburton, & Murray, 2009).

Physical Activity and Enjoyment

Enjoyment of PA may be an important psychological factor in PA participation (Currie, 2012; Trost, Owen, Bauman, Sallis, & Brown, 2002). A study of 1387 youth aged 15.1years examined competitive sports participation and dropout. The participants were asked to score their reasons for dropout from sport from a list of 12 reasons on a 7-point scale. It was observed that there were four levels of participation; samplers who spent less than 1 year in a sport, low level competitors who participated for more than one year with a low frequency of participation, high level competitors who participated at a high frequency for over one year, and elite participants who competed at a provincial or national level. The main reason ranked the highest for drop out was "Lack of Enjoyment" with a score of 3.65±2.5. This received highest score from both males with a score of 3.71 and females with a score of 3.61 which were not significantly different ($p>0.05$). Samplers also ranked "Lack of Enjoyment" as the main reason for dropout with a score of 3.9, which was significantly higher ($p<0.01$) than the score given to this by the elite group, ranking it 6th reason for dropout with a score of 2.7. This demonstrates how enjoyment can impact upon participation in sports in youth, which may signify participation in PA as an adult.

A study by Russel and Limle (2013), examined the relationship between sports involvement in youth and participation in sports and PA in young adulthood. Data relating to youth sports experience was collected from 71males aged 20.07±1.29years and 82females aged 19.57±1.32years through a 17 item 5-point scale which examined participants' perceptions of youth sport experience with statements relating to risks and benefits of sport, and reasons for participation and withdrawal. Enjoyment of PA in adulthood was measured via the Physical Activity Enjoyment Scale (PACES). It was observed that 56.9% of the participants specialised in one specific sport in youth,

though an independent t-test revealed this was not significantly linked ($t=0.496$, $p>0.05$) to enjoyment of PA in adulthood. However, participants total score of the 17 item youth sport experience perception scale was a significant predictor ($p<0.001$) of PA enjoyment in young adulthood. This suggests that a positive perception of sport and PA in youth increases the likelihood of enjoyment of PA in adulthood and therefore potentially increase participation.

A study by Huberty et al. (2008) examined the reasons for maintaining or ceasing activity after involvement in a PA promotion programme in women. A sample of 19 women aged 46±12.7years who had participated in the U Try Active Habits and Fitness programme for staff of the University of Utah in the three years prior to the study, completed the Modifiable Activity Questionnaire which measure PA level over the previous week, year and further. From this, those who achieved the weekly level of PA recommended by the ACSM for one year or more were classified as adherers and those who did not achieve this were classified as non-adherers. Focus groups were subsequently formed to gather qualitative data pertaining to reasons for maintaining or for not adhering to the programme. The authors found that one of the main reasons given by adherers for maintaining PA was "enjoyment". Strengthening the consideration that enjoyment plays a role in PA participation is that the non-adherers also gave "lack of enjoyment" as a reason for not participating in PA. This demonstrates that enjoyment is an important factor in participation in PA for women. The authors suggest that improving feelings of enjoyment and could positively impact on PA participation.

Exercise Intensity and Enjoyment

A study of nine overweight boys aged 10.7±2.9years and nine normal weight boys aged 10.1±1.8years assessed enjoyment levels when performing MCT or HIIT (Crisp,

Fournier, Licari, Braham, & Guelfi, 2012a). The participants completed 3 sessions on a cycle ergometer, each separated by 5days. The first session was a GXT and the two following sessions were both 30minutes duration, one of which at a moderate intensity, defined as the intensity at which fat oxidation was optimised as evident from the GXT. The other session involved repetitions of 2minutes at this moderate intensity followed by a 4second maximal sprints also for 30minutes. The sessions were performed in a randomised counterbalanced order to account for a possible order affect. Enjoyment was measured via the PACES scale which was administered within two minutes of completion of the exercise sessions. All normal weight participants reported a preference for the HIIT session, despite this the difference in PACES score was not significantly different. ($p=0.174$). All bar two of the overweight participants reported preferring the HIIT session but this was also not found to be significant ($p=0.964$). Although significant differences were not observed, the trend towards a preference for HIIT in this study warrant further investigation into enjoyment of HIIT versus MCT.

A similar study of 11 overweight boys aged 11.1±1.3years by the same authors compared MCT and three HIIT protocols of different interval frequency (Crisp, Fournier, Licari, Braham, & Guelfi, 2012b). Participants completed the GXT and 30minute MCT exercise as in the aforementioned study with moderate intensity classified also as the intensity at which fat oxidation is optimised, stated as being 52±7% of $\dot{V}O_2peak$. The HIIT sessions were also 30minutes duration, one interspersed with 4second maximal sprints every 2minutes, one with sprints every minute and one with sprints every 30seconds with the sessions performed in a randomised counter-balanced order. PACES scores, although only shown in figure format, were not significantly different ($p>0.05$) between the MCT, 2minute interval,

and 1minute interval sessions. However, PACES for the 30second interval session was found to be significantly lower than the MCT session (p=0.0.38) and the 2minute interval session (p=0.009), and approach being significantly lower (p=0.052) than the 1minute interval session. When asked to rank the best of the sessions, the participants rated the 2minute and 1minute sessions significantly better (p=0.035) than the other sessions. This suggests the frequency of intervals in a HIIT session can impact on enjoyment, while the rating of the best session by the participants suggests HIIT is more likely to be of preference than MCT.

However, these studies have a young sample and the results may be different for adults (Crisp, Fournier, Licari, Braham, & Guelfi, 2012a). A study of 15males aged 24±4years compared psychological responses to HIIT and MCT (Oliveira, Slama, Deslandes, Furtado, & Santos, 2013). Participants completed three sessions, one GXT on a treadmill ergometer and two exercise conditions. These were performed in random order, one MCT set at 85% of the Respiratory Compensation Point (RCP), with an average duration of 23.9±3.2minutes and one HIIT which involved intervals performed at 100% $\dot{V}O_2max$ for 2minutes with rest at 0% intensity, with a varying number of intervals per participant. No significant difference (p=0.779) was found between PACES score for MCT (96.2±16.7) or HIIT (97.8±17.3). In spite of this, there are many flaws evident in this study, such as the different number of intervals performed, different durations of sessions for each participant and that the PACES scale was administered 10minutes after the exercise sessions had been completed. This reduces the strength of the findings of the study in this regard as there is a lack of consistency both the conditions that is being assessed (Thomas, Nelson & Silverman, 2010).

