

Spring 2014

# Run sprint interval training perceived as highly enjoyable despite high session RPE in sedentary, overweight/obese women

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Run Sprint Interval Training Perceived as Highly Enjoyable despite High Session RPE in  
Sedentary, Overweight/Obese Women

Taylor K. Wenos

A thesis submitted to the Graduate Faculty of

JAMES MADISON UNIVERSITY

In

Partial Fulfillment of the Requirements

for the degree of

Master of Science

Kinesiology

May 2014

## Dedication

I would like to dedicate this thesis to my family. To my dad for always encouraging me to do my best, and for sharing a love of exercise physiology, thank you. To my mom for being such an amazing cheerleader and source of motivation, thank you. To both my mom and dad, thank you for always making physical activity a priority in our family, grad school would have looked very different had you not laid that foundation! To my siblings, Parker and Haley, for being interested in my research project and encouraging me to push through it, thank you. Finally, to my amazing husband Paul, you are my rock, and I cannot imagine getting through graduate school (data collection in particular) without you by my side; thank you! I love you all, and would not be where I am today without your love and support!

## Acknowledgements

I would like to acknowledge a number of people who helped make this thesis a reality. To my Research Chair, Dr. Elizabeth Edwards, thank you for your dedication to, and enthusiasm for, this project and helping me so much along the way. To my thesis committee, Drs. Michael Kent Todd, Christopher Womack, and David Wenos, thank you for your support and wealth of knowledge along this journey. To the other members of the research team, Jennifer Espinoza and Dr. Jeremy Akers, thank you for your instrumental and emotional support throughout data collection and the writing process. Finally, thank you to our undergraduate student assistants, Leanne Clifford, Megan Weichmann, and Grace Godfrey for all of the hours you helped us with data collection.

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## Abstract

*Purpose:* The present study compared the effect of a 12-week run-sprint interval training (R-SIT) and moderate intensity training (MIT) on perceived enjoyment and exercise adherence in sedentary, overweight/obese women (n=15; age 25-45).

*Methods:* Over 12-weeks, subjects in the R-SIT group progressed from 4 to 10 thirty second sprints each session, and the MIT group progressed from 30 to 60 minutes of continuous moderate intensity cardiovascular exercise. PACES, session RPE, intentions to modify activity behavior, attendance,  $VO_{2max}$ , and body fat percentage were recorded in both groups.

*Results:* There was a significant difference in session RPE between groups, and within the R-SIT group from baseline to 12-weeks. Body composition and  $VO_{2max}$  both improved significantly.

*Discussion:* Primary findings were that there were no significant differences in perceived enjoyment or session attendance. High session RPE was not associated with lower enjoyment or lower adherence. Secondary findings showed significant improvements in  $VO_{2max}$  for both groups, as well as significant improvements in body composition in the R-SIT group



## Chapter I

### Introduction

Obesity, defined as a BMI greater than  $30 \text{ kg/m}^2$ , is at an all-time high; the Center for Disease Control (CDC) reports that approximately one third of U.S. adults are considered obese (Center for Disease Control, 2013). Conversely, physical activity levels are at an unprecedented low, with estimated national averages falling between 26-45% of adults getting sufficient physical activity (Center for Disease Control, 2013), and up to 25% of U.S. adults not getting any leisure time physical activity (Center for Disease Control, 2013). Traditional American College of Sports Medicine (American College of Sports Medicine, 2013) recommendations for cardiovascular exercise are 30-60 minutes of moderate to vigorous exercise three to five days per week, or 150 minutes of physical activity per week (American College of Sports Medicine, 2013). The current literature shows a lack of adherence to these guidelines (Mudd et al. 2008), with the lowest adherence being represented in the overweight/obese population (Davis et al. 2006). Personal barriers, such as lack of time, feeling tired, and preference for sedentary behavior have also been shown to be inversely associated with physical activity (Salmon et al., 2003).

The most common barriers to physical activity in the United States are perceived lack of time and reported lack of enjoyment (Metcalf et al., 2012, Mullen et al. 2011, Salmon et al, 2003, Speck et al., 2003). Some studies have theorized that perceived lack of time is actually lack of interest or motivation (Reichert et al. 2007, Bowles et al. 2002). Mullen et al. (2011) report that older adults frequently identified enjoyment as motivation for them to adopt physical activity habits. Women specifically value social support when

adopting physical activity (Speck et al. 2003). Hankonen et al. (2011), though, found that women receive less social support than men, predisposing them to difficulty in modifying their behavior. This research indicates a need to develop an exercise protocol that is enjoyable, and may encourage the accumulation of the minimum amount of minutes spent in physical activity per ACSM recommendation.

High Intensity Interval Training (HIIT) is a training protocol that has recently received attention in exercise science research. HIIT is generally defined as “repeated sessions of relatively brief intermittent exercise, often performed with an ‘all-out’ effort or at an intensity close to that which elicits  $VO_{2peak}$  (ie.  $\geq 90\% VO_{2peak}$ ),” (Gibala et al., 2008.). General modalities of HIIT include cycling, running, or jogging (Kessler et al., 2012). An established HIIT protocol is Sprint Interval Training (SIT); both SIT and HIIT protocols contain multiple sprints at a fixed resistance for a designated amount of time, separated by bouts of active recovery at a lower intensity (Kessler et al., 2012). SIT training, similar to a Wingate protocol, consists of a minimum of four 30-second maximal cycle sprints, separated by 4-minute active recovery bouts (Whyte et al., 2012, Trilk et al., 2010, Gibala et al., 2006, Burgomaster et al., 2005, 2007, 2008). High intensity intervals are generally performed at a lower intensity and longer duration (Kessler et al., 2012). For the purposes of this study the primary focus will be on SIT (i.e. specific to the Wingate protocol), and will be referencing HIIT (i.e. any protocol that is not Wingate protocol) for means of comparison.

Duration of training interventions in the literature have varied, ranging from acute analysis of HIIT, to as short as two-week interventions (Hazell et al., 2010, Burgomaster et al., 2005) and as long as 12-week interventions (Hazell et al., 2014, Sijie et al., 2013);

although the majority of studies are 6-weeks in length or less (Burgomaster et al., 2007, 2008). Training interventions generally consist of three sessions per week (Metcalfe et al., 2012, Burgomaster et al., 2005, 2007, 2008). As subjects progress through the training, one to two sprint bouts per week are added depending on the length of the protocol. HIIT has demonstrated improvements in insulin sensitivity, body mass, waist circumference, and abdominal fat mass (Metcalfe et al. 2012, Gremaux et al. 2012). Metcalfe et al. studied the effect of a six-week HIIT intervention on insulin sensitivity in 29 healthy, sedentary young men and women (age 18-29). Subjects attended three sessions per week, each of which consisted of one to two 10-20 second sprint intervals, and a total session time of approximately 10 minutes. Researchers reported 12% and 15% increases in  $VO_{2peak}$  in women and men, respectively, as well as a 28% improvement in insulin sensitivity in the male sprint subjects.

