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Motives for Physical Activity and Physiological Variables as Predictors of Exercise Intentions Following a High Intensity Interval Training Protocol in College-Age Females

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MOTIVES FOR PHYSICAL ACTIVITY AND PHYSIOLOGICAL VARIABLES AS PREDICTORS OF EXERCISE INTENTIONS FOLLOWING A HIGH INTENSITY INTERVAL TRAINING PROTOCOL IN COLLEGE-AGE FEMALES

by

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(Under the Direction of Jody Langdon)

ABSTRACT

Recent data collected on college-aged females indicates that more females are classified as insufficiently active and may have little time for physical activity (Ligouri, et al., 2011). High intensity interval training (defined as very short intense intervals, usually above 85% maximum heart rate accompanied by alternated passive recovery periods; HIIT) has become a popular alternative to the more traditional continuous training utilized by individuals due to its time efficiency. In fact, HIIT has been shown to induce many of the same physiological changes as moderate intensity training with less training time. It is possible that college-aged females may benefit from HIIT and its inherent time-saving qualities. To test this hypothesis, this study sought to determine the influence of a HIIT protocol on general motives for being physically active and intentions for future HIIT behaviors. Participants included sixty five female students between the ages 18 and 25 who were enrolled in a physical activity class that included HIIT as a part of the curriculum. Physiological responses to the HIIT protocol were measured via exercise intensity (as measured by heart rate) and calories burned, while motives and intentions were measured through questionnaires. Results revealed no changes in any variables over the course of the study with the exception of blood pressure. Fitness was the only variable that significantly predicted intentions for exercise and thus future

exercise behaviors. These results show some promise for HIIT in this young population but the nature of the relationship between motives and intentions call for future research to determine why more intrinsic motives, including competence, were not related to intentions to HIIT in order to promote long term adherence to exercise programs.

INDEX WORDS: High Intensity Interval Training, Self-Determination Theory, Females, Motivation

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CHAPTER 1

INTRODUCTION

National College Health Assessment data from 2009 illustrates that undergraduate first year students had an overweight and obesity prevalence of 28.1%, as measured by a body mass index (BMI) of greater than 25. Overweight and obesity frequency increased to 34.7% in fourth year students and again to 43.8% in students in their fifth year. Due to this increase, it is crucial that prevention strategies, including feasible and enjoyable physical activities, are implemented during these important years of transition and development.

Physiological Basis for Interval Training

Comorbidities are also associated with lower than average VO_2max and are common with overweight and obesity (Katzmarzyk & Lear, 2011). In an obese population, steady state continuous exercise (CT) is commonly utilized as it induces improvements in cardiovascular factors and includes increased fatty acid utilization; however, it is less efficient than high intensity interval training (HIIT). HIIT can be defined as very short intense intervals, usually above 85% maximum heart rate, alternated with either less intense active recovery periods or passive recovery periods. In recent research, 2.5 hours of HIIT training produced comparable muscular biomechanical adaptations to 10.5 hours of continuous training over two weeks (Giabla, et al., 2006).

Talanian et al. (2006) found an increase in whole body fat oxidation in recreationally active women in only two weeks. Participants completed 10 four minute bouts of cycle ergometer at 90% with two minutes rest in between. The authors submitted that HIIT with work interval intensity of 80-95% was a compromise between supramaximal HIIT, which could be

difficult for the untrained, and moderate intensity exercise, which could be time consuming. Another study that focused on overweight and obese women found significant increases in cardiovascular factors, but no significant fat loss over four weeks (Trilk, Singhal, Bigelman, & Cureton, 2011). A proposed reason for the lack of fat loss was the short duration of these studies. An eight-week study demonstrated fat loss; however, there was no difference between the HIIT and CT group (Wallman, Plant, Rakimov, & Maiorana, 2009). A potential reason for these results was that kilocalories expended between the groups were not controlled for. In addition, the HIIT group utilized a one-to-two work-to-rest ratio, so the increased rest with the HIIT protocol could have decreased its effectiveness. In contrast, Trapp et al. (2008) found that young women doing HIIT with a two-to-three work-to-rest ratio an average fat loss of 4.3%, which was significantly greater than the CT group regardless of the reduced exercise time.

Despite this evidence that HIIT produces significant physiological improvements several studies less than 10 weeks in duration did not produce any changes in blood pressure after HIIT protocol (Rognomo, Hetland, Helgerud, & Slordahl, 2004; Wallman, Plant, Rakimov, & Maiorana, 2009). Studies lasting 12 to 16 weeks demonstrated significant reductions in blood pressure in a variety of populations utilizing HIIT. A 12 week study comparing HIIT to CT found that middle aged obese individuals reduced diastolic blood pressure (DBP) in both groups (Schjerve, I. E.,Tyldum, G. A., Tjonna, A. E., Stolen, T., Loennechen, J. P., Hansen, H. E., Haram, P. M., Heinrich, G., Bye, A.; Najjar, S. M., Smith, G. L., Slodahl, S. A.; Kemi, O. J., Wisloff, U., 2008). These findings were similar to another study examining those with metabolic syndrome over 16 weeks (Tjonna, A. E., Lee, S. J., Rognmo, O., Stolen, T. O., Bye, A., Haram, P. M., Loennechen, J. P., Al-Share, Q. Y., Skogvoll, E., Slordahl, S. A., Kemi, O. J., Najjar, S. M., Wisloff, U., , 2008). Though both groups improved their systolic blood pressure (SBP), only

the HIIT group demonstrated reductions in DBP. A 16 week study nomotensive population of young females with a family history of hypertension and a 12 week study of health young males both demonstrated reductions in SBP in both HIIT and CT groups (Ciolac, E. G., Bocchi, E. A., Bortolotto, L. A., Carvalho, V. O., Greve, J. M., Guimaraes, G. V., 2010; Nybo, L., Sundstrup, E., Jakobsen, M. D., Mohr, M., Hornstrup, T., Simonsen, L., Bulow, J., Randers, M. B., Nielsen, J. J., Aagaard, P., Krustrup, P., 2010). The Ciolac, E. G., Bocchi, E. A., Bortolotto, L. A., Carvalho, V. O., Greve, J. M., Guimaraes, G. V. (2010)study demonstrated a reduction in DBP in both groups as well . While the Nybo et al. (2010) study only demonstrated a reduction in DBP in the CT group (Nybo, et al., 2010). A potential reason for this was that work volume was not equated between the groups resulting in the 60 minute CT session and the 20 minute HIIT sessions, so it is likely that the CT group expended a greater number of calories. In brief, HIIT can induce significant improvements in BP in many populations given adequate time is allotted for the adaptations to take place.

Results from these studies have demonstrated a usefulness of HIIT for weight loss and cardiovascular improvements in a population with exercise time constraints. As a result, popular workout trends incorporated this training type as a part of a more extensive exercise regimen for faster results (Thompson, 2012). Because HIIT can produce impressive improvements in body composition in females, it is important to examine the feasibility of HIIT in this population, especially those protocols with a shorter duration rest intervals to increase workout time efficiency. A determination of how feasible HIIT is for a young, busy female population and how likely they are to engage in HIIT is absent in present research.

Enjoyment and intrinsic motivation for HIIT

Due to the demonstrated purposes of HIIT, research is warranted concerning motivation toward this activity in a young female population (The Obesity, 2010). This research provides insight concerning how the motivation contributes to attitudes towards HIIT. This has implications for decreasing future obesity or preventing initial excess weight gain by determining whether HIIT can be a part of a favorable exercise program in a young female population. The physiological benefits of HIIT are inconsequential if the population that could benefit most from it demonstrates dissatisfaction towards it in comparison with traditional CT.