A study of 8 males aged 25±5years comparing enjoyment of MCT and HIIT had more consistency (Bartlett et al. 2011). Participants completed an incremental $\dot{V}O_2$max test on a treadmill along with a running economy exercise test to more accurately set the running velocities of participants in the subsequent conditions. Participants completed two exercise sessions, one MCT and one HIIT in random order, both of 50minutes duration. The intensity of the MCT session was set at 70% $\dot{V}O_2$max. The HIIT session consisted of a 7minute warm-up and 7minute cool-down both at 70% $\dot{V}O_2$max. Six intervals were performed in the HIIT session consisting of 3minutes high intensity activity at 90% $\dot{V}O_2$max interspersed with 3minutes of active recovery at 50% $\dot{V}O_2$max. This resulted in the sessions having being of equal average intensity, duration, and not being significantly different (p=0.383) in regards total EE (MCT: 832+136kcal, HIIT: 811+83kcal). The HIIT protocol was found to result in a significantly greater (p=0.004) PACES score than the MCT (HIIT: 88+6, MCT: 61+12). The authors conclude that interval running may provide a low-cost means of increasing PA participation which needs minimal equipment where enjoyment could lead to greater rates of exercise adherence (Bartlett et al. 2011).

Conclusion

There is a strong body of evidence to show that PA and fitness level positively impact upon health (Gill, Celis -Morales & Ghouri, 2014; Richard, Martin, Wanner, Eichholzer & Rohrmann, 2015). The impact of PA and exercise on women's health is also strongly documented such as the findings that PA can reduce the risk of breast cancer and ovarian cancer (Moorman, Jones, Akushevich, & Schildkraut, 2011; Xi et al. 2014). From the data found in the CSO and NCRI it is clear that the rates of these forms of cancer are increasing in Irish women (CSO, 2015; NCRI, 2015). Given the evidence from SLAN that 31% of Irish women perform only a low level of weekly PA, it is clear that promoting PA to Irish women is important (Loprinzi, & Lee, 2014; Morgan et al. 2009).

The PA guidelines for Ireland and the ACSM exercise recommendations provide a model from which to design health promoting PA programmes (ACSM, 2011; Department of Health and Children, & Health Service Executive, 2009). Both MCT and HIIT have been observed to elicit health benefits (Tjønna et al. 2009). Intensity of exercise can be measured by both physiological and perceptual means (Coquart et al. 2012). The perceptual measure of RPE has been found to be a valid and reliable method of regulating exercise intensity (Morris, Lamb, Hayton, Cotterrel, & Buckley, 2010). Despite PA being important for health and well-being number of barriers are often reported by individuals which prevent them from partaking in regular PA such as lack of time and facilities (Cramp & Bray, 2011). Components of the PA guidelines such as type of activity and exercise intensity have been found to impact upon PA participation (Rhodes, Warburton, & Murray, 2009). Performing exercise on a preferred ergometer or type of activity has been observed to result in positive

psychological responses, therefore psychological factors such as perception of exercise play an important role in partaking in PA (Daley, & Maynard, 2003).

Enjoyment of activity is an important factor in partaking in PA (Sallis, & Brown, 2002). This has been seen to be especially important for women with "enjoyment" reported as a reason for adhering to PA health promotion programmes and "lack of enjoyment" reported as a reason for not maintaining activity (Huberty et al. 2008). This emphasises the importance for considering enjoyment when designing PA health promotion strategies (Trost, Owen, Bauman, Sallis, & Brown, 2002). Exercise intensity has been observed to impact upon enjoyment, with HIIT being preferred over MCT, however some studies have a very young sample (Crisp, Fournier, Licari, Braham, & Guelfi, 2012a; Crisp, Fournier, Licari, Braham, & Guelfi, 2012b). Although the findings of Oliveira, Slama, Deslandes, Furtado, and Santos, (2013) suggest that adult males find neither MCT nor HIIT more enjoyable than the other, the study conducted by Bartlett et al. (2011) had a better design with stronger controls. Bartlett findings provide a strong sign that HIIT is found more enjoyable than MCT but as the other studies, only males are used as a sample.

Given that a considerable amount of Irish women only achieve a low level of weekly PA and chronic illness is increasing, using a similar design to that used by Bartlett et al. (2011), utilising Irish women as a sample could aid to determine whether MCT or HIIT is found more enjoyable by women, and thus aid in designing effect PA based health promotion programmes while also filling a gap in the literature by using females a sample (Morgan et al. 2009).

Hypothesis

H_1	High intensity interval exercise will result in higher levels of enjoyment than continuous moderate intensity exercise in Irish women.
H_2	High intensity interval exercise will be perceived as being of a higher intensity than continuous moderate intensity exercise by Irish women.

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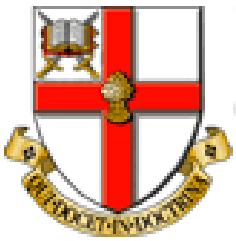

University of Chester

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MSc, Diploma, Certificate
In
Exercise & Nutrition Science – Dublin

Research Study

Enjoyment Levels of Irish Women Performing Continuous Moderate Intensity Exercise Versus High Intensity Interval Exercise

Word Count: 3987

Proposed Journal: The American Journal of Health Promotion

The American Journal of Health Promotion publishes projects focused on methods of facilitating people discover ways of living healthier lifestyles (Instructions to Authors American Journal of Health Promotion, 2015). Published projects centre on enabling, and supporting positive behavioural change; and on developing effective interventions and strategies at individual, community, and governmental levels so that individuals can attain optimal health. The focus of this project is to aid in developing effective intervention strategies for promoting health through physical activity. By determining which of the two forms of intensity of exercise examined is more enjoyable, this can aid in improving exercise adoption and adherence, thus making positive health an easier choice.

Abstract

Purpose: Although PA is important for optimal health, 31% of Irish women attain only a low level of weekly PA. Exercise can be performed in the form of HIIT or MCT. Enjoyment impacts upon exercise adherence. Determining whether HIIT or MCT is perceived as more enjoyable can help develop effective PA-based health promotion programmes.

Design: Repeated-Measures

Setting: Participants were recruited from members of Oak Gym, Dundalk, Ireland.

Participants: 10 recreationally active females (age 28.7±3.47years)

Intervention: One MCT and one HIIT trial were performed on a treadmill. Both were 50minutes and isoenergetic. MCT was at 70% $\dot{V}o_2max$. HIIT involved a 7minute warm-up and cool-down at 70% $\dot{V}o_2max$ and six 3minute bouts at 90% $\dot{V}o_2max$ interspersed with 3minute periods of active recovery at 50% $\dot{V}o_2max$.

Measures: Perceived Exertion was measured using the 6-20 RPE scale. Enjoyment was measured using the Physical Activity Enjoyment Scale (PACES).

Analysis: A paired t-test was used to analyse PACES and average HR. A fully repeated measures ANOVA analysed RPE. Average RPE was analysed using a Wilcoxon Signed Rank Test.

Results: HIIT was found to be significantly more enjoyable than MCT (118.4±5.17 vs 93.5±9.58). A significant interaction and effect of time were found for RPE but no significant effect of trial. Average RPE was significantly higher for MCT than HIIT (Median=11, Range=6-13 vs Median=10, Range=7-12). There was no significant difference between average HR values.

Conclusion: Although of a similar physiological intensity, HIIT was perceived as being of a lower intensity and found to be more enjoyable than MCT.