Gremaux et al. (2012) studied the impact of a 9-month lifestyle intervention combined with HIIT on body composition, cardiometabolic risk, and exercise tolerance in 62 overweight/obese subjects (age 43-63). The lifestyle intervention consisted of 2-3 weekly supervised exercise training sessions that included nutritional counseling, resistance training, and HIIT. The prescribed resistance training consisted of a 20 minute circuit that included free weight and elastic band exercises. Subjects alternated between repeated bouts of 15-30 second HIIT bouts at 80% maximum aerobic power and 15-30 second bouts of passive recovery. A 4 minute passive recovery separated two 10 minute bouts of HIIT, making the total exercise time 34 minutes. Post testing results revealed significant improvements in body mass, waist circumference, BMI, total and trunk fat mass, cardiometabolic risk, and functional capacity (Gremaux et al., 2012).

Similarly, Trilk et al. (2010) studied the effect of SIT on circulatory function in 28 previously sedentary, overweight and obese women (age 23-37). After a four week exercise intervention, they found that SIT improved cardiovascular function at submaximal levels by increasing stroke volume and reducing heart rate, as well as increasing  $VO_{2max}$  by 12% in the SIT group, compared to a control group that was instructed to maintain their normal physical activity patterns. This contradicts conventional belief that these physiological changes occur in proportion to the training volume (Trilk et al., 2010). Including recovery time between sprints, the experimental group accumulated approximately half the training volume of traditional ACSM guidelines by the end of the study (Trilk et al. 2010). SIT and HIIT protocols elicit many of the same physiological adaptations of traditional aerobic training at approximately 90% less than the traditionally recommended training volume (Burgomaster et al., 2008). Consequently, this type of training protocol might be a better option for the overweight population, especially in the early phases of incorporating physical activity into their lifestyle, as it is an effective strategy for attaining the benefits of physical activity participation with a smaller training volume.

Traditional SIT protocols require braked cycle ergometers, yet access to these machines is limited. Alternatively, Bartlett et al. (2011) suggested greater perceptions of accessibility and economic practicality in running or treadmill use, increasing accessibility of this training protocol to the general population. Very few studies to date have examined the effects of run sprint interval training (R-SIT). Sandvei et al. (2012) studied the effect of R-SIT on insulin sensitivity and cholesterol profile in 23 healthy, normal BMI adult men and women over an 8-week period (age 18-35). Subjects were

randomly divided into a moderate intensity training (control) group and an R-SIT group, and were required to attend three sessions a week. The R-SIT protocol began with five 30-second maximal sprints (completed on a 5-8% gradual incline, outside) paired with three minutes of rest, and progressed to 10 sprints by week 8. The moderate intensity protocol progressed from a 30 minute continuous run at week 1, to a 60 minute continuous run by week 8. Post testing revealed an increase in insulin sensitivity and plasma LDL cholesterol was reduced by 9%, compared to the moderate intensity protocol.

Similarly, Macpherson et al. (2011) compared the effects of R-SIT to traditional endurance training over a six week period, measuring changes in body mass, body composition, RMR, run time trial performance,  $VO_{2max}$ , maximal cardiac output, and maximal a-vO<sub>2</sub> difference. Twenty healthy, recreationally active young men and women (age 19-27) were matched and randomly separated into moderate intensity and R-SIT protocols, each of which met 3 days per week. The R-SIT protocol started with four 30-second maximal sprints (on a manually powered treadmill) paired with 4 minutes of active recovery, and progressed to 6 sprints by week 6. The moderate intensity protocol progressed from a 30 minute continuous run to a 60 minute continuous run by week 6. The moderate intensity protocol saw a 9.5% improvement in maximal cardiac output, and the sprint group saw a 7.1% increase in a-vO<sub>2</sub> difference. Both groups experienced similar improvements in  $VO_{2max}$ , time trial performance, and body composition.

Two other studies to date have examined the effect of a running interval intervention on sedentary, and/or overweight women. Sijie et al., (2013) examined the effect of a 12-week running HIIT workout on overweight (BMI > 25 kg/m<sup>2</sup>) young

women (age 19-20). Subjects, who were randomly divided into either the HIIT or moderate intensity control group, reported to a track three days a week. The HIIT group completed 5 x 3 minute running intervals at 85%  $VO_{2max}$ , each bout separated by a three minute recovery at 50%  $VO_{2max}$  (monitored via heart rate reserve). The control group completed 40 minutes of continuous walking and/or jogging at 50%  $VO_{2max}$  (monitored via heart rate reserve). At the end of 12-weeks, both groups experienced improvements in body mass, BMI, body fat percentage, and waist-to-hip ratio. Specifically, the HIIT group saw a 9.9% decrease in body fat, whereas the control group saw 5.2% decrease in body fat. The HIIT group also experienced a significant increase in  $VO_{2max}$  of 8.4% compared to the control group who experienced a 4.7% increase. Likewise, Hazell et al., (2014) studied the effect a 6-week R-SIT protocol in 15 recreationally active women (age 19-26). Subjects completed four 30-second sprints paired with 4 minutes of active recovery on a self-powered treadmill set to manual mode, three days per week. Post-testing revealed significant decreases in body mass, fat mass, body fat percentage, and waist circumference, as well as a significant increase in  $VO_{2max}$  by 8.7%. This was also one of the first R-SIT studies to examine session rate of perceived exertion (RPE), which was assessed on a 10-point RPE scale and allowed the examiner to gauge how difficult the exercise bout was for the subject. There were no significant differences in session RPE over time.

The addition of HIIT or SIT to an exercise regimen could be beneficial to a wide variety of the general population. In a recent study controlled for time (i.e. both training sessions lasted 50 minutes), eight healthy men completed a HIIT session (seven, three minute sprint bouts, separated by three minutes of active recovery) and a moderate

intensity session, seven days later. Upon completing each session, subjects were asked to fill out the Physical Activity Enjoyment Scale (PACES) to provide feedback on their perceived enjoyment. Ratings of perceived enjoyment were greater during the HIIT session than the MIT session, thus suggesting this form of exercise to have larger implications for exercise prescription (Bartlett et al. 2011). The frequent breaks have also been shown to be perceived as more enjoyable than traditional moderate intensity training, which can be highly motivating (Bartlett et al. 2011). Additionally, Trilk et al. (2010) suggests that the frequent breaks between intense bouts might be beneficial for those unaccustomed to extended periods of moderate or vigorous exercise sessions.

As discussed earlier, there are a number of physiological benefits that result from HIIT and SIT that occur in a fraction of the training volume of traditional cardiovascular exercise, and these improvements can be very motivational to someone who is having trouble adopting a regular exercise routine (Speck et al. 2003). Exercise and physical activity adherence is necessary to acquire the minimal amounts of physical activity necessary to elicit health benefits, hence the importance of finding activities that people enjoy (Bartlett et al., 2011). Overweight/Obese individuals might find R-SIT appealing, as they receive multiple breaks and only have to focus on small bursts of intense training, allowing them to overcome their barriers to exercise (Gaesser et al., 2011). Females in particular may be drawn to this training protocol because of those rest periods, where they can socialize with their peers completing the same exercise program.