Self-determination theory (SDT) proposes that when highly motivated individuals demonstrate inherent enjoyment and curiosity towards a task they are said to be intrinsically motivated (Ryan & Deci, 2000). SDT also posits that the needs of autonomy (e.g. a person enjoys the freedom to choose their workout), relatedness (e.g. a person feels comfortable and connected to other gym goers), and competence (e.g. a person believes they will be able to complete a specific number of sets and reps of an exercise) are crucial in the growth or diminishment of engagement in a task for enjoyment. As such, a high degree of autonomy, relatedness, and competence is often associated with intrinsic motivation and intrinsic regulation. In other words, the activity interests the person and participation is continual due to the inherent enjoyment. Motivational regulations are said to exist on a continuum, of which intrinsic regulation is the ultimate goal. In contrast, an amotivated person would experience non-regulation and have no intention to participate. In between these two extremes, extrinsic motivation is described as having one of several regulations: 1) external regulation, meaning that the person finds the task uninteresting and they only would engage due to an external reward or punishment, 2) introjected regulation, where a person participates to avoid feelings of guilt, and

3integrated/identified regulation, meaning that the person finds participation uninteresting, yet they value its purpose and are personally committed to participating to achieve a particular outcome (Deci & Ryan, Handbook of Self-Determination Theory Research, 2002)..

Using the above-mentioned tenets of SDT, Ryan, R. M., Frederick, C. M., Lepes, D., Rubio, N., Sheldon, K. M. (1997) examined five motives towards physical activity that were associated with intrinsic or extrinsic motivation among Tae Kwon Do participants. The motives included fitness, (being active due to the desire to be healthy and energized); appearance (physical activity participation to improve self-image perception); competence/challenge (engaging in activity to become more proficient at it); social (exercising in hopes of interacting with others); and enjoyment (exercising because it causes an internal feeling of happiness).

Using the Motives for Physical Activity Measure (MPAM), researchers found that Tae Kwon Do participants scored higher on competence and enjoyment motives and these were related to better adherence, contrasting with the higher body-related motives associated with the aerobics class which was not related to improved adherence (Ryan et al., 1997). Still, an obese person who has little exercise experience and is motivated by competence for a task will struggle with a very new exercise form despite knowledge that HIIT can induce similar training adaptations to continuous training with less training time (Ryan & Deci, 2000).Similarly, a study comparing cyclist and exerciser motives towards exercise found that though both competitiveness towards cycling and exercise was related to higher interest and enjoyment scores, there was no relationship between competiveness and adherence in the exercising group (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). Nevertheless, findings from these studies agreed with Ryan and Deci (2007), who discussed how sports are more likely played for intrinsic enjoyment. Still it was the interplay of intrinsic and the more common extrinsic (fitness, health)

motives that need to be considered together in determining motivation quality (Ryan & Deci, 2007).

Within the context of the current study, if a participant is intrinsically motivated towards HIIT, they would potentially score highest on the enjoyment and competence constructs, as these items are associated with intrinsic motivation and intrinsic regulation through competence and autonomy. . The fitness variable on the MPAM-R is associated with participating out of a desire to improve well-being and health. This motive could be characterized as an extrinsic motive with integrated regulation in which the person may find the task unappealing but still be personally committed toward participating in it because they recognize its value. Therefore those scoring high on this motive might not necessarily have intrinsic motivation towards HIIT, and still be likely to adhere to it in the future.

When extrinsic rewards are offered for participating in an activity, they may either support or hinder intrinsic motivation and regulation (Biddle, 1999). If a reward is offered that supports the basic need of competence, then intrinsic motivation may be improved. For example, positive feedback may promote intrinsic motivation, unless it is given in a higher pressure situation. In HIIT training, participants receive feedback following each interval by recording their repetitions and comparing it to prior bouts and intervals. Additionally, choice when engaging in the behavior would be perceived as information and support autonomy. Participants have the option to choose their modification and to take a short break if needed for each exercise with HIIT training. In contrast, if the reward is perceived to be controlling, meaning that the goal of engaging in the behavior is to obtain the reward, then the absence of the reward will result in a decrease in the behavior and intrinsic motivation. Rewards, deadlines, and surveillance may be some such factors that cause a lack of control over engaging in the behavior and decrease

autonomy. Chatzisarantis and Biddle emphasize that the importance of autonomy in these situations because intentions are correlated with exercise participation only when they are viewed as autonomous (Chatzisarantis & Biddle, 1998). Nevertheless, there is evidence to suggest that control beliefs in conjunction with autonomous motives can contribute to the engagement in moderate to vigorous physical activity (Wilson, Blanchard, Nehl, & Baker, 2005).

The Theory of Planned Behavior utilizes attitudes, subjective norms, and perceived behavioral control to predict intentions and future exercise behaviors (Hausenblas, Carron, & Mack, 1997). In this study, it was used with the purpose of demonstrating likelihood of future participation in HIIT. Perceived behavioral control relates to autonomy and competence beliefs based off past experiences. It is defined as "the perceived ease of difficulty of performing the behavior (Ajzen, 1988)." There may be unique qualities of HIIT that manipulate perceived ease of participation.

Potential barriers to HIIT

Though studies have reported "lack of time" as a barrier to participation in activity (King, Castro, Wilcox, Eyler, Sallis, & Brownson, 2000), a study by Jung and Brawley (2010) states that there is a difference between a stated barrier to activity and an excuse. Though people continuously report lack of time as a barrier to why they did not engage in exercise, the data showed no significant difference between those meeting ACSM guidelines for physical activity, and those not meeting ACSM guidelines for physical activity, in the number of hours per week spent on non-exercise goals like homework, work, and family.

The decision to exercise is a volitional one and requires self-regulation. Individuals may opt for more instantly gratifying behaviors like sitting on the couch versus completing a HIIT session. These decisions may be quick responses not requiring cognitive evaluation as people

may be avoiding what they perceive to be aversive and gravitating towards what is pleasurable. One reason why 87% of women who exercise on a daily basis participate in traditional aerobics may be because they feel comfortable with it (BLS Spotlight on statistics: Sports and Exercise, 2008). However, if a participant notices fitness improvements over the course of the study and they increase their knowledge of these types of workouts, they could become more comfortable. It is likely that their enjoyment of HIIT and intentions will also increase due to increased competence or skill towards the exercise task, and improved self-image (Sears & Stanton, 2001; Ryan & Deci, 2007). HIIT may provide the inducement for quick adaptations and improve long-term adherence in those who get discouraged quickly. However, improvement in enjoyment may not be significant because relative exercise intensity will increase as fitness increases over the course of the study and potentially cause an aversive response according to dual mode model (Ekkekakis & Acevedo, 2005).

Affective attitudes are the emotional benefits one can gain from participation and the extent to which one wants to gain those (French, D. P., Sutton, S., Hennings, S. J., Mitchell, J., Wareham, N. J., Griffen, S., Hardeman, W., Kinmonth, L., 2005). These affective attitudes are a subcomponent of attitudes discussed in the Theory of Planned behavior, and they contribute to cognitive evaluations towards exercise participation. Affective attitudes are based off of past experiences and help predict future exercise behavior for up to 12 months. In contrast, instrumental attitudes such as "I want to lose weight" or "I want to improve my cardiovascular fitness" are different cognitions that help exercisers obtain their goals. As a result, the present study will be utilizing a brief survey to determine attitudes towards HIIT in order to predict future engagement in HIIT.

A potential reason why HIIT might not be feasible for all populations is due to its high intensity. One study proposed that as exercise intensity increases, affect will decrease, or it will become aversive (Ekkekakis & Acevedo, 2005). When looking at vigorous exercise at or around ventilatory threshold, this model proposes that there will be large individual differences in affect and attitude towards the activity. Most individuals will find moderate intensity exercise pleasurable. As the intensity becomes more vigorous, some may find it aversive based upon their past exercise experiences. HIIT is classified as vigorous activity. The intervals are typically performed near ventilatory threshold, and this may result in negative affect. According to Dual Mode Model it would be unlikely that people would pursue this type of training (Decker, Ekkekakis, Welch, & Welk, 2009).