Introduction

A reduced risk of a range of chronic non–communicable illnesses is widely recognised as being associated with Physical Activity (PA) and exercise (Chien, Chen, Hsu, Su, & Lee, 2009; Hallal et al. 2012). Promoting PA to women is particularly important as low levels of regular PA have been linked to increased risk of both breast and ovarian cancer (Loprinzi & Lee, 2014; Moorman, Jones, Akushevich, & Schildkraut, 2011). In Ireland, the number of newly diagnosed breast cancer cases rose from 2740 in 2009 to 2860 in 2012, and from 297 in 2009 to 376 in 2012 new cases of ovarian cancer (Central Sataistics Office, 2015; National Cancer Registry, 2015). In Ireland, 31% of women achieve only a low level of weekly PA (Morgan et al. 2008). Exercise guidelines outline how health can be promoted through PA in the form of Moderate Continuous Exercise (MCT) or High Intensity Interval Training (HIIT) (ACSM, 2011; Department of Health and Children, & Health Service Executive, 2009). Type and intensity of exercise have been observed to impact upon exercise adherence (Rhodes, Warburton, & Murray, 2009).

It has also been observed that perception of PA impacts upon adherence, with a positive perception increasing adherence (Daley & Maynard, 2003; Russel & Limle, 2013). Enjoyment has been observed to influence PA participation (Currie, 2012). A study of 19 women aged 46±12.7years examined reasons for adhering to or dropping out of a PA based health promotion programme (Huberty et al. 2008). Using focus groups, it was discovered that “enjoyment” was reported as a reason for adhering to the programme and “lack of enjoyment” was reported as a reason for dropout.

Bartlett et al. (2011) conducted a study to determine whether MCT or HIIT was found more enjoyable by a group of 8 recreationally active males aged 25±5years. The participants completed two trials of equal duration, average intensity and energy

expenditure (EE). The participants found the HIIT trial significantly more enjoyable ($p<0.05$) than the MCT trial (HIIT; 88±6, MCT: 61±12). A similar study by Oliveira, Slama, Deslandes, Furtado, and Santos (2013) did not find significant differences in enjoyment however this was not measured until 10minutes after completing exercise, potentially skewing the findings.

The aim of the present study is to use a similar design to Bartlett et al. (2011) using women as a sample to fill a gap in the research by determining whether MCT or HIIT is found more enjoyable by Irish women which has relevance to developing effective PA based health promotion programmes aimed at Irish women.

Hypothesis

H_1	High intensity interval exercise will result in higher levels of enjoyment than continuous moderate intensity exercise in Irish women.
H_2	High intensity interval exercise will be perceived as being of a higher intensity than continuous moderate intensity exercise by Irish women.

Materials and Methods

Design

A repeated measures design was employed with all participants completing a familiarisation of a submaximal exercise test, the exercise test and two exercise trials. Participants completed the trials in a random counter-balanced order to reduce the possibility of an order affect. The independent variable was exercise intensity, being either MCT or HIIT, and the dependant variables were enjoyment and RPE. Participants completed a Chester Step Test (CST) in the first session as a familiarisation and repeated the procedure in the second session 2-3days later (30cm Chester Step Test Kit, Cartwright Fitness Ltd, UK). The third and fourth sessions were either HIIT or MCT performed in a random counter-balanced order. The third session was performed 5-7days after second and the fourth session 4weeks after the third. The 4week interlude between these sessions was to ensure each was performed at the same stage of the menstrual cycle as this can affect psychological parameters such as those being measured (Natale & Albertazzi, 2006).

Participants/Sample

Eleven healthy, recreationally active females aged 18-35 who had partaken in aerobic PA at least three days weekly for six months prior to the study were recruited from Oak Gym Jocelyn Street, Dundalk, Co Louth, Ireland. Participants were provided with an information leaflet outlining the study which can be found in **Appendix 1**. Participants gave informed consent, a copy of which is found in **Appendix 2**, and were provided with a copy for their own records and subsequently completed a health screening form which can be found in **Appendix 3** prior to participating in the study. One participant chose not to participate in the study after the familiarisation session, thus ten participants completed the study.

Materials/Apparatus

Heart Rate (HR) was measured using a Polar FT1 monitor during the familiarisation, testing and exercise trials (Polar FT1, Polar Electro, Finland). Perceived exertion was measured using the 6-20 RPE scale during these sessions (Borg, 1973).

Enjoyment was measured using the Physical Activity Enjoyment Scale (PACES) (Kendzierski, & DeCarlo, 1991). This has been found to be both a valid and reliable means of measuring enjoyment of PA (Motl et al. 2001). A copy of the version of this which was given to participants is found in **Appendix 4**.

The exercise trials were all performed on the same Precor C966i motorized treadmill in Oak Gym Jocelyn Street, Dundalk, Co Louth, Ireland (Precor, C966i, Precor, USA).

Ethical Considerations

Ethical approval to conduct the study was gained from the University of Chester, Faculty of Life Sciences Research Ethics Committee prior to beginning the project. A copy of this confirmation can be found in **Appendix 5**. All participants gave informed consent, found in **Appendix 2**, after reading an information leaflet which outlined the details of the study, found in **Appendix 1**. Participants' anonymity and confidentiality was maintained by allocation of random codes and were given right of withdrawal. Participants completed a health screening form prior to participating in the study, found in **Appendix 3**, and were considered ineligible if they had not partaken in aerobic PA at least three days weekly for six months prior to the study, were pregnant, or had an illness or injury that could be aggravated by participating in PA. All testing and exercise trials were performed in Oak Gym, Jocylen Street, Dundalk, Co Louth, Ireland, confirmation of permission for this is found in **Appendix 6**.

Procedure

Chester Step Test

All tests and trials were performed after an overnight fast with participants refraining from alcohol, caffeine and other forms of exercise 24hours before each session. In order to determine aerobic capacity ($\dot{V}O_2max$), all participants performed a submaximal exercise test in the form of the CST which is considered valid and reliable (Sykes & Roberts, 2004). The test involves stepping onto and off of a 30cm step to the rhythm of a metronome, the speed of which increasing every 2minutes. HR was measured each minute during the test using a Polar FT1 monitor and RPE was also recorded each minute using the Borg Scale. Termination criteria for the test were reporting an RPE of 15, achieving 80% HRmax or inability to maintain pace due to fatigue (Sykes & Roberts, 2004). From the results of the test, $\dot{V}O_2max$ was calculated using CST analysis software. Participants completed a familiarisation of the CST during the first session, and repeated the CST 2-3days later, the result of the second CST was used for subsequent calculations. The familiarisation was performed as this has been observed to improve validity and reliability if the results (Buckley, Sim, Eston, Hession & Fox, 2004). Both the familiarisation and second CST sessions were performed in a private room in the facility to ensure the metronome could be heard clearly and to avoid distraction of the participant.