### Purpose

The purpose of this study is to determine if perceived enjoyment and exercise adherence are greater in an R-SIT experimental group compared to a moderate intensity

(MIT) control group, in sedentary, overweight/obese women during and after a 12-week intervention.

### Hypotheses

It is hypothesized that perceived enjoyment, evaluated via the Physical Activity Enjoyment Scale, will be greater in the R-SIT group than the MIT group, at both 6 and 12-weeks. It is also hypothesized that perceived enjoyment in the R-SIT group will be greater at 12-weeks than 6-weeks and baseline.

It is hypothesized that exercise adherence will be greater in the R-SIT than the MIT group, at 12-weeks, due to increases in perceived enjoyment.

### Assumptions

It is assumed that the subjects in this study will be able to run on a treadmill, and that they will reach their maximal exertion level for every maximal bout of exercise. It is also assumed that the subjects will refrain from any outside dietary or exercise modifications.

### Limitations

We are only studying overweight/obese, sedentary women, ages 25-45, thus we can only apply our results to this specific population.

### Delimitations

A delimitation of this study is that we are only studying women, not men.

### Definition of Terms

Sedentary- Not meeting ACSM guidelines of 30-60 minutes of moderate to vigorous physical activity 3-5 days per week, or 150 minutes of physical activity per week.

Overweight- A BMI between 25.0-29.9 kg/m<sup>2</sup>

Class I obese- A BMI between 30.0-34.9 kg/m<sup>2</sup>



## Chapter II

### Methods

#### Research Design

The design of this study was a 12-week, randomly controlled experimental protocol. Subjects were divided into two different groups, an experimental sprint protocol and a continuous moderate intensity control protocol. Perceived enjoyment,  $VO_{2max}$ , and body composition were assessed at baseline, 6-, and 12-weeks. Session RPE was assessed at the end of each session and averaged in three week blocks. Perceptions of exercise and social support were assessed at baseline and 12-weeks.

#### Subjects

For this study we recruited 15 women (ages  $33.6 \pm 1.7$ ), from James Madison University and the local Harrisonburg Community. To be considered for the study, subjects had to be free of known cardiovascular, pulmonary, or metabolic diseases (as assessed with the PAR-Q and Health Status Questionnaire), as well as sedentary (as defined by the ACSM and assessed by the International Physical Activity Questionnaire (IPAQ)). The IPAQ consists of 5 activity domains, asked independently, in which the subjects report about their time spent being physically active in the last 7 days (Hagströmer et al. 2006). Subjects were excluded if they had a BMI less than  $25 \text{ kg/m}^2$  (subjects were required to have a medical examination if they had a BMI greater than  $34.9 \text{ kg/m}^2$ ), pregnant or postmenopausal, or had any signs or symptoms of Cardiovascular Disease (CVD) that placed them at high risk according to ACSM guidelines. Upon consenting to the procedures approved by the James Madison

University Internal Review Board, subjects were randomly divided into one of two training groups.

### Measures

*Informational Session:* Subjects were brought to the Human Assessment Lab in Burruss Hall at James Madison University for an initial familiarization session, where they were informed about testing procedures, fitted for the mask for metabolic testing, and familiarized with the treadmill. Next, subjects filled out a modified version of the Physical Activity Enjoyment Scale questionnaire (PACES).

PACES assesses perceived physical activity enjoyment through a series of questions presented to them on a seven point scale (“disagree a lot” to “agree a lot”); 1 being associated with negative perceptions, 7 being associated with positive perceptions, and the higher the score, the greater the enjoyment (Kendzuerski et al., 1991). A modified five point scale was used for this study, using the same descriptors as the original questionnaire.

*Fitness Measures:* On a separate day, subjects arrived to the Human Assessment Lab, where resting heart rate and blood pressure were recorded using a Prosphyg Standard Aneroid cuff and an Adscope-lite stethoscope. Next, subjects completed a  $\text{VO}_{2\text{max}}$  test on a Cosmos Treadmill (Germany). After a three minute warm up, subjects self-selected a speed they felt they could comfortably maintain for the remainder of the test. Every three minutes the percent grade increased until a maximal effort was achieved, or until volitional fatigue. Maximal effort was determined by a Respiratory Exchange Rate (RER) of at least 1.1, a Rating of Perceived Exertion (RPE) at least a 19 out of a 20 point scale (Borg Scale), and/or a heart rate within 10 beats of their age predicted maximum

heart rate. Heart rate and rating of perceived exertion were obtained at every stage, and averaged from the final 30 seconds. Total body fat percentage was assessed using a GE iDXA on a separate day from fitness training.

*Exercise Training:* Subjects were randomly separated into two different training groups: an experimental run sprint interval training protocol (R-SIT) and a control moderate intensity training protocol (MIT). All training sessions were supervised and completed on-site in Godwin Hall, on a treadmill, three days a week, and progressed in three week increments. Training groups were kept separate, and researchers encouraged subjects throughout the intervention. Every exercise session began with a five minute dynamic warm up followed by a five minute walking warm up on the treadmill with a speed of 2.5 mph, 0% grade.

R-SIT (n=8)- In the first 3-week training block, members of the R-SIT group completed four 30-second maximal sprints at a 3-5% grade. Treadmill grade was incorporated for two reasons, 1.) To help the subjects achieve maximal effort in the thirty second time frame, and 2.) evidence suggests that exercising on a slight incline produces less orthopedic stress in overweight/obese individuals (Ehlen et al., 2010). Subjects were encouraged to sprint as fast as they could to elevate their heart rate to as close to maximal as possible. Heart rate and RPE were recorded immediately after each sprint to ensure maximal effort. Speed and grade were adjusted as subjects progressed throughout the 12 weeks to maintain maximal heart rate and RPE. Sprints were paired with a four minute walking recovery, and each session ended with a five minute walking cool down at 2.5 mph at 0% grade. Every 3-weeks the number of sprints increased by two, with the final 3-week increment consisting of 10 maximal sprints.

MIT (n=7)- Members of the MIT group walked or jogged for 30 minutes on a treadmill at a 3-5% grade, at an intensity ranging between 45-55% of their heart rate reserve (HRR), which falls within the recommended range for moderate intensity exercise (American College of Sports Medicine, 2013). A 5-minute cool down at 2.5 mph at 0% grade completed each session. Every three weeks the exercise sessions increased by 10 minutes, with the final 3-week block consisting of a 60 minute session, 3-days per week.

By the end of the 12-week training period, the R-SIT group was obtaining 15 minutes of vigorous physical activity per week, and the MIT group was obtaining 180 minutes of moderate intensity physical activity per week (Table 1).