However, it is important to note that if the rest period allows for recovery below threshold; a positive affect may result, which would be a beneficial contributor to future exercise bouts. These rest periods not only give relief after working at very intense levels, they might lend themselves nicely to having that sense of gratification and be quite memorable. Therefore, if the client is having extreme enjoyment due to the stark contrast from the intense work to no work, they might experience what the Dual Mode Model refers to as a rebound affective response (Decker, Ekkekakis, Welch, & Welk, 2009). Affective literature states that positive affect often times rises higher than baseline levels, immediately after an exercise bout (Kwan & Bryan, 2010). The proposed cause is that people are relieved that their exercise bout is completed. When a HIIT type modality is performed, there is numerous potential for this rebound effect with the recovery period in which the person may feel accomplished for having completed a round of activity and can prepare for the next one. As a result, it is important to determine if HIIT is enjoyable despite its high intensity in this population.

As a measure of affect, one study demonstrated the influence of intensity in HIIT on rating of perceived exertion (RPE). A study comparing high resistance and low resistance high intensity intervals in recreationally trained males utilized RPE to determine this populations' subjective feelings of effort (Gearhart, Becque, Palm, & Hutchins, 2005). Results indicated that force production, not total accumulated work, predicted RPE. Still, the amount of muscle tension was also associated with increased RPE. It is possible that the intermittent sharp increases in muscle tension in the current study will cause a high RPE rating and potentially lead to a reduction in enjoyment. Measuring participant's RPE will allow an analysis to be performed to determine if a correlation exists between high effort ratings, motives of young adult females for HIIT, and how likely these participants are to continue HIIT based of their intentions.

Purpose

Despite numerous studies that demonstrated the efficiency of HIIT to improve aerobic fitness in apparently healthy young adults and the use of HIIT for fat reduction, there is a lack of research combining physiological measures, motives and adherence towards this activity. Therefore, the purpose of this study was to determine the motives for HIIT as well as to determine if these motives, along with physiological measures, predicted exercise intentions. HIIT may be optimal for this population due to its time-effective characteristics; however, it may be unreasonable for those unaccustomed to exercise (Decker, Ekkekakis, Welch, & Welk, 2009). Change in physiological variables and motives for HIIT over the course of the protocol was also examined. It is hypothesized that those that hold more intrinsic motives (i.e, enjoyment) for HIIT participation will have higher intentions to engage in HIIT in the future.

CHAPTER 2

Methods

Participants

Undergraduate students at a Southeastern university who enrolled in an aerobics course during the spring semester were informed about the study. Those interested completed a Health History Questionnaire to determine if it would be safe for them to participate and if they were eligible for the study. The sample consisted of primarily Caucasian (N=27) and African American (N=27) female participants in their second year of their undergraduate education. Participants were between ages 18 and 25. Exclusion criteria included pregnancy, a Health History Questionnaire (HHQ) that revealed cardiovascular disease risk factors, or any disability that would hinder ability to perform intense body weight exercise. Participants were given extra credit for participation in the study. Those that did not participate were allowed to complete an equivalent assignment for extra credit.

Instrumentation

Motives for physical activity. Participants completed the Motives for Physical Activity Measure-Revised immediately following their first HIIT session as well as following their last workout of the intervention (MPAM-R; Ryan et al., 1997). The measure contains 23 items assessing reasons for participating in an exercise activity, rated on a seven point Likert scale (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). The subscales of enjoyment, competence, social, fitness, and appearance were scored by taking an average of the participants' scores on the items pertaining to each subscale. These all have an internal reliability alpha of .93, .93, .84, .74 and .74 respectively for each subscale within this study, which is comparable to values found in Ryan et al. (1997).

Exercise intentions. A measure adapted from Chatzisarantis, Biddle, and Meek (1997) was used to assess participants' intention to participate in HIIT after the end of the aerobics course. This three-item questionnaire was constructed with responses on a 7-point Likert scale and indicated how likely participants would be in participating in HIIT in the next month. Internal consistency of this measure was comparable to previous studies, with the three items being highly correlated (Cronbach's $\alpha = .83$). Overall scores were calculated by averaging question responses.

Anthropometric measures. Anthropometric testing was conducted prior to the first workout and following the final workout. This includes measurement of height and weight on a secca scale. These measurements were then utilized to calculate BMI because of the convenience of the calculation since the main goal of this study was not to determine body composition changes. BMI has been correlated with cardiovascular disease risk in women (Capuano, Bambacaro, D'Arminio, Vecchio, & Cappuccio, 2003).

Blood pressure. Blood pressure testing took place prior to any activity after 10 minutes of resting. An Omron automated blood pressure cuff was utilized. The measurement was repeated following the final workout.

Workout Intensity

Heart rate. In order to measure exercise intensity each participant put on a heart rate monitor at the beginning of each class. The monitor recorded the maximum, minimum, and average heart rate as well as kilocalories expended for the class and relayed the data to the Polar Team Base Station© which collected the data for future upload and analysis. Each participant's heart rate monitor sent their heart rate data via Bluetooth technology to a computer for each

workout. Heart rates were encouraged to be between 85 to 100% heart rate maximum because most HIIT studies were conducted within this range (Cunningham, McCrimmon, & Vlanch, 1979; Gorostiaga, Walter, Foster, & Hickson, 1991; Talanian, Galloway, Heigenhauser, Bonen, & Spriet, 2006). The heart rate monitors were returned after each class, washed, and prepared for the next class.

Perceived exertion. Prior to each exercise session, participants were briefed on the Borg RPE scale and verbally cued on the meaning of each of the levels. Because the main purpose of the RPE scale was to understand the subjective feeling of intensity during the workout, the Borg CR-10 scale rather than the original RPE scale was utilized. The CR-10 scale is a culmination of ratio and categorical scales (Borg G. , 1998). The CR-10 scale allowed participants to rate their exertion with fractions and has no upper limit. A rating of "10" indicates an "extremely strong" exertion. Additionally, the standard one to ten range may be somewhat more comprehensible for participants. This scale has reliability coefficients of .96, and .97 for perceived exertion, and heart rate respectively and construct validity coefficients of .85 (Ljunggren & Johansson, 1988). During each training session a RPE was taken immediately after the HIIT portion of the workout to determine changes in RPE over the course of the study, and to determine if RPE ratings correlate with future intentions to engage in HIIT. The participants wrote their rating on a workout paper each training session.

Exercise Training

Training took place in the group fitness room at a Southeastern university's Recreational Activities Center. While training in an open air conditioned group environment, the participants engaged in a five minute warm up consisting of dynamic stretching and light cardiovascular activity that mimicked the workout. Fifteen to twenty minutes of body weight interval training

ensued. The HIIT consisted of work intervals ranging between 20 seconds and 50 seconds with rest periods equal to or less than the work duration. More complex exercises were completed during the longer work periods. For example, regular pushups were conducted during a short interval while a renegade pushup in which the participant completes a push up and rows the arm back, was completed in a longer interval. After the HIIT workout, a light cardiovascular cool down, in addition to stretching was performed. Participants were encouraged to complete as many repetitions as possible during a given work period while taking rest in a work interval if necessary. After the HIIT workout was completed, a light aerobic cool down and stretching took place. Workouts were performed on Monday and Wednesday mornings for nine weeks.

Participants were informed that they could stop at any time if needed but to try to complete the warm up, workout, and cool down to the best of their ability. Because many interval training studies with females are conducted at lower intensities, the participants were asked to try to complete as many repetitions as their physical capacity allowed during the given work interval (Gorostiaga, Walter, Foster, & Hickson, 1991; Poole & Gaesser, 1985). Their workout was not classified as "high intensity" unless their heart rate was at least 85% of their maximum heart rate. The age predicted heart rate formula was utilized to determine maximum heart rate. Nineteen training sessions took place over the course of the study. Participants must have completed 16 sessions to be included in the analysis.