Moderate Continuous Intensity Trial

The MCT trial was performed on a treadmill ergometer at 70% $\dot{V}O_2max$ for 50minutes duration. The appropriate speed was calculated using the results of the CST and the ACSM metabolic equations (Buckley, Sim, Eston, Hession & Fox, 2004; Thompson, Gordon, & Pescatello, 2010). In order to do this the incline of the treadmill was set to1.5% as it also closely replicates the energy cost of outdoor running (Jones, & Doust,

1996). RPE and HR were measured every 5minutes during the trial. The PACES scale was administered within 2minutes of completing the trial.

High Intensity Interval Trial

The HIIT trial was performed on the same ergometer and was also of 50minutes duration. This consisted of a 7minute warm-up at 70% $\dot{V}O_2$max with six high intensity bouts performed at 90% $\dot{V}O_2$max for 3minutes interspersed with six bouts of active recovery at 50% $\dot{V}O_2$max for 3minutes before a 7minute cool down at 70% $\dot{V}O_2$max. The appropriate speeds were calculated using the results of the CST and the ACSM metabolic equations (Buckley, Sim, Eston, Hession & Fox, 2004; Thompson, Gordon, & Pescatello, 2010). In order to do this the incline of the treadmill was set to1.5% as it also closely replicates the energy cost of outdoor running (Jones, & Doust, 1996). RPE and HR were measured every 5minutes during the trial. This ensured both sessions were isoenergetic, and of equal duration and average intensity. The PACES scale was administered within 2minutes of completing the trial.

Statistical Analysis

Data was analysed using Statistical Package for Social Sciences (SPSS) version 21 for Windows. All data was analysed for normality using the Shaprio-Wilks test. A fully repeated measures ANOVA was performed to analyse the overall effect of each trial and time on RPE. This data did not meet the assumption of normal distribution. In spite of this the fully repeated ANOVA was performed as the test is considered robust enough to withstand violations of this assumption (Pallant, 2010). A paired t-test was performed to analyse differences in PACES scores and between average HR values for each session. A Wilcoxon Signed Rank Test was performed to compare differences between average RPE values between each trial. Significance was accepted at the value of $p \leq 0.05$. These statistical tests were selected as they follow the same method

of analysis for HR, RPE and PACES as those performed by Barlet et al. (2011). Data is shown in Mean and Standard Deviation unless otherwise stated. Relevant output from the SPSS analysis can be found in Appendix 7.

Results

The participants were aged 28.7±3.47years with a BMI of 23.0±2.27kg.m^{-2}. A summary of characteristics of the participants can be found in **Table 1**.

Table 1. Participant Characteristics

Characteristic	Mean (SD)
Age (years)	28.7 (3.47)
BMI (kg.m^{-2})	23.0 (2.27)
$\dot{V}O_2$max (ml.kg^{-1}.min^{-1})	40.8 (4.64)
50% $\dot{V}O_2$max (ml.kg^{-1}.min^{-1})	20.4 (2.32)
70% $\dot{V}O_2$max (ml.kg^{-1}.min^{-1})	28.6 (3.25)
90% $\dot{V}O_2$max (ml.kg^{-1}.min^{-1})	36.7 (4.17)
Speed at 50% $\dot{V}O_2$max (km.hr^{-1})	5.1 (0.69)
Speed at 70% $\dot{V}O_2$max (km.hr^{-1})	7.5 (0.96)
Speed at 90% $\dot{V}O_2$max (km.hr^{-1})	9.91 (1.24)
HR of MCT Session (beats.min^{-1})	141 (17)
HR of HIIT Session (beats.min^{-1})	148 (7)
EE of MCT Session (kcal)	419.8 (89.14)
EE of HIIT Session (kcal)	419.8 (89.14)

Values are Mean and SD

Enjoyment

The paired t-test revealed that enjoyment score was significantly higher ($p<0.005$) for the HIIT trial (118.4±5.17) than the MCT trial (93.5±9.58). This can be observed in **Figure 1**.

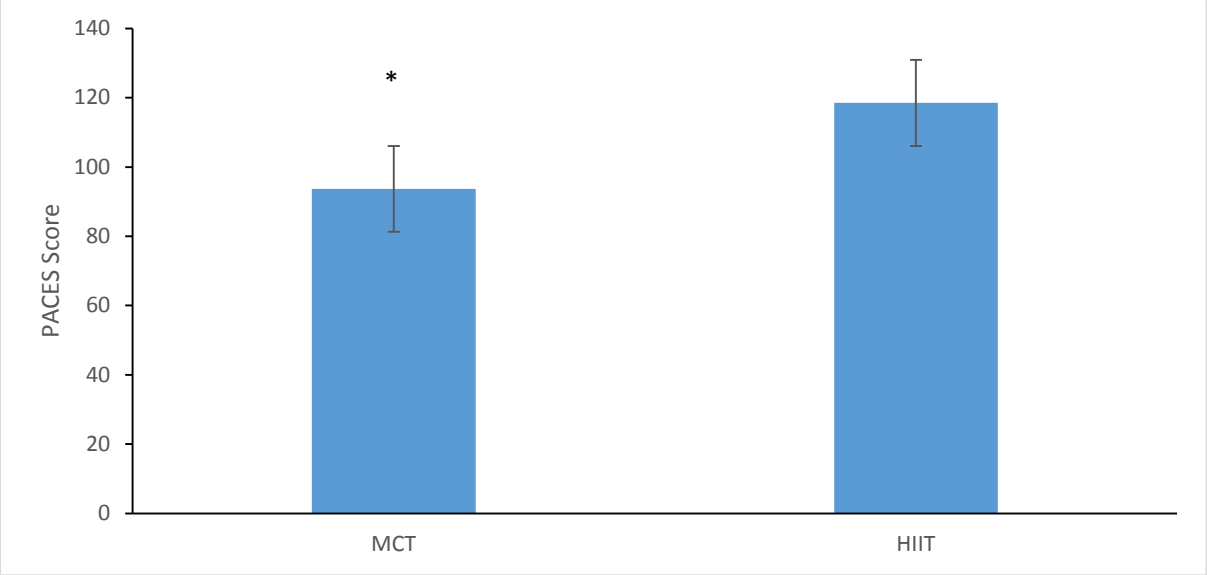

Figure 1. Enjoyment Scores HIIT versus MCT.*Significantly different from HIIT trial (p<0.005)

Rating of Perceived Exertion

The RPE values across each trial can be observed in **Figure 2**. The fully repeated measures ANOVA revealed no significant main effect for exercise trial (p=0.064). A significant interaction (p<0.005) and main effect of time (p<0.005) were observed.