*Session RPE and Exercise Adherence:* At the end of every training session, subjects were asked to report an overall rating of perceived exertion, or “session RPE”. Session RPE was averaged over each 3-week block to examine the effect of each increase in time and/or sprints. Each subject was asked how challenging the exercise session felt to them based on a 10 point RPE scale (Herman et al., 2008, Foster et al., 2001, Borg et al., 1982). Exercise adherence was defined as the percentage of sessions completed at the end of the 12 weeks, out of 36 possible sessions.

### Statistical Analysis

Statistical analysis was completed using SPSS version 21. PACES, session RPE, body fat percentage, and  $VO_{2max}$  were analyzed using a two way, mixed design ANOVA, and exercise adherence was analyzed using an independent samples *t*-test. Statistical

analysis was only run on data from subjects who successfully completed the entire intervention. Significance was set *a priori* at  $p < 0.05$ .

## Chapter III

### Journal Manuscript

Journal Format: Non-specified

Manuscript Title: Run Sprint Interval Training Perceived as Enjoyable despite High Session RPE in Sedentary, Overweight/Obese Women

#### Abstract

*Purpose:* The present study compared the effect of a 12-week run-sprint interval training (R-SIT) and moderate intensity training (MIT) on perceived enjoyment, behavior modification, and exercise adherence in sedentary, overweight/obese women (n=15; age 25-45).

*Methods:* Over 12-weeks, subjects in the R-SIT group progressed from 4 to 10 thirty second sprints each session, and the MIT group progressed from 30 to 60 minutes of continuous moderate intensity cardiovascular exercise. PACES, session RPE, attendance,  $VO_{2max}$ , and body fat percentage were recorded in both groups.

*Results:* There was a significant difference in session RPE between groups, and within the R-SIT group from baseline to 12-weeks. Body composition and  $VO_{2max}$  both improved significantly.

*Discussion:* Primary findings were that there were no significant differences in perceived enjoyment, attitudes towards physical activity, or session attendance. High session RPE was not associated with lower enjoyment or lower adherence. Secondary findings showed significant improvements in  $VO_{2max}$  for both groups, as well as significant improvements in body composition in the R-SIT group.

## Introduction

It has been well established that obesity levels are at an all-time high, and inversely physical activity levels are at an all-time low (Centers for Disease Control, 2013). Traditional American College of Sports Medicine (ACSM) recommendations for cardiovascular exercise are 30-60 minutes of moderate to vigorous exercise three to five days per week, or 150 minutes of physical activity per week (American College of Sports Medicine, 2013). The current literature shows a lack of adherence to these guidelines (Mudd et al. 2008), with the lowest adherence being represented in the overweight/obese population (Davis et al. 2006). Personal barriers, such as lack of time, feeling tired, and preference for sedentary behavior have also been shown to be inversely associated with physical activity (Salmon et al., 2003). The most common barriers in the United States are reported as lack of time and lack of enjoyment (Mullen et al., 2011). For women specifically, lack of social support has been reported to negatively impact physical activity participation (Speck et al., 2003).

High Intensity Interval Training (HIIT) is a training protocol that has recently received attention in exercise science research. HIIT is generally defined as “repeated sessions of relatively brief intermittent exercise, often performed with an ‘all-out’ effort or at an intensity close to that which elicits  $VO_{2peak}$  (ie.  $\geq 90\% VO_{2peak}$ ),” (Gibala et al., 2008.). A version of HIIT is Sprint Interval Training (SIT); both SIT and HIIT protocols contain multiple sprints at a fixed resistance, for a designated amount of time, separated by bouts of active recovery at a lower intensity (Kessler et al., 2012). SIT training, similar to a Wingate protocol, consist of a minimum of four 30-second maximal cycle

sprints, separated by four minute active recovery bouts (Whyte et al., 2012, Gibala et al., 2006, Trilk et al., 2010, Burgomaster et al., 2005, 2007, 2008).

Duration of interventions in the literature have varied, ranging from acute analysis of HIIT, to training interventions as short as two-weeks (Hazell et al., 2010, Burgomaster et al., 2005) and as long as 12-weeks (Hazell et al., 2014), with most studies averaging 6-weeks (Burgomaster et al., 2007, 2008). In 28 previously sedentary, overweight and obese women (ages 23-37), a four week SIT protocol improved cardiovascular function at submaximal levels by increasing stroke volume and reducing heart rate, as well as increasing  $VO_{2max}$  by 12% as compared to a control group who maintained their normal physical activity patterns (Trilk et al., 2010). This contradicts conventional belief that these physiological changes occur in proportion to the time put into training (Trilk et al., 2010). Including recovery time between sprints, the experimental group accumulated approximately half the training volume of traditional ACSM guidelines by the end of the study (Trilk et al. 2010). Similar research in healthy BMI subjects has shown improvements in insulin sensitivity, BMI, waist circumference, and abdominal fat mass (Metcalf et al. 2012, Gremaux et al. 2012).

Traditional SIT protocols utilize braked cycle ergometers, yet access to these machines is limited and it has been suggested that there are perceptions of greater accessibility to running or treadmills (Bartlett et al., 2011). Very few studies to date have examined the effects of run sprint interval training (R-SIT), but those that have report improvements in insulin sensitivity, LDL cholesterol,  $VO_{2max}$ , and body composition (Hazell et al., 2014; Sandvei et al., 2012; Macpherson et al., 2011), compared to traditional moderate-intensity training. Research also indicates that SIT is perceived as



more enjoyable than traditional training, suggesting greater implications in exercise adoption (Bartlett et al., 2011).

The benefits associated with HIIT and SIT that occur in a reduced training volume of traditional moderate intensity exercise, and these improvements can be very motivational to someone who is having trouble adopting a regular exercise routine (Speck et al. 2003). Exercise and physical activity adherence is necessary to acquire the minimal amounts of physical activity necessary to elicit health benefits, thus the importance of finding activities that people enjoy. Overweight/obese individuals might find SIT-R appealing, as they receive multiple breaks and only have to focus on small bursts of intense training. Females in particular may be drawn to this training protocol because of those rest periods, where they can socialize with their peers completing the same exercise program.

#### *Purpose*

The purpose of this study is to determine if perceived enjoyment and exercise adherence differ in a SIT-R experimental group as compared to a moderate intensity (MIT) control group, in sedentary, overweight/obese women during and after a 12-week intervention.

#### *Hypothesis*

It is hypothesized that perceived enjoyment, evaluated via PACES, will be greater in the SIT-R group than the MIT group, at both 6 and 12-weeks. It is also hypothesized that perceived enjoyment in the SIT-R group will be greater at 12-weeks than 6-weeks.

It is hypothesized that exercise adherence will be greater in the SIT-R than the MIT group, over 12-weeks, and that the greater adherence will be related to increases in perceived enjoyment.

## Methods

### *Study Design*

The design of this study was a 12-week randomized, controlled experimental protocol. Subjects were divided into two different groups, an experimental sprint protocol and a continuous moderate intensity control protocol. Perceived enjoyment,  $VO_{2max}$ , and body composition were analyzed at baseline, 6-, and 12-weeks. Session RPE was averaged and analyzed every three weeks. Perceptions of exercise and social support were analyzed at baseline and 12-weeks.