Procedure

The study was performed in aerobics classes instructed by the principle investigator of this project. Coercion of the participants was minimized by reminding participants, both verbally and on the informed consent, that their grade in the course and relationship with the instructor was not contingent upon their participation in the study. Each questionnaire and survey was

coded by having the student pick a piece of paper with a number on it out of a bag. All information was kept on the principle investigator's personal laptop and in the graduate student office cabinets which was locked. Only the principle investigator and other investigators had access to the files and records of these tests. The key for this coding was only available to the principal investigator and was kept in a locked drawer of a locked office. It is important to note that the questionnaires were filled out while the principal investigator was not in the room to avoid pressuring participants to respond in a certain way.

Participants were informed about the study on the first day of class. Each interested participant completed a Health History Questionnaire (HHQ) which was administered as described in *ACSM's Guidelines for Exercise Testing and Prescription* to screen for cardiovascular risk factors (Thompson, Gordon et al., 2009). The participants were informed that this is a safety oriented screening tool. The American College of Sports Medicine recommends that physician's clearance is warranted given two or more risk factors for participation in vigorous exercise. If the screening revealed that they fit the inclusion criteria and do not exhibit the exclusion criteria, written and verbal informed consent was obtained. Then a demographic survey was given, blood pressure screening was conducted, the HHQ was completed and reviewed, and anthropometrics were collected. Anthropometric results were recorded on a lab sheet specific to this study with the participant's study number on it. This testing also happened at the 9th week mark after the group of participants completed the MPAM-R and behavioral intention questionnaire. Following these tests, the initial training session took place.

Twice a week for nine weeks the participants engaged in an undergraduate Aerobics class that included body weight muscular endurance and cardiovascular HIIT. Upon entering the classroom, participants picked up their assigned heart rate monitor. The participant dabbed water

on the inside surface of the heart rate monitor to aid conductivity. Then they placed the monitor one inch below their sternum and assured that the monitor was flush against the body. The chest strap was then tightened to secure the monitor in place. Then the five to ten minute warm up, the body of the HIIT workout, and the cool down took place. Participants returned their assigned heart rate monitor and the Polar Base Station collected the data so that every participant in all three classes had clearly tracked heart rate data for the entire class.

Immediately following the first workout, the participants received written and oral instructions for the MPAM-R. The MPAM-R questionnaire was administered in order to get a baseline determination of motives towards HIIT. Participants were instructed to consider HIIT specifically, completely read each statement, and select the appropriate level of the Likert scale. They were asked to distance themselves from other participants to avoid socially desirable results. The assistant reminded the participants when reading the questionnaire directions that they should voice any feelings of pressure to participate. If a participant felt pressured to participate, they were reminded they could withdraw from the study with no penalty at all. Once all participants completed their questionnaire, they were given the opportunity to ask questions regarding their involvement in the study. After the last workout of the 19 sessions has taken place, participants took a second MPAM-R, had their blood pressure taken, and anthropometric testing was repeated. They also were given written and oral instructions to consider only HIIT for the exercise intentions three item questionnaire. This was completed in order to draw conclusions about possible future HIIT participation.

Data Analysis

Statistical analysis was conducted using SPSS 19. A dependent t-test was conducted utilizing the subscales of the MPAM-R (interest, competence, fitness, appearance, and social),

resting heart rate, blood pressure, blood pressure category, weight, weight category and BMI to determine if there were changes over the course of the study on these variables. A multiple step wise regression analysis was conducted to determine if subscales of the MPAM-R, BMI, blood pressure, resting heart rate, mean average heart rate percentage, average maximum heart rate percentage, and average workout RPE predict exercise intentions. This aided in a determination of future HIIT participation. The alpha level was .05.

CHAPTER 3

RESULTS

Descriptives

Descriptive analyses were performed to generate an accurate understanding of the population studied, as well as determine the means of variables that were entered into the dependent t-test and multiple regression analyses (see Table 1 &2, Appendix E). 33.3% responded with a 4 out of 5 on their intentions to participate in HIIT and 31.3% responded with a 5 out of 5. Most participants were categorized as being of normal weight, based upon BMI (N=30), in contrast the average BMI of all participants (N=57) was 24.91 at the onset of the study and 25.34 at the end of the study (N=52). These averages verge on the overweight BMI category. Only 51.7% of participants met minimum exercise recommendations at the start of the study. Table 3 (Appendix E) shows how many of the individual scores for motivation were already higher than the midpoint on a seven point Likert-type scale. For example, the fitness related item on the MPAM-R that stated "Because I want to maintain my physical strength" had an average score of 6.55 ± .67. In contrast, the social related item, "Because my friends want me to" scored an average of 1.65 ± 1.09. The RPE scores reported following each workout seem to be relatively consistent from the workout on day one (M = 6.37, SD = 1.29) to day 19 (M = 7.68, SD = 1.53) (Table 4, Appendix E). These values are associated with a rating of "very hard" on the Borg CR-10 scale. Still, the range on these values was very large suggesting that some participants did not exert themselves as much as others.

Effectiveness of the HIIT Training

Physiological variables, in addition to the MPAM-R were measured at week one and again at week nine. A dependent t- test of these variables revealed significant differences only on blood

pressure variables. Results indicate a significant decrease from week 1 systolic blood pressure ($M = 119.37$ mmHg, $SD = 11.78$) to week 9 ($M = 111.54$ mmHg, $SD = 9.74$; $t(51) = 5.23$, $p < .001$). Diastolic blood pressure also dropped from an average of 73.73± 8.28 mmHg to 69.44 ± 7.00 mmHg, ($t(51) = 4.13$, $p < .001$). All other variables including resting heart rate (RHR), weight, BMI, and motivational constructs were not statistically different from pre to post. As a result, the post measurement variables were used for the correlations and regression with the exception of blood pressure in which both pre and post measurements were included in the analysis.

Relationships between Motives, Physiological Measures, and Intentions

A number of significant correlations emerged in the data. Positive correlations existed between intentions to engage in HIIT in the future and interest ($r = .423$, $p < .001$), competence ($r = .520$, $p < .001$), and fitness($r = .570$, $.p < .001$) motives. Similarly, as interest increased, competence ($r = .865$, $p < .001$), fitness ($r = .526$, $p < .001$), and social motives ($r = .520$, $p < .001$) increased. Competence motives were significantly correlated with fitness motives ($r = .639$, $p < .001$) and social motives ($r = .312$, $p < .05$). While the other motives are known to be more intrinsically oriented, it seems logical that appearance would only be correlated with the fitness ($r = .523$, $p < .001$) and social motives ($r = .348$, $p < .05$). Fitness scores were also positively correlated with social motives ($r = .283$, $p < .05$).

Interestingly, there was a significant, yet small positive correlation between appearance motives and average percentage heart rate max ($r = .281$, $p < .05$) of all workouts. The average amount of kilocalories (Kcals) utilized per workout was positively associated with both appearance ($r = .315$, $p < .05$) and social motives ($r = .331$, $p < .05$). Aside from interest motives, competence motives, appearance motives, and fitness motives, and social motives were

positively related to weight category ($r = .298$, $p < .05$). Weight category was positively associated with BMI ($r = .876$, $p < .001$), systolic ($r = .343$, $p < .05$) and diastolic blood pressure ($r = .346$, $p < .05$), mean average heart rate percentage ($r = .380$, $p < .05$), average heart rate maximum percentage($r = .273$, $p < .05$), and calories burned in each workout ($r = .664$, $p < .001$). Those in higher weight categories are more likely to have higher blood pressures and burn more calories due to the additional weight. Therefore, it is not surprising that the BMI variable shared the same correlations as weight category in addition to being negatively correlated with total work completed ($r = -.329$, $p < .05$).

Average kcals burned was also associated with systolic blood pressure ($r = .398$, $p < .05$), Inexplicably, diastolic blood pressure was correlated with the average heart rate percentage maximum when systolic blood pressure was not ($r = .437$, $p < .05$), Like BMI, total work was negatively correlated with diastolic blood pressure ($r = -.279$, $p < .05$). As expected systolic post measurements were correlated with diastolic post ($r = .67$, $p < .001$), measurements and both systolic and diastolic post blood pressure measurements were associated with average heart rates. Mean average heart rate percentages were positively associated with average heart rate maximums ($r = .764$, $p < .001$), in addition to calories burned ($r = .794$, $p < .001$). This is logical as these variables are all related to cardiovascular health.