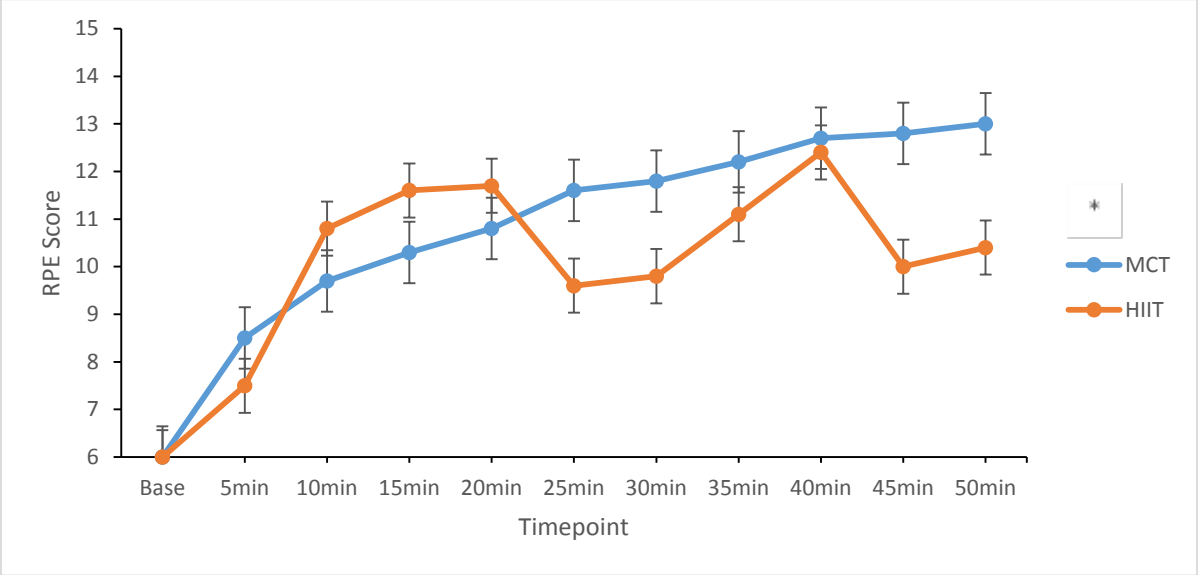

Figure 2. RPE Scores across HIIT and MCT Trials. * Significant interaction and main effect of time.

The Wilcoxon Signed Rank test revealed that average RPE scores were significantly higher (p=0.046) for the MCT trial (Median=11, Range=6-13) than the HIIT trial (Median=10, Range=7-12). This can be observed in **Figure 3**.

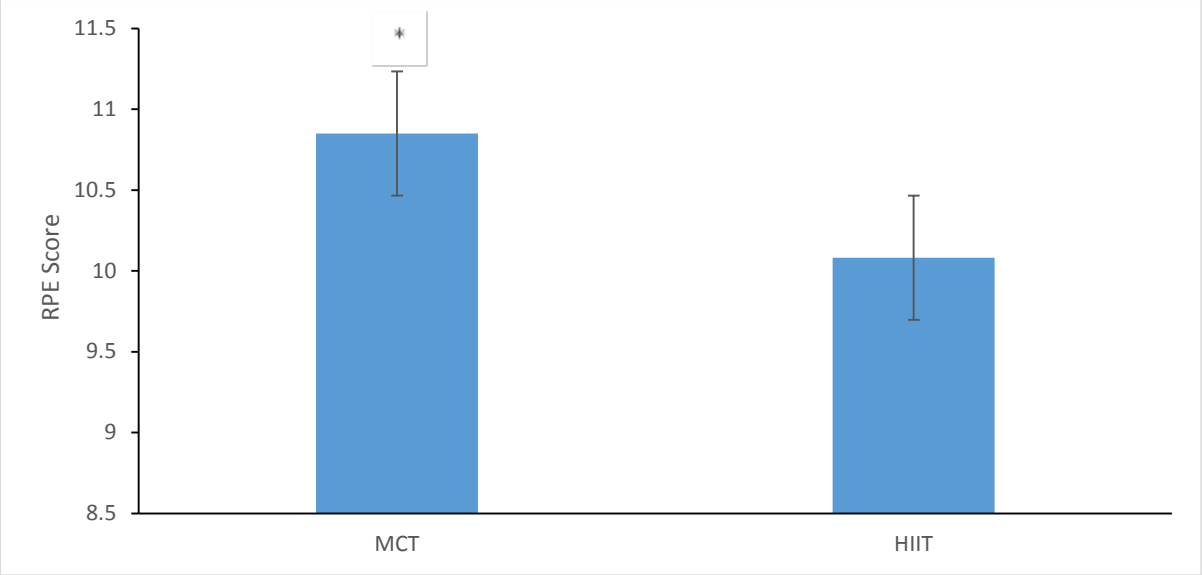

Figure 3. Average RPE Scores for MCT and HIIT Trials. *Significantly different from HIIT trial (p=0.046)

Heart Rate

The paired t-test revealed no significant difference (p=0.156) between average HR measurements between the MCT trial (141±17beats.min^{-1}) and the HIIT trial (148±7beats.min^{-1}).

Discussion

Following as similar a method as feasibly possible as that used by Bartlett et al. (2011) makes the findings of the present study comparable to the findings of Bartlett et al. (2011) with the main difference of gender recruited as a sample.

Enjoyment

The first hypothesis is supported as enjoyment was observed to be significantly higher following the HIIT trial than the MCT trial. This concurs with the previous findings of Bartlett et al. (2011) for recreationally active males. The participants of the present study were considered to be recreationally active as the mean $\dot{V}O_2max$ was 40.8±4.64ml.kg^{-1}.min^{-1}. This suggests that recreationally active females find HIIT more enjoyable to MCT. What is of interest in the data, is that the extent to which the scores differ between HIIT and MCT for females is greater than that observed in the study by Bartlett et al. (2011) for males. In the present study, the participants reported a score of 118.4±5.17 for the HIIT trial and a score of 93.5±9.58 for the MCT trial. In the study by Bartlet et al. (2011), the participants report a score of 88±6 for the HIIT trial and a score of 61±12 for the MCT trial. The scores in the present study are distinctly higher for both trials than that of Bartlet et al. (2011). This may due to the participants in the present study being female, however it is possible that this difference may be due to the mode of exercise being of greater preference for the present sample (Daley & Maynard, 2003). As previously mentioned, exercise mode can impact upon perception of exercise and a preferred exercise mode generates a greater positive affect which may account for the higher enjoyment scores reported by the participants in the present study (Daley & Maynard, 2003). In spite of this variance, the findings of the present study support those of Bartlett et al. (2011). Although the findings of the present study counter those of Oliveira, Slama, Deslandes, Furtado,

and Santos (2013) in regards enjoyment of HIIT versus MCT, a number of flaws were noted in the study. Therefore as they support those of Bartlett et al. (2011), it can be considered that HIIT is found to be more enjoyable than MCT in recreationally active women.