### *Subjects*

The sample consisted of 15 women (ages  $33.6 \pm 1.7$ ) from the James Madison University and Harrisonburg communities, recruited via email, flyers, and word of mouth. Initial screening included the PAR-Q and International Physical Activity Questionnaire (Hagströmer et al. 2006) to establish disease risk and activity status. Subjects were excluded if they had known cardiovascular, pulmonary, or metabolic diseases, were pregnant or postmenopausal, or had any known orthopedic issues. It was required that subjects be previously sedentary for at least 3 months prior to beginning the study. Subjects were also required to have a BMI greater than  $25 \text{ kg/m}^2$ . Upon consenting to the procedures approved by the James Madison University Internal Review Board, subjects were randomly divided into one of two training groups.

Three subjects in the experimental group dropped out of the study, two for knee injuries from pre-existing conditions that were aggravated by the vigorous exercise, and one due to scheduling conflicts (unable to complete 3 training sessions each week); these each occurred within the first 3-weeks of training, resulting in a final sample size of 12.

## Measures

### *Informational/Familiarization Session and Randomization*

Subjects attended an initial familiarization session, where they were informed about testing procedures, fitted for the mask for metabolic testing, and familiarized with the treadmill. Subjects also completed the baseline questionnaires.

### *Physical Activity Enjoyment*

PACES assesses perceived physical activity enjoyment through a series of questions presented to them on a seven point scale (“disagree a lot” to “agree a lot”); 1 being associated with negative perceptions, 5 being associated with positive perceptions, and the higher the score, the greater the enjoyment (Kendzuerski et al., 1991). A modified five point scale was used for this study, using the same descriptors as the original questionnaire.

### *Physiological Measures*

On a separate day from the informational and familiarization session, subjects completed a  $\text{VO}_{2\text{max}}$  test to volitional fatigue on a Cosmos Treadmill (Germany).  $\text{VO}_{2\text{max}}$  protocol consisted of a warm up for 3 minutes at a self-selected speed, and then selected a pace they felt they could maintain for a prolonged time for the rest of the test. Percent grade increased every three minutes until volitional fatigue, or the subject achieved a

respiratory exchange rate of at least 1.1, an RPE of at least 19 out of 20, or was within 10 beats of their age predicted heart rate max. Total body fat percentage was assessed using a GE iDXA on a separate day from fitness testing.

#### *Session RPE and Exercise Adherence*

At the end of each training session, subjects were asked to report an overall rating of perceived exertion (session RPE). Each subject was asked how challenging the exercise session felt to them based on a 10 point RPE scale (Herman et al., 2008, Foster et al., 2001). Session RPE was averaged in three week blocks, in line with the progression of training. Exercise adherence was quantified as the percentage of sessions completed at the end of 12 weeks, out of 36 possible sessions.

#### *Training Protocol*

Subjects were randomly separated into two different training groups: an experimental run sprint interval training group (R-SIT) and a control moderate intensity training group (MIT). All training sessions were supervised and completed on-site, on a treadmill, three days a week, and progressed in three week increments. Training groups were kept separate, and researchers encouraged subjects throughout the intervention. Every exercise session began with a five minute dynamic warm up followed by a five minute walking warm up on the treadmill with a speed of 2.5 mph and 0% grade.

R-SIT (n=8)- In the first 3-week training block, members of the SIT group completed four 30-second maximal sprints at a 3-5% grade. Treadmill grade was incorporated for two reasons, 1.) To help the subjects achieve maximal effort in the thirty-second time frame, and 2.) Evidence suggests that exercising on a slight incline produces less orthopedic stress in overweight/obese individuals (Ehlen et

al., 2010). Subjects were encouraged to sprint as fast as they could to elevate their heart rate to as close to maximal as possible. Heart rate and RPE were recorded immediately after each sprint to ensure maximal effort. Speed and grade were adjusted as subjects progressed throughout the 12 weeks to maintain maximal heart rate and RPE. Sprints were paired with a four minute walking recovery at 2.5 mph at 0% grade, and each session ended with a five minute walking cool down. Every three weeks the number of sprints increased by two, with the final 3-weeks consisting of 10 maximal sprints.

MIT (n=7)- Members of the MIT group walked or jogged for 30 minutes on a treadmill at a 3-5% grade, at an intensity ranging between 45-55% of their heart rate reserve (HRR), which falls within the recommended range for moderate intensity exercise (American College of Sports Medicine, 2013). A 5-minute cool down at 2.5 mph and 0% grade completed each session. Every three weeks the exercise sessions increase by 10 minutes, with the final three week block consisting of a 60 minute session, three days per week.

Total time commitment was matched between the groups. By the end of the 12-week training period, the R-SIT group was obtaining 15 minutes of vigorous physical activity per week, and the MIT group was obtaining 180 minutes of moderate intensity physical activity per week.

### *Statistical Analysis*

Statistical analysis was completed using SPSS version 21. PACES, the physical activity behavior change questionnaire, session RPE, body fat percentage, and  $VO_{2max}$  were analyzed using a two way, mixed design ANOVA, and exercise adherence was

analyzed using an independent samples *t*-test. Statistical analysis was only run on data from subjects who successfully completed the entire intervention. Significance was set *a priori* at  $p < 0.05$ .

## Results

### *Subject Characteristics*

Independent samples *t*-tests were conducted to assess differences in baseline characteristics between groups, and are presented in Table 2. There were no significant differences in age, height, weight, BMI, or  $VO_{2max}$  between groups at baseline. Neither group saw significant changes in weight or BMI over the 12-week intervention, but there was a significant change in baseline to 12-week R-SIT body fat percentage ( $-1.62 \pm .4$ ;  $p = .016$ ), and a trend towards significance between 6-week and 12-week R-SIT body fat percentage ( $-.82 \pm .4$ ;  $p = 0.05$ ). There was also a trend towards significance from baseline to 12-week ( $-1.1 \pm .5$ ;  $p = .05$ ), and 6- to 12-weeks ( $-.6 \pm .5$ ;  $p = .058$ ) in MIT body fat percentage. Physiological data for both groups is presented in Table 3.

### *VO<sub>2max</sub>*

While there were no significant difference between groups in  $VO_{2max}$  at baseline, 6-weeks, and 12-weeks, there were significant differences within each group respectively (Figure 1). A 1-tailed alternative was used to analyze  $VO_2$  data due to the expected physiological gains that occur with training.

### *Perceived Enjoyment*

There were no significant differences in perceived enjoyment between or within groups (Figure 2).

### *Session RPE and Exercise Adherence*

There was a significant difference between groups in session RPE ( $p=0.000$ ), as well as several significant differences within each group (Figure 3). There were no significant differences in exercise adherence between groups, with the R-SIT group attendance at 96% ( $34.6\pm.51$ ), and the MIT group attendance at 92% ( $33.0\pm1.23$ ). As there was no difference in adherence, and adherence was high in both groups was high, the association between enjoyment and adherence was not evaluated.