Regression Analysis

A step-wise multiple regression analysis was performed to determine which variables, both psychological, and physiological, might contribute to a person's intentions for HIIT. Appearance, enjoyment, social, fitness, and competence motives, as well as, blood pressure, BMI, resting heart rate, and average heart rates were incorporated to the regression. Among these variables, fitness motives were the only significant predictor of intentions to participate in

HIIT. The analysis revealed that 32.5% of the variance in intentions to engage in HIIT could be explained by the participants' fitness motives ($F(1) = 22.11$, $p < .001$; Table 6).

CHAPTER 4

Discussion

The purpose of this study was to determine if there is a relationship between physiological measures, motives for HIIT, and intention for exercise behavior of HIIT in young healthy women. Change in physiological variables and motives were also studied. The hypothesis that the motives associated with more intrinsic motivation would predict HIIT intentions was partially supported. Approximately 65% of participants had the intention to engage in HIIT in the future and fitness was the only construct that contributed to the regression equation. In contrast, appearance was a more externally motivated construct and did not contribute to intentions to engage in HIIT. As such, the hypothesis was partially supported. This is not surprising as the appearance item "Because I want to be attractive to others" revolves around an external reward.

The enjoyment motive may not have contributed to the equation because though there was a positive correlation between interest/enjoyment with intentions, it is possible that some may respond negatively to items like "Because it's fun" but still have high intentions for HIIT due to their high fitness motives. The fitness motive, would be considered an identified or integrated regulation of extrinsic motivation as described by Ryan and Deci (2000). In examining the actual questionnaire items, participants were able to demonstrate personal importance of the HIIT protocol, but not show outright enjoyment with the activity. Although it is considered an extrinsic motivation, the perceived locus of causality is more internally driven, as indicated by the item "Because I want to maintain my physical health and well-being". HIIT may offer faster adaptations than traditional modalities of training which may lead to increased satisfaction with outcomes (Giabla & Mcgee, 2008; Helgerud, et al., 2007). Knowledge of this among this

population possibly contributed to higher motivation scores for fitness motives, and the relationship between fitness scores and intentions.

Satisfaction with outcomes plays an immense role when looking at maintenance of exercise behavior. If an individual is exercising with the goal of improving fitness levels, and he/she is engaging in a training program without substantial results, then his/her motivation will diminish. This notion is supported by SDT, which submits that physical activity participation is influenced by competence for the task (Deci & Ryan, 2002). Long-term behavior change requires consideration of what the population values, what activity program will provide those results as well as supports their basic needs, otherwise they will be likely to quit. A study comparing cancer patients and individuals without cancer sought to determine the extent to which autonomous and controlled motives predicted physical activity participation and outcome expectations. Both those suffering from cancer and cancer-free participants demonstrated that autonomous motivation mediated outcome expectations, while autonomous and controlled motives contributed to engagement in moderate to vigorous physical activity (Wilson, Blanchard, Nehl, & Baker, 2005).

These results provide grounds for further research to determine whether autonomous undergraduate females in the classroom setting demonstrated higher outcome expectations than their less intrinsically motivated counterparts and if even the controlling external influences of class setting could contribute to exercise participation outside of the classroom. Because the fitness motive, which falls under the integrated regulation category of extrinsic motivation, was the only contributing motive to intentions, it is possible that controlling motivations of the classroom setting influenced future HIIT participation.

Self- efficacy and self-regulatory behaviors also contribute greatly to exercise adherence (McAuley, et al., 2011). It is the person's self-confidence and their abilities to successfully engage in the task regardless of barriers that are posed. For example, someone's perceived ability to complete a 20-minute body weight HIIT training session would demonstrate their self-confidence. A prospective study of those engaging in a physical fitness program found that self-efficacy played a larger role in exercise adherence than outcome expectations, though both contributed (Desharnais, Bouillon, & Godin, 1986). Competence, which is a construct related to intrinsic regulation, did not contribute to prediction of intentions and expected adherence in the present study. When discussing volitional and thus autonomous exercise it is imperative to encourage the client to consider their self-regulation, and self-efficacy for the task in order to complete it more frequently. In contrast with the present study, another study demonstrated an increase in self-regulatory self-efficacy following two weeks of HIIT. In addition, their increased self-efficacy for HIIT increased their self-efficacy for engaging in other exercise modes. This is important because despite having participated in a lab based protocol, participants believed that they would be able to engage independently (Terada, T., Friesen, A., Chahal, B. S., Bell, G. J., McCargar, L. J., Boule, N. G., 2013).

The most powerful way to increase self-efficacy is to increase the participant's number of mastery experiences (Bandura, 1995). It is important for individuals to personally experience success because as soon as they have that successful experience, they learn that they will be able to accomplish it again. This may be a reason why competence for this population was consistently high for HIIT. In a practical model of HIIT where 10 intervals are being performed, there are 10 examples of successful completion of the task. Each interval can act as a mastery experience and an opportunity to bolster self-efficacy. In contrast, traditional continuous modes

of exercise only allow for one mastery experience at the end of the exercise bout. At the end of a HIIT workout, the participant might experience a heightened sense of accomplishment. This increase in mastery experience may also improve self-efficacy. Exercise psychology literature maintains that an individual engages in something achievable yet challenging, self-efficacy will increase much more so than if they were to engage in something mediocre in terms of challenge (Schunk, 1991). Therefore, if HIIT is more challenging than CT, then it would likely lead to higher levels of self-efficacy for those experiencing repeated mastery experiences. Future research should compare the two exercise forms for self-efficacy and competence to tasks in order to test this notion.

Unanswered questions remain concerning adherence to HIIT. Further research is needed that considers self-efficacy, basic need satisfaction with outcomes, and in effect, whether people will actually adhere to HIIT. This may be achieved by following people for a longer period of time following HIIT trials, continuing integrated research, and performing these tests in a wide variety of populations to increase generalizability by speaking to the safety of HIIT in chronic disease populations in addition to determining the locations in which HIIT is most effective. Likewise, research is warranted to determine why these intrinsic motives, including competence, were not related to intentions to HIIT in order to promote long term adherence to exercise programs.

Additionally, the authors hypothesized that motives for HIIT would increase over the course of the study; however, no change was demonstrated. It is important to note that mean values for interest, competence, appearance, and especially fitness, were already elevated at the start of the study. This may demonstrate some participant bias of those who opted to participate in the study. It is unlikely that the participants' prior activity contributed to these higher motive

values because only 51.7% of participants met cardiovascular exercise recommendations and only 3.5% of participants met muscle strengthening recommendations. The cardiovascular statistics are consistent with the general United States population with half of the adults meeting recommendations (One in five adults meet overall physical activity guidelines, 2013). Still, 3.5% is less than the nation's 33% of adults meeting strengthening recommendations. Twenty percent meet both muscle strengthening and aerobic recommendations. The findings of the present study suggest that body weight HIIT might be a viable option for increasing the percentage of young females that also meet muscle strengthening recommendations

The aerobics course took place during the spring semester and the high appearance motives at the beginning of the study may be a product of upcoming spring and summer breaks. Despite these higher motive scores in the sample, only 47.4% of the participants were meeting minimum physical activity recommendations prior to the start of the HIIT protocol. This is an example of the disconnect between motives and intentions to exercise. One previous study suggests that a possible reason for this is an inadequate understanding of not only competence but the qualitative breadth of perceived autonomy (Teixeira, Silva, Mata, Palmeira, & Markland, 2012). Nevertheless, these findings seem to diverge from the majority of self-determination theory research demonstrating that intrinsic motivations typically are related to increased exercise participation (Ingledew & Markland, 2008; Teixeira, Carraca, Markland, Silva, & Ryan, 2012)

Furthermore, none of the physiological variables contributed to predicting intentions to continue HIIT. There are a variety of possible reasons for this. For instance, heart rate maximum has a genetic component to it and is related to fitness level (Hanson, et al., 1989). Those who are cardiovascularly fit may experience increased plasma volume, increased contractility, alteration

of sinoatrial node function and decreased beta adrenergic receptor number (Zavorsky, 2000). These alterations have the potential to decrease maximum heart rate. As such, utilizing the age predicted heart rate maximum equation is not ideal for this population. Percentages of heart rate maximum were based off of this model for convenience reasons, as the Polar Team 2 Software utilized this calculation as a preset setting. Mean average percentage heart rate readings and mean maximum heart rate readings of the workouts would be influenced by this with some individuals achieving supramaximal heart rates due to a higher maximum genetic limit and others struggling to meet the 85% maximum heart rate minimum requirement for high intensity exercise due to a naturally occurring lower true heart rate maximum. Similarly, it was more difficult for fit individuals to elevate their heart rates to the higher intensities due to improved recovery abilities. This caused variability in heart rate measurements. Others had reduced heart rate percentage averages simply because they were not exerting themselves as much.