Rating of Perceived Exertion

Although the significant main effect of time observed for RPE values supports the previous findings of Bartlett et al. (2011), the second hypothesis is rejected as the MCT trial was perceived as being of a higher intensity than the HIIT trial via the Wilcoxon Signed Rank test analysis, and no significant difference between the trials observed via the fully repeated measures ANOVA. This is opposes the findings of Bartlett et al. (2011). A potential cause for this disagreement in the findings may be due to the timing of the measurements. In the study by Bartlett et al. (2011), HR was measured continuously and RPE was measured every minute during each trial and the average for each 5minute stage calculated. In the present study, the HR and RPE measurements were taken at 5minute interims as an alternative as it was considered such regular interaction with the participants could be a cause of distraction and affect the measurements (Zwarun, & Hall, 2014). This is a potential flaw in the study design. However it is also clear when the data is examined that the time-point at which the measurements were taken during the HIIT trial had the greatest impact. The higher RPE values which were reported were generally recorded during the high intensity phase of the intervals, and the lower RPE values recorded during periods of active recovery. This would account for the significant interaction found in the analysis. In spite of this, the participants reported finding the MCT session to be more strenuous than the HIIT session during informal discussions after the trials, which supports the results of the analysis. Despite this contradicting the findings of Bartlett et al. (2011), it is in support of previous findings of a study by Coquart et al. (2008) using 10 obese

females aged 51.2±6.5years as a sample. The participants completed two trials, one MCT at 100% of the Ventilatory Threshold (VT), and one HIIT alternating between 2minutes at 80% VT and 2minutes at 120% VT both being of 32minutes duration (Coquart et al. 2008). Participants reported a significantly lower ($p<0.05$) RPE for the HIIT trial (11.9±1.1) than the MCT trial (13.2±1.6). Therefore the findings of the present study support that of previous research using females as a sample. This suggests that perception of PA may be a more important factor in PA participation for females than males (Cramp, & Barry, 2011).

What is also interesting to note is that the HIIT trial was enjoyed more by the participants and perceived as a lower intensity. Although this is contrary to the findings of Bartlett et al. (2011), it may provide a rationale as to why the MCT trial was perceived as a higher intensity than the HIIT trial. One of the findings by of Russel and Limle (2013) was that if an individual had a positive perception of PA, enjoyment of PA was also higher. Perceived competence has also been observed to significantly ($p<0.05$) affect enjoyment of PA (Puente, & Anshel, 2010). This study of 238adults aged 20.4±2.16years also found that perceived competence significantly affected ($p<0.05$) enjoyment and exercise frequency. Therefore, the participants' lower enjoyment score for the MCT trial in the present study may be due a lack of feeling competent to carry out the activity and thus lead to it the perception of it being of a higher intensity. This is important to consider when designing PA programmes for health promotion for this population (Loprinzi, & Lee, 2014).

Heart Rate

The findings of the present study that HR was not significantly different between the trials supports those of Bartlett et al. (2011). This confirms that although the speeds for the intensities for the exercise trials were determined calculated using metabolic

calculations instead of the economy of effort test, the trials were of a similar average intensity (Thompson, Gordon, & Pescatello, 2010). This also supports the findings of Coquart et al. (2008) where no significant difference ($p>0.05$) was observed for average HR between the MCT (110±13beats.min^{-1}) and HIIT (108±16beats.min^{-1}) trials, and further highlights the important role the perception of exercise and PA when designing PA programmes. Although the characteristics of the sample used by Coquart et al. (2008) differ from the participants of the present study, these findings demonstrate that this is also the case for normal weight recreationally active females.

Limitations

The sample size of the study can be considered as being too small given that the data violated the test of normality for the fully repeated measures ANOVA and can therefore be considered as a limitation to the interpretation of the findings (Pallant, 2010). This subsequently weakens the findings of the study in relation to RPE.

The present study used the CST as a means of estimating $\dot{V}O_2max$ which is considered to be valid and reliable. Although not feasible in the present study, the use of a maximal Graded Exercise Test (GXT) may have elicited slightly different results for participants and thus had an impact on subsequent calculations (Thomas, Nelson, & Silverman, 2010).

Unlike Bartlett et al. (2011), it was not possible to conduct an economy of effort test to ensure the speeds for the corresponding intensities of exercise were as accurate as possible. Also the study by Bartlet et al. (2011) used a metabolic cart to monitor overall EE during both trials, which was also not possible in the present study. The metabolic equations outlined by the ACSM were used as an alternative to both of these (Thompson, Gordon, & Pescatello, 2010). Although the MCT trial in the study by Bartlett et al. (2011) was observed to result in greater overall EE (832+136kcal) than the HIIT trial (811+83kcal), this was not observed to be significantly different ($p>0.05$). In spite of this, the use of the equations to calculate the speeds for the intensities in the trials and the lack of monitoring of overall EE in the present study limits the accuracy of the findings.

Music and Perceived Exertion

Unlike the familiarisation and CST which were conducted in a separate private room, the exercise trials were conducted on the gym floor of the facility in which they were performed. As a result of this, the background music being played throughout the

facility was clearly audible throughout all exercise trials. This can have a considerable impact on the findings as music has been observed to have a motivational affect and impact on perceived exertion during exercise (Karageorghis, Terry, Lane, Bishop, & Priest, 2012). A review of literature by Karageorghis and Priest (2012) found that music reduced perceived exertion, increased energy efficiency and increased work output during endurance-type activities of a continuous moderate intensity. It was also observed that although also having an ergogenic affect during high intensity activities, this reduction in perceived exertion ceased at intensities above the anaerobic threshold.

A study by Mohammadzadeh, Tartibiyan, and Ahmadi (2008) examined the effect of music on RPE in 12 trained individuals aged 23.31±2.06years and 12 untrained individuals aged 22.96±2.31years. All participants completed two Bruce protocol GXT sessions, one listening to music, one without any music, in random order. The 0-10 Borg scale was used to measure perceived exertion. For all participants, RPE was significantly lower ($p<0.05$) in the music condition (Trained: 3.64±1.43, Untrained: 3.82±0.97) than the no music condition (Trained: 3.98±1.51, Untrained: 4.79±1.02). There was also a significant interaction ($p<0.05$) observed between fitness level and the effect of music on RPE with a larger effect observed in untrained participants. What is also important to note is that a significantly greater ($p<0.05$) exercise performance, measured via time to exhaustion was observed for all participants in the music condition (Trained: 13.40±0.75mins, Untrained: 11.23±0.25mins) compared to the no music condition (Trained: 13.25±0.89mins, Untrained: 10.94±0.36mins). This demonstrates the considerable impact of music on perceived exercise intensity and exercise performance. Therefore not controlling for this can be regarded as a limitation in the present study as it may have a considerable impact upon the findings particularly

in relation to RPE, which may have contributed to the violation of the assumption of normality for the fully repeated measures ANOVA.

Recommendations for Further Research

In future research, important factors to control for are music or background noise. Given the impact of music on psychological parameters such as RPE, this is particularly important to improve the quality of further research on this topic (Mohammadzadeh, Tartibiyan, & Ahmadi, 2008). This could be done in a number of different ways, such as by ensuring that no music is audible to the participants, or if this is not possible, ensuring the same music is audible to the participants in each trial. However, this may also become an issue in the interpretation of the findings as the type of music may not be preferred by the participants (Karageorghis, & Priest, 2012). Therefore allowing the participants to listen to their own self-selected music would reduce the risk of this if removal of background music is not a viable option.