### Discussion

The purpose of this study was to assess differences in perceived enjoyment and exercise adherence between an experimental R-SIT protocol and a control MIT protocol at both 6- and 12-weeks. The primary findings of this study were that there were no significant differences in perceived enjoyment, attitudes towards physical activity, or exercise adherence between the experimental and control groups, which contradict our hypotheses that the R-SIT group would perceive greater enjoyment than the MIT group, which would lead greater exercise adherence than compared to the MIT group. This is the first study, to our knowledge, to evaluate an R-SIT protocol on an electric motor treadmill as opposed to a manually operated treadmill.

Our findings that there were no differences in perceived enjoyment between the R-SIT and MIT groups conflict with the finding by Bartlett et al., (2011) that report significantly higher ratings of perceived enjoyment in an experimental HIIT group compared to a control MIT group. This could be due to a number of factors. First, the study by Bartlett et al., (2011) studied a group of men. Our results are specific to the population of overweight/obese women in an intentionally social atmosphere, which

could have potentially affected perceived enjoyment in both groups. Second, our study was over the course of 12-weeks whereas the protocol for Bartlett et al., (2011) was a within subject design that studied the acute effects of R-SIT on perceived enjoyment compared to the acute effects of MIT on perceived enjoyment. Ultimately, in the present study, the PACES scores for both groups were high, which has implications for incorporating R-SIT into future exercise programming. This lends support to previous findings that women value social support (Hankonen et al., 2011; Speck et al., 2003), and perhaps receiving support is more important than the actual exercise protocol. The researchers (specifically those who were directly involved with data collection) created a unique, all female environment, and strongly encouraged physical activity adoption.

Physical activity adoption is especially important in the sedentary, overweight/obese population. Along with high levels of perceived enjoyment (ideally) comes an increased adherence rate (Mullen et al., 2011). There were no significant differences in session attendance between the R-SIT and MIT groups. There were a few drop outs at the beginning of the study (due to a history of knee pain that was aggravated by the sprinting and scheduling complications), which does beg the question if there is a polarizing effect of the R-SIT protocol that could deter certain personality types from participating in it (i.e. dropout was due to disliking the protocol), but the majority of the subjects in the experimental protocol were able to complete the sprints successfully. There was some concern initially of how the subject's knees would be able to handle the impact of sprinting on the treadmill, but in line with Ehlen et al., (2010) incorporating a minimal grade appeared to absorb most of the impact of the sprint. Additionally, the incline allowed subjects to sprint at a slightly slower speed than they would have to



otherwise to increase their heart rate to near maximal. Many subjects reported feeling more comfortable at a steeper incline and slower speed for balance reasons, specifically, those who were less familiar with running on a treadmill.

There were three secondary findings that were significant: session RPE between the R-SIT and MIT groups, body fat percentage in the R-SIT group, and  $VO_{2max}$  over the 12-week intervention in both groups. Session RPE was significantly greater at all four time points (3-, 6-, 9-, and 12-weeks) in the R-SIT group than the MIT group. The R-SIT group also experienced a significant progressive increase in session RPE over 12-weeks as the number of sprints increased. The MIT group experienced a significant decrease in session RPE from 3-weeks to 6-weeks. While statistically significant, this drop was not practically significant dropping from an RPE of 3 to 2.9. Our session RPE data differs from that of Hazell et al., (2014) who reports no significant differences in session RPE over the course of 6-weeks ( $9.06 \pm 0.17$ ). Specifically, our average session RPE at 4-sprints ( $5.22 \pm .35$ ) is lower than those reported at 4-sprints from Hazell et al., (2014), likely due to our use of an electric powered treadmill, however our R-SIT protocol experienced similar improvements in body fat percentage and  $VO_{2max}$  to the subjects from Hazell et al., (2014).

There was a question as to whether or not increased session RPE would affect perceived enjoyment in the R-SIT group. As stated earlier, there were no significant differences in perceived enjoyment between groups. The average score of both groups by 12-weeks were within the 90<sup>th</sup> percentile, and the higher the score the higher the perceived enjoyment. Thus, in an overweight/obese population, intense, vigorous activity with regular breaks was perceived as equally enjoyable as moderate intensity

walking/jogging, once again varying from the study by Bartlett et al. (2011). Our results show a visual trend towards greater enjoyment in the R-SIT group, so likely these results would be significant with a larger sample size. Though these were not formally analyzed, a number of subjects in the R-SIT group reported enjoying the sprint protocol because “*Anyone can do anything for 30 seconds*” (Subject 8), and “*I feel like I am getting a really good workout even with the breaks in between [sprints],*” (Subject 4). Additionally, many of the subjects commented on a desire to have a companion to exercise with regularly, which is consistent with the findings from Speck et al., (2003) that reported that women desire more social support specific to physical activity. Together, these findings imply that an R-SIT protocol would be an appropriate addition to an exercise program for overweight/obese women.

The R-SIT group experienced a significant decrease in body fat percentage from baseline to 12-weeks, which is consistent findings by Hazell et al. (2014) who reported significant decreases in body composition ( $24.7 \pm 4.9$  to  $23.0 \pm 4.6\%$ ) after 6 weeks of R-SIT training. Similarly, the study by Sijie et al., (2013) reported a significant 9.9% decrease in body fat percentage in sedentary, overweight college-aged females after a 12-week run HIIT intervention, making these two of the first run sprint studies to have this effect in women. Conversely, there appears to be no correlation between decreased body fat and increased adherence or perceived enjoyment, which refutes previous evidence that suggested perceived health benefits and aesthetic improvements would lead to increased activity participation (Speck et al., 2003). It should be noted once again that adherence was high in both groups, so perhaps the social environment of the intervention was motivating despite the lack of changes in body composition in the MIT protocol.

$VO_{2max}$  significantly increased in both groups from baseline to 12-weeks, and 6-weeks to 12-weeks. The practical significance is that the training volume for the R-SIT group was much smaller than the experimental group, yet both groups experienced the same increases in  $VO_{2max}$ . This finding supports much of the R-SIT and HIIT literature (Trilk et al., 2010, Metcalfe et al., 2012, Creer et al., 2004, Sijie et al., 2013, Hazell et al., 2014). As there was no significant difference from baseline to 6-weeks in either group, perhaps there is a critical threshold in terms of number of sprints per session that elicit changes in  $VO_{2max}$ , similar to that of dose-response effect in moderate intensity training that has been well established (Oja et al., 2001). This was contrary to evidence presented by Hazell et al., (2014), though, which reported increases in  $VO_{2max}$  within a 6-week time frame utilizing an R-SIT protocol. Likewise, the MIT group did not experience significant changes in  $VO_{2max}$  from baseline to 6-weeks. This is likely due to the low intensity (45-55% HRR), and once again the dose-response relationship.