This was not necessarily reflected in RPE as this is a subjective measure. Participants were prompted as to the meaning of the levels; still, they may have interpreted them differently based on prior exercise experience or other factors. Resting heart rate measurements were also subject to variability because they were not true resting heart rates taken upon waking. Participants were asked to relax for five minutes upon entering class; however was not necessarily enough time for the heart rate to return to resting after walking to class. Some participants entered class late when taking resting heart rates, which may also introduced internal variability.

Similarly, blood pressure could have been influenced by emotional or physical exertion prior to measurement though there was a fifteen-minute rest time prior to measurement. Despite the potential for variability, a dependent t-test revealed a significant difference from pre levels to post levels. At the start of the study 42.95% of the participants were classified as prehypertensive

and 2.9% were classified as hypertensive while only 21.2% of participants at the end of the study were classified as prehypertensive and no one was classified as hypertensive. This finding was unexpected because training only took place twice per week. This may be evidence supporting the research that suggests there is some strong evidence to suggest that if HIIT can be performed, it is more cardioprotective than moderate activity even when exercise volume is controlled for (Gormley, et al., 2008; Swain & Franklin, 2006).

Though there were only nine training weeks and 19 sessions, the study spanned over duration of 12 weeks. The participants were still participating in the HIIT training during two of the twelve weeks. These weeks were not included in the analysis due to technical difficulties with the heart rate monitors. The third week that was not accounted for in the analysis was spring break during which the protocol did not take place. It is possible that the time period over which the study took place, in addition to potential outside activity induced reductions in BP (Nybo, et al., 2010; Schjerve, et al., 2008; Tjonna, et al., 2008). Research indicates that study duration of at least 12 weeks may be necessary to observe significant reductions in BP. Additionally, there is research to suggest that greater improvements in BP are correlated with larger increases in VO_2max which is a possibility for the current study (Nemoto, Gen-no, Masuki, Okazaki, & Nose, 2007). Still, studies of shorter duration did not exhibit complimentary increases in the two variables (Astorino, Allen, Roberson, & Jurancich, 2012).

As expected, two HIIT sessions per week was not a strong enough stimulus to influence RHR, weight, or BMI. Blood pressure was significantly decreased, though; the study was not controlled such that the change can be directly attributed to the intervention. Because it seems as though most motives were not directly linked to intentions and thus physical activity levels, it is possible that some participants increased their activity levels outside class or improved their diet

over the course of the semester to influence the variable. Other studies, did demonstrate health and fitness improvements, however, failed to produce any body composition changes (Talanian, Galloway, Heigenhauser, Bonen, & Spriet, 2006; Trilk, Singhal, Bigelman, & Cureton, 2011). The lack of change in these studies was likely because they were not long enough or the workouts were not frequent enough because numerous studies on women that met minimum recommendations for physical activity and were longer than eight weeks produced significant reductions in body fat (Sijie, Hainai, Fengying, & Jianxiong, 2012; Trapp, Chisholm, Freund, & Boutcher, 2008). Though unlikely, it is possible that BMI remained unchanged due to an increase in lean body mass over the course of the 12-week period study if participants did improve diet and exercise behaviors outside of the classroom. Because directly measuring body fat percentage may be a better indicator of disease risk, a systematic review and meta-analysis of the ability of BMI to identify obesity revealed that this measure does not identify half of the people with excess adiposity (Okorodudu, et al., 2010). As a result, directly measuring lean body mass might better predict disease risk and health.

The generalizability of these results is limited to a disease free young female population in a mandatory physical activity course. This is due to influences on young females in a class setting that might not exist in an independently prescribed HIIT program or a regular group fitness setting. Additionally, extra credit was used to encourage participation in the study which was a potential source of external motivation. Still, there was alternative extra credit project offered, as they often times are in these types of classes. As a result, these external motives are consistent with motives females commonly experience in these classes. Both extra credit options were only worth 2.5% of the participants ‘grade. As such, it would not have much bearing on the

participant's grade and their participation would not necessarily be contingent upon receiving the reward because the likelihood of it impacting their grade was minimal.

The fact that this study took place during a mandatory physical activity class as opposed to a voluntary group fitness class may have contributed to the lower social related scores. It was interesting how social scores were low in this population even in a class setting because research demonstrates that low social support may be related to increased exercise program drop out. This might explain why some people in the present study chose to stop participating (Pridgeon & Grogan, 2012). A study on comparing at home cardiac rehabilitation versus hospital group based rehabilitation utilizing interval training found no differences between the groups for quality of life improvements or adherence (Moholdt, Vold, Grimsmo, Slordahl, & Wisloff, 2012). There were statistically insignificant evidence of decreased compliance in home based HIIT programs. Some participants noted lack of time. Social motives may not be crucial because compliance for all groups was particularly high.

The present results of this study support these findings because it was not seen as a highly socially supportive activity, and intentions to engage in HIIT in the future were favorable. Still, the 35.4% of participants that did not score high on future intentions were possibly influenced by the classroom setting in a negative way. Teaching style was not manipulated in the present study. Though the workouts built upon each other and had the potential to improve competence for the task, this had no bearing on competence motives. The lack of change in social motives may also demonstrate no change in the basic need of relatedness. The instructor attempted to support autonomy by offering modifications, relatedness by encouraging a judge free classroom, and competence by building on previous exercises; however no specific training on autonomy support took place. In previous studies, when comparing an autonomy supportive group fitness

situation to one that lacked autonomy support, differences emerged. Autonomy, competence, intrinsic motivation, attendance during the program, and adherence five weeks following the program were all increased with the autonomy support condition (Moustaka, Vlachopoulos, Kabitsis, & Theodorakis, 2012). As a result, findings may be different if young females were exercising in a different environment.

Additionally, there may be a participant bias due to subject mortality. The study started with 67 participants and ended with 57 participants. The drop in participants was mainly caused by participants dropping the course or choosing to no longer attend class. Others chose to complete an alternative extra credit project instead of participating in the study for extra credit. It is possible that the data was collected from more highly motivated individuals than the general population. On another note, this study was longer than other HIIT feasibility studies which may also have contributed to the increased subject mortality. The ACSM states that moderate intensity exercise is more enjoyable, it's better tolerated and it is more likely to be continued than high intensity activities (Glass & Chvala, 2001). However, such a statement cannot be made with total confidence prior to carefully examining the literature and many forms of vigorous intensity exercise. Still, it is important to consider whether clients will adhere to HIIT training programs, and participate in it of their own volition in order to make a sizable difference in the health of the nation.

Conclusion

Those who scored higher on fitness motives were more likely to score high on intentions and potentially engage in HIIT in the future. Following up with the participants to determine actual exercise behaviors and physiological changes would be beneficial for developing useful exercise programs that young females will want to engage in and that will support the basic

needs of autonomy, relatedness and competence. The mandatory classroom setting may have contributed to lower social scores and may have caused lower relatedness. Changes in motivation were non-existent for this population. This preliminary research lays the groundwork for studies concerning adherence to body weight HIIT programs and branches away from the more commonly conducted treadmill and cycle ergometer intervention program.