Conducting the data collection in a laboratory setting would also be of benefit as this would allow for a maximal GXT to be carried out along with an economy of effort test. This would improve the accuracy when determining the speeds for corresponding intensities during the exercise trials while allowing HR and RPE to be recorded more regularly (Thomas, Nelson, & Silverman, 2010). A larger sample size would also reduce the potential for error when analysing the data.

The use of a qualitative design in future research may be beneficial. The study by Huberty et al. (2008) used a qualitative design with focus groups to shed light on specific reasons for adhering to or dropping out of a PA based health promotion programme. Using a qualitative design in this way could aid in understanding why participants report greater enjoyment for one trial over another. This could assist further in designing effective PA based health promotion programmes.

Conclusion

The findings of the present study support that of Barltett et al. (2011) and therefore conclude that HIIT is found to be more enjoyable the MCT by young recreationally active women. Although the findings of the present study disagree with those of Bartlett et al. (2011) in regards RPE, they add to those of Coquart et al. (2008) and thus can be concluded that young recreationally active women perceive HIIT to be of a lower intensity than MCT despite the two being of similar average intensity.

This information is relevant for the design of effective PA based health promotion programmes for this population as enjoyment of PA effects exercise adherence (Huberty et al. 2008). Utilizing HIIT in the form of running in PA based health promotion programmes is a both cost-effective means of overcoming the barriers of lack of facilities which also requires less frequency to achieve health benefits (ACSM, 2011). The results of the present study propose that high intensity interval running is also likely to be more enjoyable by young women and therefore lead to greater rates of exercise adherence and subsequently promote health (Loprinzi, & Lee, 2014).

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Appendix 1: Participant Information Leaflet

Participant information sheet

Enjoyment Levels of Irish Women Performing Moderate-Intensity Continuous Aerobic Exercise Versus High Intensity Interval Exercise

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 us 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?
This research is being undertaken on healthy women aged 25-35. The project is to find out if there is a difference in enjoyment levels between continuous moderate intensity exercise and high intensity interval exercise. Moderate intensity exercise will be set at 70% maximal capacity, and high intensity interval exercise will alternate between 90% and 50% maximal capacity.

These have been chosen as the aim is to use the findings to design effective exercise programmes which promote positive health in women. Enjoyment effects whether people take up and maintain exercise. Both moderate intensity and high intensity interval exercise are widely used to promote health as they lead to a number of health benefits. Determining which one of these is found to be more enjoyable can help to design exercise programmes which people are more likely to partake in and maintain.

Why have I been chosen?
You have been chosen because you are a healthy woman aged 25-35.

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 come to 4 sessions, all of which will be in Oak Gym, Roden Place, Dundalk, Co Louth. In the first session you will be asked to complete a sub-maximal exercise test involving stepping up onto and down off a step. This is for you to become familiar with the test being used. In the second session you will be asked to repeat this test. These will be 20 minutes in duration. In the third and fourth sessions you will be asked to run on a treadmill; one session at a constant moderate speed, and the other session alternating between high and low speeds. These will be 50 minutes in duration. You will be asked to complete a short questionnaire after the third and fourth sessions. No-one will be identifiable in the final report. The first and second sessions will be 2-3 days apart. The third session will be 5-7 days after the second session. The fourth session will take place 4 weeks after the third session.

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 be contributing to the development of health promotion interventions through exercise for women.

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 Life Sciences, University of Chester, Parkgate Road, Chester, CH1 4BJ, United Kingdom, +441244 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 report for the 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 a MSc in Exercise & Nutrition Science within the Department of Clinical Sciences and Nutrition at the University of Chester. The study is organised with supervision from the department, by Lawrence Torris, 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:

Lawrence Torris. 1324201@chester.ac.uk.

Thank you for your interest in this research.

Appendix 2: Informed Consent Record

University of Chester

Title of Project: Enjoyment Levels of Irish Women Performing Moderate-Intensity Continuous Aerobic Exercise Versus High Intensity Interval Exercise

Name of Researcher: Lawrence Torris

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 3: Health Screening Form

University of Chester

Pre-test Questionnaire

Enjoyment Levels of Irish Women Performing Moderate-Intensity Continuous Aerobic Exercise Versus High Intensity Interval Exercise

Researcher *:* *Lawrence Torris*

Name:_____ Test date:_____

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. If you have answered 'yes' to any of the above questions, unfortunately you will not be able to participate in this study.

Appendix 4: Physical Activity Enjoyment Scale

I enjoy it	1	2	3	4	5	6	7	I hate it
I feel bored	1	2	3	4	5	6	7	I feel Interested
I dislike it	1	2	3	4	5	6	7	I like it
I find it pleasurable	1	2	3	4	5	6	7	I don't find it pleasurable
I am very absorbed in this activity	1	2	3	4	5	6	7	I am not at all absorbed in this activity
It's no fun at all	1	2	3	4	5	6	7	It's a lot of fun
I find it energizing	1	2	3	4	5	6	7	I find it tiring
It makes me depressed	1	2	3	4	5	6	7	It makes me happy
It's very pleasant	1	2	3	4	5	6	7	It's very unpleasant
I feel good physically when doing it	1	2	3	4	5	6	7	I feel bad physically when doing it
It's very invigorating	1	2	3	4	5	6	7	It's not at all invigorating
I am very frustrated by it	1	2	3	4	5	6	7	I am not at all frustrated by it
It's very gratifying	1	2	3	4	5	6	7	It's not at all gratifying
It's very exhilarating	1	2	3	4	5	6	7	It's not at all exhilarating
It's not at all stimulating	1	2	3	4	5	6	7	It's very stimulating
It gives me a strong sense of accomplishment	1	2	3	4	5	6	7	It doesn't give me a strong sense of accomplishment
It's very refreshing	1	2	3	4	5	6	7	It's not at all refreshing
I felt as though I would rather be doing something else	1	2	3	4	5	6	7	I felt as though there is nothing else I would rather be doing

Appendix 5: Ethical Approval

Provisional Approval

Faculty of Life Sciences
Research Ethics Committee

frec@chester.ac.uk

Lawrence Torris
Dundalk
Co. Louth
Ireland

29th September 2014

Dear Lawrence,

Study title: **Enjoyment Levels of Irish Women Performing Moderate Intensity Continuous Aerobic Exercise versus High Intensity Interval Exercise.**
FREC reference: **972/14/LT/CSN**
Version number: **1**

Thank you for sending your application to the Faculty of Life 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. However, the Committee would like to request the following minor amendment:-

- On the Participant Information Sheet:-
  - Rephrase the first sentence of the third paragraph.
  - Include the expected duration time of the sessions.