There were a few limitations to this study, the primary one being the small sample size. As this is an ongoing study, the hope is to continue recruiting subjects to complete the R-SIT intervention to increase the statistical power. A second limitation is the intentionally supportive environment created by the researchers. There appears to be a connection between increased social support and exercise adherence, however this type of environment might not always be accessible or naturally created in the everyday gym setting. Finally, our subjects had immediate access to the treadmills which, again, does not fully mimic an everyday gym setting. There is a great opportunity for future study utilizing the treadmill based R-SIT protocol. As was the original intent of this particular study, a comparison between the R-SIT protocol and a blended protocol (two days of R-

SIT, one day of MIT) would be beneficial to mimic a more practical option to present to the general public. We also had a wide range of BMI's amongst our subjects; future studies should compare the effect of R-SIT on different BMI classes to see if there are similar effects on perceived enjoyment, activity adherence, and body composition. Finally, because there appears to be a small relationship between pre-existing knee conditions and aggravated knee pain following an R-SIT session, future studies should incorporate a pre-training resistance regimen to strengthen the muscles around the knee as there might be a certain strength threshold that permits certain people to complete R-SIT pain free.

### *Conclusion*

In conclusion, the present study sought to determine differences in perceived enjoyment and exercise adherence between an experimental R-SIT protocol and a control MIT protocol, over 12-weeks. There is practical significance in that perceived enjoyment and attendance were high in both groups, despite the significantly higher session RPE in the R-SIT group, when in a supportive environment. The fact that there were improvements in  $VO_{2max}$  and body composition, similar to previous R-SIT studies, but utilizing an electric motor treadmill as opposed to a manually driven treadmill is also practically significant in regards to exercise prescription and accessibility to the general population.

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Table 1. Exercise Protocols and Time Commitment

<b>Weeks</b>	<b>Protocols</b>		<b>Time Commitment</b>	
	<b>R-SIT</b>	<b>MIT</b>	<b>R-SIT*</b>	<b>MIT<sup>+</sup></b>
<b>1-3</b>	4 sprints	30 minutes	6- minutes	90-minutes
<b>4-6</b>	6 sprints	40 minutes	9-minutes	120-minutes
<b>7-9</b>	8 sprints	50 minutes	12-minutes	150-minutes
<b>10-12</b>	10 sprints	60 minutes	15-minutes	180-minutes

Table 1. Comparison of exercise protocols and time commitment between an experimental R-SIT protocol and control MIT protocol, over 12-weeks.

\*Vigorous intensity exercise

<sup>+</sup>Moderate intensity exercise



Table 2- Baseline Characteristics

	<b>SIT (n= 5)</b>	<b>MIT (n=7)</b>
Age (yrs)	36.8 ± 3.35	31.3 ± 1.21
Height (cm)	163.03 ± 2.44	168.1 ± 2.43
Weight (kg)	87.29 ± 15.16	82.5 ± 4.06
BMI (kg/m <sup>2</sup> )	32.3 ± 4.67	29.5 ± 1.84
VO <sub>2max</sub>	29.5 ± 3.26	26.7 ± 2.35

Data are presented as mean ± SD. There are no significant differences between groups.

Table 3- Physiological Measures

	Measure	Baseline	6-Weeks	12-Weeks
<b>R-SIT</b>	Weight (kg)	87.3 ± 15.16	87.4 ± 15.70	86.6 ± 14.85
	BMI (kg/m <sup>2</sup> )	32.3 ± 4.67	32.3 ± 4.65	32.0 ± 4.59
	% Body Fat	44.6 ± 4.07	43.8 ± 3.93	42.9 ± 3.98*
	VO <sub>2max</sub> (mL/kg/min)	29.5 ± 3.26	29.8 ± 2.86	35.6 ± 4.66*†
<b>MIT</b>	Weight (kg)	82.5 ± 4.06	82.3 ± 4.19	81.7 ± 4.12
	BMI (kg/m <sup>2</sup> )	29.5 ± 1.84	29.1 ± 1.65	28.9 ± 1.64
	% Body Fat	45.3 ± 2.72	44.8 ± 2.35	42.7 ± 2.08 <sup>α</sup>
	VO <sub>2max</sub> (mL/kg/min)	26.7 ± 2.35	29.5 ± 1.63	35.3 ± 2.48*†

Data are presented as mean ± SD.

\*Significant (p<0.05) from baseline

† Significant (p<0.05) from 6-weeks

<sup>α</sup> Trend toward significance (p=.058) from baseline

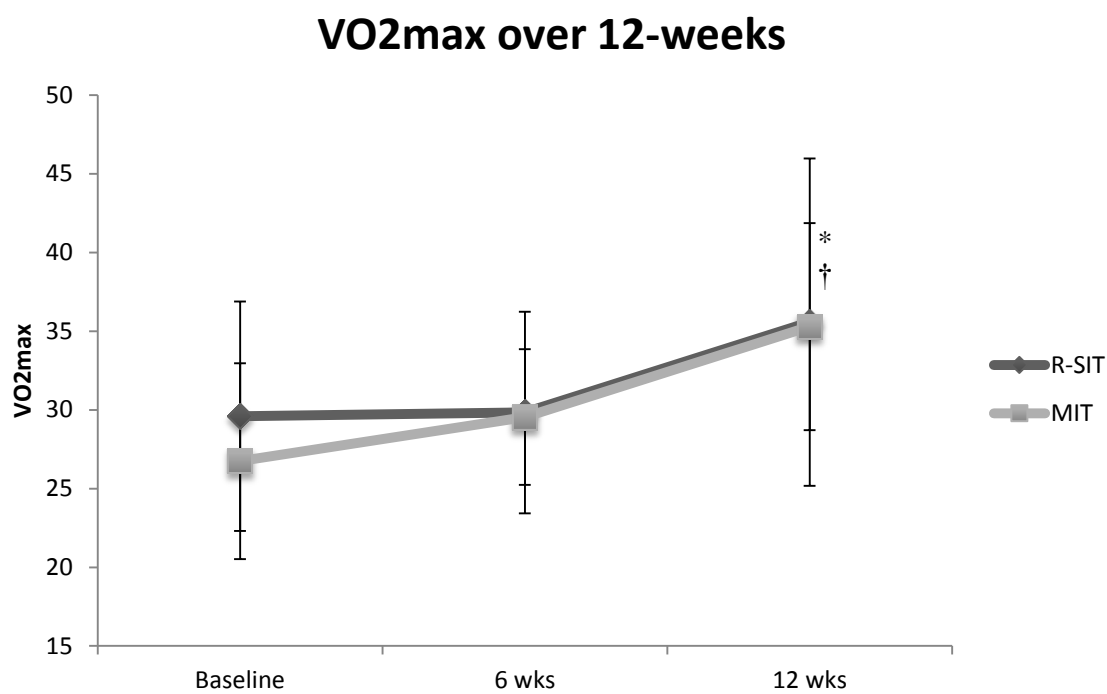
Figure 1-  $VO_{2max}$ Figure 1.  $VO_{2max}$  at baseline, 6 weeks, and 12 weeks.\*Significant ( $p < 0.05$ ) from baseline (for both groups)†Significant ( $p < 0.05$ ) from 6 weeks (for both groups)