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APPENDIX A

HYPOTHESES AND LIMITATIONS

- Research Hypotheses

The purpose of this study is to determine if there is a relationship between physiological measures, motives for HIIT, and intention for exercise behavior of HIIT in young asymptomatic women. Because HIIT is shown to be a time efficient way of inducing many of the same physiological changes as moderate intensity training, including increased fatty acid oxidation, the authors predict that higher scores on interest/enjoyment, social relatedness, and competence were expected to be positively related to higher intention to exercise scores.

Secondarily, fitness motives for HIIT are likely to increase among most participants as they gain more regular exposure to the benefits of HIIT and potentially experience fitness improvements throughout the study. Appearance/ body related motives may also increase due to this. It is important to note that part of this study took place in the weeks prior to spring break, so this external factor may also influence body related motives towards HIIT. Social relatedness is also predicted to increase if the participants perceive the group exercise setting to be supportive. Additionally, intentions to engage in HIIT may also increase if participants witness others they perceive to be similar to them succeeding (Bandura, Health promition from the perspective of social cognitive theory, 1998). Similarly, competence is predicted to increase as the participants become more accustomed to the exercises and working out at the prescribed intensity. On the other hand, interest/enjoyment may not change due to the high intensity nature of the exercise. Those who show an increase in intrinsic motivation towards HIIT were more likely display more inclination towards continuing participation in this activity.

RPE was examined to determine if high intensity interval training is a practical option to meet minimum exercise recommendations. Gearhart et al. found that recreationally active participants had higher RPE ratings with exercises requiring greater force production. Additionally, Doherty, Smith, Hughes, and Collins (2001) found that exercise at a very high intensity in well trained males resulted in increasing RPE ratings as a function of time.

It was likely that the RPE ratings in the current study would mimic results found in previous studies because participants were unaccustomed to the force production during the intense intervals, in addition to their inexperience with exercise of any duration. It was possible that intermittent sharp increases in muscle tension in the current study caused a greater increase in RPE. Over the course of the study there was the potential for a slight decrease in RPE as participants become more accustomed to exercise. However, this decrease may not be significant because their relative intensities will be increasing because they may have to complete more repetitions during a given time interval in order to achieve their prescribed heart rate zone over the course of the study.

- Limitations

Subject mortality due to class drop out and participants not coming to class was a barrier. Potential reasons for drop out were possibly due to the intense nature of the protocol and the attendance requirements. Additional participants may be recruited at the beginning of the study to maintain adequate power. Additionally, a convenience sample was utilized so a volunteer effect might occur. For instance, those who participate in the study may have higher levels of motivation towards exercise than those who choose not to participate. Additionally, some participants were unaccustomed to working out and could have trouble reaching the desired intensities. Lastly, the MPAM-R relies on memory of HIIT sessions over the course of the study.

The participants might demonstrate different motives than they felt while completing the exercises or they might feel compelled to answer in a way they think the researcher would want them to answer.

- Delimitations

This study only included apparently healthy females, ages 18 to 25. Volunteers were be excluded for pregnancy, medications for hypertension, or medications influencing the heart, diabetes, blood pressures exceeding 140/90 because this constitutes hypertension, and disability that may hinder their ability to perform the exercises. Because this is a narrow group of people, the results might not generalize to other age ranges or people of a male gender.

- Assumptions

It is assumed that the participants would not over think the items on the MPAM-R or the Intentions for HIIT scale, and that they were comfortable answering these types of questions. It is also assumed that participants give their maximal effort in workouts by maintaining their prescribed heart rate zones.

- Definitions

The Borg CR10 scale was utilized to measure the participants' perception of exertion during training. This scale ranges from no perceived exertion to maximum or almost maximal exertion where the participant can no longer continue.

Short rest intervals are defined as a passive rest equal to or less than the duration of the work period.

HIIT is defined as very short intense intervals, above 85% maximum heart rate, alternated with either less intense active recovery periods or passive recovery periods

APPENDIX B

EXTENDED LITERATURE REVIEW

The United States has an obesity prevalence of greater than 20% in each state (Behavioral Risk Factor Surveillance System Survey Data, 2010). Additionally, 36 states have above a 25% obese population. High rates of obesity are most troublesome in women due to the severe risk for comorbidities (type II diabetes, most cancers and cardiovascular disease) associated with a body mass index (BMI) greater than 30 kg/m^2 and a waist circumference greater than 80 cm (James, Leach, Kalamara, & Shayeghi, 2001). Recent statistics demonstrated that women worldwide have a 64.1% incidence of overweight and obesity when the BMI classification is utilized (Overweight and Obesity Statistics, 2010).

Female students reported a lack of time as an exercise barrier (Adachi-Mejja, et al., 2010; Grubbs & Carter, 2002). Sufficient activity for adults for health includes a minimum of 30 minutes of moderate intensity aerobic exercise, five days per week or 20 minutes of vigorous intensity exercise three days per week, or a combination of these to meet the recommendation (Haskell, et al., 2007). 2012 worldwide obesity trends include exercise and weight loss, military training inspired boot camp, and functional fitness being ranked seventh, eighth, and ninth respectively (Thompson, 2012). These trends may be a result of time constraints for exercise and the growing obesity problem.

Body weight high intensity interval training (HIIT) is a form of functional fitness that is incorporated into many boot camps. HIIT may provide a time effective means by which students can adhere to the vigorous activity minimum recommendation for cardiorespiratory fitness and the resistance training recommendation. The resistance training recommendation includes

training each muscle group two times per week as prescribed by the American College of Sports Medicine's minimum recommendation (Garber, et al., 2011).

HIIT Responses in Sedentary Individuals

Physiological changes in sedentary subjects were compared for CT and HIIT with the same relative workloads three days per week for eight weeks (Gorostiaga, Walter, Foster, & Hickson, 1991). The HIIT group completed 30 seconds of work at an intensity of 100% and 30 seconds at rest while the continuous training group trained at 50% for 30 minutes. Results indicated that the HIIT group increased their work rate, power output and VO_2max from 9% to 16%. The continuous training group increased only five to seven percent for the same measures and increased citrate synthase. These aerobic improvements decrease disease risk. Both groups demonstrated decreases in blood lactate, and respiratory quotient denoting an increase in fatty acid oxidation. Adenylate kinase, an enzyme involved in adenosine triphosphate production (ATP) was also increased. These findings indicate an increase in fitness because the body was working more efficiently to produce energy.

These results suggest that HIIT was more effective in increasing maximal oxygen consumption and maximal exercise capacity while continuous training was more efficient in elevating muscle oxidative capacity and delaying blood lactate accumulation (Gorostiaga, Walter, Foster, & Hickson, 1991). This supports the notion that HIIT can benefit a sedentary population by invoking greater power and oxygen consumption increases by using short work intervals compared to CT. This is crucial due to the positive relationship between higher scores and cardiovascular health (Katzmarzyk & Lear, 2011). However, the participants experienced higher heart rates and RPE (Gearhart, Becque, Palm, & Hutchins, 2005). Therefore, HIIT might

not be feasible if RPE is a barrier to exercise adherence. The authors submit a possible cause for this may be attributed to increased rates of fast twitch muscle fiber recruitment and firing. Because muscle fibers are recruited successively, these faster twitch fibers are among the last to be recruited. As such, they are more highly activated as intensity increases and fatigue more easily than slow twitch muscle fibers which are primarily utilized with continuous moderate intensity training (Laursen & Jenkins, 2002).