Please forward an amended electronic copy to frec@chester.ac.uk

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

Document	Version	Date
Application Form	1	September 2014
Appendix 1 – List of References	1	September 2014

Appendix 2 – C.V. for Lead Researcher	1	September 2014
Appendix 3 – Participant Information Sheet	1	September 2014
Appendix 4 – Participant Consent Form	1	September 2014
Appendix 5 – Written Permission, Oak Gym, Co. Louth	1	September 2014
Appendix 6 – Validated PACES Scale	1	September 2014
Appendix 7 – Risk Assessment Form	1	September 2014
Appendix 8 – Health Screening Questionnaire	1	September 2014
Appendix 9 – Chester Step Test Protocol	1	September 2014
Appendix 10 – Continuous Moderate Intensity Exercise Trial	1	September 2014
Appendix 11 – High Intensity Interval Trial Protocol	1	September 2014
Appendix 12 – Borg Scale	1	September 2014
Appendix 13 – Time Frame Flow Charts	1	September 2014

Please note that this approval is given in accordance with the requirements of English law only. For research taking place wholly or partly within other jurisdictions (including Wales, Scotland and Northern Ireland), you should seek further advice from the Committee Chair / Secretary or the Research and Knowledge Transfer Office and may need additional approval from the appropriate agencies in the country (or countries) in which the research will take place.

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

Approval Confirmation

Faculty of Life Sciences
Research Ethics Committee

frec@chester.ac.uk

Lawrence Torris
34 Belfry Crescent
Dundalk
Co. Louth
Ireland

13th October 2014

Dear Lawrence,

Study title:	**Enjoyment levels of Irish women performing moderate intensity continuous aerobic exercise versus high intensity interval exercise.**
FREC reference:	**972/14/LT/CSN**
Version number:	**1**

Thank you for providing the documentation for the amendments recommended following the approval of the above application. These amendments have been approved by the Faculty Research Ethics Committee.

- Participant Information Sheet, version 2.

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

Yours sincerely,

Dr. Stephen Fallows
Chair, Faculty Research Ethics Committee

Appendix 6: Permission for use of Facility

Oak Gym,
Jocelyn Street,
Dundalk,
Co Louth,
Ireland.
23-07-2014

To whom it may concern,

This letter is to confirm that Lawrence Torris has been granted permission to recruit participants for his research project from the members of Oak Gym, Jocelyn Street, Dundalk, Co Louth, Ireland.

Lawrence has also been given permission to use the facilities and equipment in Oak Gym to conduct the testing and trials involved for the project also.

Yours faithfully,

Darren Donnelly
Owner of Oak Gym

Appendix 7: Relevant SPSS Output

PACES Test of Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Interval PACES	.246	10	.087	.950	10	.665
Continuous PACES	.185	10	.200*	.864	10	.085

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

PACES Paired T-test

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Interval PACES - Continuous PACES	24.90000	8.46496	2.67686	18.84453	30.95547	9.302	9	.000

RPE Test of Normality

Tests of Normality[a,d]

	Kolmogorov-Smirnov[b]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
5min Interval RPE	.222	10	.178	.906	10	.258
10min Interval RPE	.197	10	.200*	.916	10	.321
15min Interval RPE	.263	10	.049	.904	10	.241
20min Interval RPE	.305	10	.009	.826	10	.030
25min Interval RPE	.202	10	.200*	.841	10	.045
30min Interval RPE	.181	10	.200*	.950	10	.668
35min Interval RPE	.276	10	.030	.805	10	.017
40min Interval RPE	.314	10	.006	.839	10	.043
45min Interval RPE	.198	10	.200*	.884	10	.144
50min Interval RPE	.217	10	.199	.915	10	.313
5min RPE Continuous	.260	10	.053	.860	10	.076
10min RPE Continuous	.212	10	.200*	.930	10	.447
15min RPE Continuous	.169	10	.200*	.927	10	.421
20min RPE Continuous	.143	10	.200*	.934	10	.487
25min RPE Continuous	.272	10	.035	.750	10	.004
30min RPE Continuous	.261	10	.052	.748	10	.003
35min RPE Continuous	.262	10	.050	.790	10	.011
40min RPE Continuous	.349	10	.001	.585	10	.000
45min RPE Continuous	.335	10	.002	.745	10	.003
50min RPE Continuous	.300	10	.011	.727	10	.002

*. This is a lower bound of the true significance.

a. Base Interval RPE is constant. It has been omitted.

b. Lilliefors Significance Correction

d. Base RPE Continuous is constant. It has been omitted.

RPE Fully Repeated Measures ANOVA

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
intensity	Sphericity Assumed	32.841	1	32.841	4.446	.064
	Greenhouse-Geisser	32.841	1.000	32.841	4.446	.064
	Huynh-Feldt	32.841	1.000	32.841	4.446	.064
	Lower-bound	32.841	1.000	32.841	4.446	.064
Error(intensity)	Sphericity Assumed	66.477	9	7.386		
	Greenhouse-Geisser	66.477	9.000	7.386		
	Huynh-Feldt	66.477	9.000	7.386		
	Lower-bound	66.477	9.000	7.386		
Timepoint	Sphericity Assumed	703.827	10	70.383	45.545	.000
	Greenhouse-Geisser	703.827	2.512	280.230	45.545	.000
	Huynh-Feldt	703.827	3.563	197.555	45.545	.000
	Lower-bound	703.827	1.000	703.827	45.545	.000
Error(Timepoint)	Sphericity Assumed	139.082	90	1.545		
	Greenhouse-Geisser	139.082	22.604	6.153		
	Huynh-Feldt	139.082	32.064	4.338		
	Lower-bound	139.082	9.000	15.454		
intensity * Timepoint	Sphericity Assumed	110.209	10	11.021	12.403	.000
	Greenhouse-Geisser	110.209	2.550	43.227	12.403	.000
	Huynh-Feldt	110.209	3.642	30.257	12.403	.000
	Lower-bound	110.209	1.000	110.209	12.403	.006
Error(intensity*Timepoint)	Sphericity Assumed	79.973	90	.889		
	Greenhouse-Geisser	79.973	22.946	3.485		
	Huynh-Feldt	79.973	32.782	2.440		
	Lower-bound	79.973	9.000	8.886		

Average Heart Rate Test of Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
AVG_HR_MCT	.163	10	.200*	.958	10	.759
AVG_HR_INT	.165	10	.200*	.948	10	.643

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Average Heart Rate Paired T-Test

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 AVG_HR_INT - AVG_HR_MCT	6.41818	13.10186	4.14317	-2.95433	15.79069	1.549	9	.156

Average RPE Test of Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
INT_RPE_AVG	.235	10	.126	.860	10	.077
MCT_RPE_AVG	.221	10	.183	.828	10	.032

a. Lilliefors Significance Correction

Average RPE Wilcoxon Signed Rank Test

Test Statistics[a]

	MCT_RPE_AVG - INT_RPE_AVG
Z	-1.992[b]
Asymp. Sig. (2-tailed)	.046

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.