Figure 2- PACES

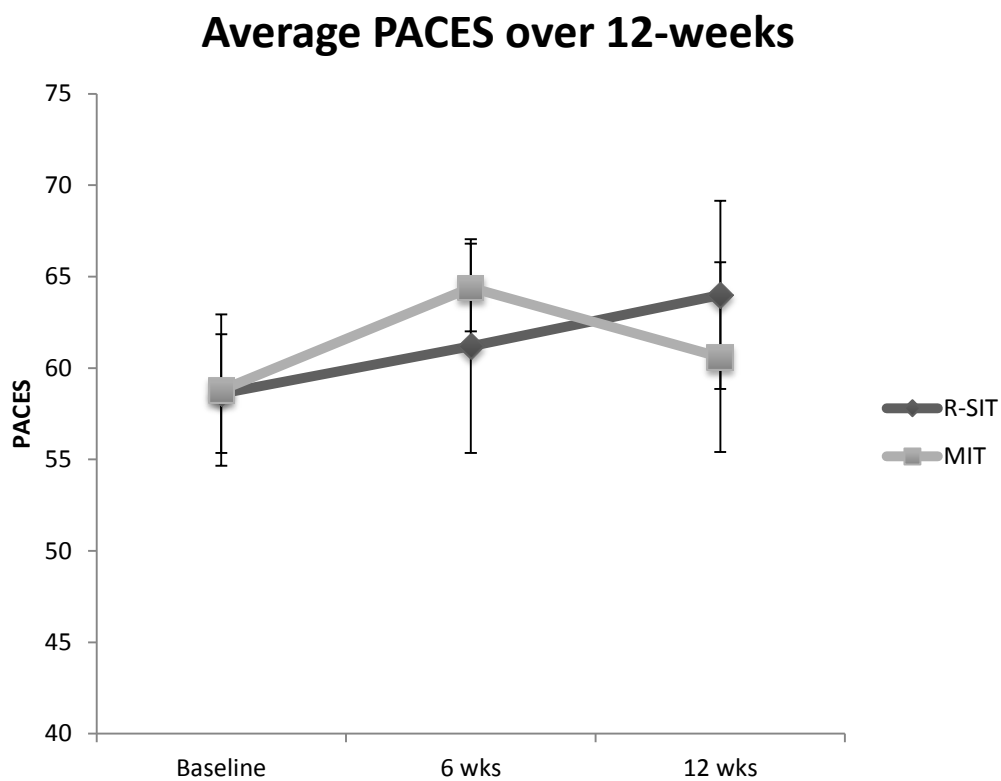


Figure 2. Comparison of average PACES over 12-weeks.

Figure 3- Session RPE

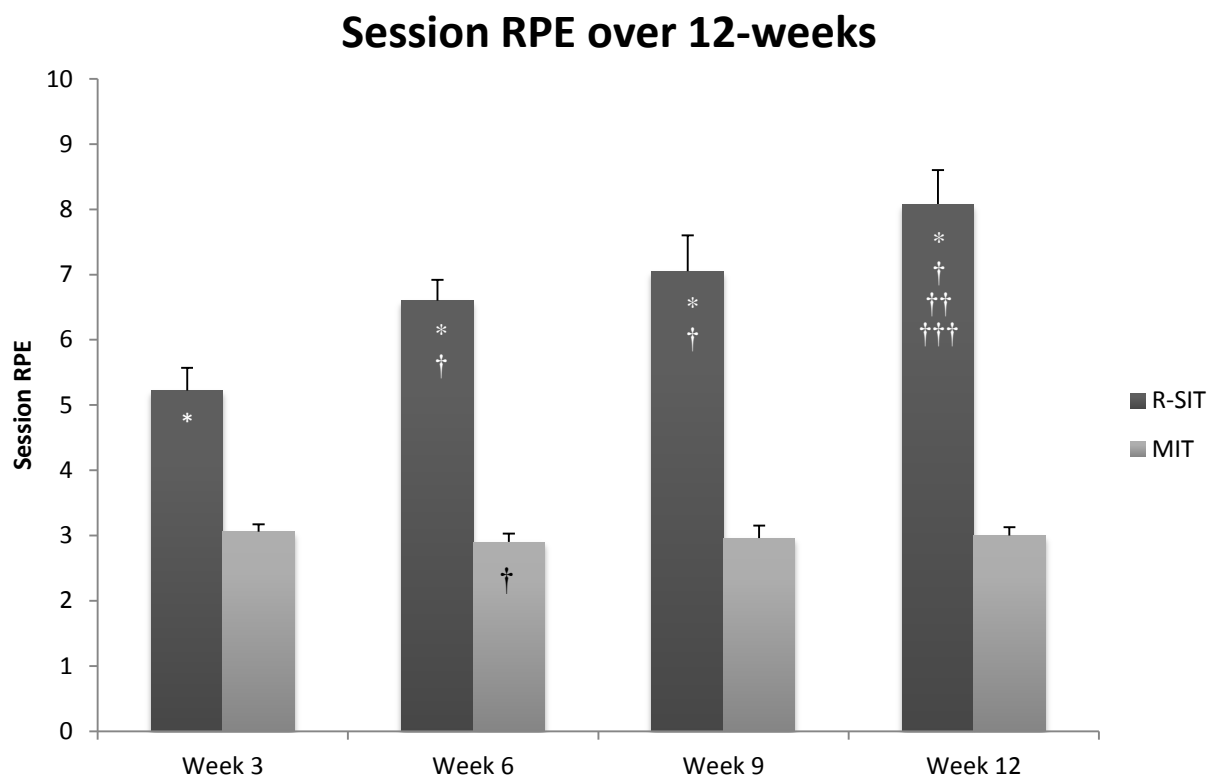


Figure 1. Comparison of session RPE between R-SIT and MIT groups over 12-weeks.

\*Significant ( $p < 0.05$ ) between groups

† Significant ( $p < 0.05$ ) from Week 3 (within group)

†† Significant ( $p < 0.05$ ) from Week 6 (within group)

††† Significant ( $p < 0.05$ ) from Week 9 (within group)

## Appendix A. PACES

<i>When I am physically active:</i>
-------------------------------------

	Disagree a lot	Disagree	No opinion	Agree	Agree a lot
1. I enjoy it	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. I feel bored	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. I dislike it	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. I find it pleasurable (same as 1)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<hr/>					
	Disagree a lot	Disagree	No opinion	Agree	Agree a lot
5. It's no fun at all	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. It gives me energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. It makes me sad	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. It's very pleasant/fun	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<hr/>					
	Disagree a lot	Disagree	No opinion	Agree	Agree a lot
9. My body feels good	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. I get something out of it	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. It's very exciting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. It frustrates me	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<hr/>					
	Disagree a lot	Disagree	No opinion	Agree	Agree a lot
13. It's not at all interesting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. It gives me a strong feeling of success	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. It feels good	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. I feel as though I would rather be doing something else	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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