Contrary to the findings of Gorostiaga et al. (1991), Essen et al. (1977) studied substrate utilization in the legs of five males who performed 15 seconds of work, and 15 seconds of rest or 60 minutes of continuous training. Both conditions had similar average oxygen uptake and power output during exercise. Both the continuous group and the HIIT group demonstrated a decrease in blood lactate accumulation. Because both groups demonstrated similar responses, the authors suggest that some metabolite was invoking a reduction in glycolysis during the HIIT leading to an increase in lipid utilization. One suggested cause for this was that increased citrate synthase, a rate limiting enzyme in the Citric Acid cycle, contributed to lipid utilization in one session of HIIT . This was beneficial as HIIT may allow for more work to be performed and increased workout efficiency. More work completed during the workout of a given duration may lead to enhanced weight management or fat loss due to a potential increase in calories expended during the workout and increased excess post exercise oxygen consumption, the increase in post workout above resting post workout usually associated with increased metabolic rate.

Similar to the findings by Essen, et al. (1977), Gaitanos et al. (1993) also suggested that PCr and glycolysis were primary sources of energy during HIIT. In this study, eight males completed 10 rounds of six-second sprints with 30 seconds of intermittent rest and a biopsy of the vastus lateralis was obtained prior to and after the first and last sprints. A 57% drop in PCr

during the first sprint in conjunction with a blood lactate increase to 28.6mm/kg suggests use of ATP-PCr and anaerobic glycolysis energy systems (Gaitanos, et al., 1993). A blood lactate accumulation spike following the fifth sprint was highly correlated with the amount of work performed in the first five sprints and the significantly reduced lactate increase in the tenth sprint demonstrated reduced glycolysis despite high blood epinephrine. These findings indicated that aerobic metabolism is utilized when fatigue occurs in HIIT. These findings show that a one-to-one work-to-rest ratio resulted in a more rapid utilization of aerobic metabolism during interval training (Essen, Hagenfeldt, & Kaijser, 1977). On the other hand, a one-to-five work-to-rest ratio primarily utilized anaerobic energy systems and may have induced different physiological adaptations due to this. This work to rest interval may be more optimal for athletes attempting to improve in sporting events that utilize the anaerobic glycolysis energy system. The one-to-one work-to-rest ratio may be best for aerobic and health improvement and it might be more manageable than traditional continuous training at the high intensity in a sedentary population. The decreased rest time might serve as too great of a challenge for severely deconditioned individuals which may warrant starting out with a more anaerobically tailored program, then gradually decreasing rest time as it becomes more tolerated to further improve the aerobic system.

A five month long protocol on middle aged individuals demonstrated how HIIT with a one-to-one work-to-rest ratio may have proved to be insufficient rest for this population (Nemoto, Gen-no, Masuki, Okazaki, & Nose, 2007). The mean age of the participants was 63 years. The moderate training group was asked to exercise at 50% of their VO_2peak four or more days per week. The HIIT group was asked to complete five or more sets of walking for three minutes at 40% VO_2peak alternated with three minutes at 70% or more of VO_2peak . Only 46%

of women in the HIIT group met these requirements, while 73% of the women followed the CT exercise protocol. The HIIT group showed a significant reduction in SBP and DBP, nine mmHg and 5mmHg respectively. This reduction was significantly greater than that seen in the CT group. The authors noted that high reductions in SBP were correlated with greater increases in VO_2peak. This suggests that greater cardiovascular improvements with HIIT may translate to further improved blood pressure in comparison with CT.

HIIT responses in sedentary females. Physiological improvements seen with HIIT relate to similarities between HIIT and CT with overall oxygen consumption in a given time period (Bogdanis, et al., 1998). The majority of studies examined the health benefits, and physiological effects of HIIT have been conducted on males. Therefore Cunningham, McCrimmon, and Vlanch, (1979) investigated central and peripheral cardiovascular adaptions following HIIT in women. Sedentary women between ages 18 and 25 were randomly assigned to CT, HIIT or a non-exercise control group. The CT group exercised for 40 minutes per session, four times per week, at 70 to 80%VO_2max. The HIIT group also exercised for 20 minutes per session completing two minutes at 90% VO_2max followed by one minute of rest. This protocol differs from the protocols used in the majority of the all-male studies because of the slightly lower intensity and longer work period utilized (Gorostiaga, et al., 1991; Poole & Gaesser, 1985). Total amount of work was equated between training groups (Cunningham, McCrimmon, & Vlanch, 1979).

Results from the Cunningham, et al. (1979) study suggested that women have similar cardiovascular benefits following HIIT because VO_2max increases showed no significant differences between the HIIT and CT groups. The HIIT group increased VO_2max 23.3% and the continuous training group increased VO_2max 20.2% within the first four weeks of training.

Cardiac output and stroke volume improvements trended toward significance in both groups. From eight to 12 weeks the maximal arterial to venous oxygen content difference was increased by 20% via HIIT and 8.9% with CT. This increase in maximal arterial to venous oxygen content difference demonstrated greater peripheral adaptations with HIIT than CT. The absence of a difference between the HIIT group and CT group in regards to VO_2max improvements was possibly due to less muscle mass being utilized in cycling compared to other modes of exercise like running. Helgerud, et al., (2007) had moderately trained individuals perform HIIT running and found significant stroke volume increases to be correlated with VO_2max increases.

Utilizing a protocol similar to Tabata, et al., (1996), Weber and Schneider, (2002) contradicted those findings that indicated similar cardiovascular improvements in men and women. Only men demonstrated significant improvements in oxidative capacities via an improvedVO_2max. This stark difference was possibly due to training or a confounding gender differences. Still, results showed similar increases in maximal accumulated oxygen deficits, and decreases in blood lactate response. These studies suggested that HIIT was more effective than CT; however, comparisons between training styles were a secondary goal. Overall, women exhibited the same cardiovascular and anaerobic benefits from HIIT as men (Cunningham, et al., 1979; Eddy, et al., 1977). Therefore, though a large amount of research concerning the efficiency of HIIT has been conducted on males, it is likely that results would hold true for females based upon the findings of the previously discussed studies.

Because the present study is concerned with the prevention of overweight and obesity in a young female population, it is important to examine the influence of HIIT in this population. Body composition, cardiac function, and aerobic capacity were examined prior to and following a 12 week HIIT, CT, or control intervention (Sijie, Hainai, Fengying, & Jianxiong, 2012).

Participants completed HIIT or CT five times per week while the control group maintained their normal sedentary lifestyle. The HIIT group consisted of walking or jogging at a heart rate corresponding with 85% of their VO_2max for three minutes, alternated with three minute active rest intervals at a heart rate corresponding to 50% of their VO_2max. The CT group maintained a steady state heart rate corresponding to 50% of their VO_2max for 40 minutes. Body fat percentage was reduced 9.9% and 5.2%, VO_2max increased 8.4% and 4.7% and ventillatory threshold increased 11.7% and 7.1% in the HIIT and CT group respectively. Stroke volume increased in the HIIT group while no change was observed in the CT group, while resting heart rate had a much larger effect size in the HIIT group (1.47) versus the CT group (.62). These findings are crucial in preventing poor cardiovascular outcomes associated with obesity in this young population. However, it is important to note that this training protocol was intensive, and may not be feasible for a sedentary population due to the intense physical demand and lack of individualized supervision by a health professional.

A sedentary male and female sample was utilized to determine the effects of a lower exertion interval training on insulin sensitivity and aerobic capacity (Metcalke, Babraj, Fawkner, & Vollaard, 2012). Twenty-nine subjects were randomly assigned to the intervention group which completed three exercise sessions per for six weeks or the control group which maintained their sedentary lifestyle. Each exercise session was 10 minutes long and consisted of low intensity cycling with only two intermittent all out sprints which increased from 10 seconds to 20 seconds in the last three weeks of the study. A 75g load glucose tolerance test to determine how the body utilized sugar was conducted prior to and three days post training intervention. These short intervals were utilized because glycogenolysis is greatest within the first 15 seconds of a sprint and is subsequently attenuated because ATP production was primarily derived from PCr

degradation and oxidative metabolism (Metcalke, Babraj, Fawkner, & Vollaard, 2012). Therefore, short intervals and short workouts may be optimal for optimizing time efficiency. However, females display reduced glycogen usage compared to males (Metcalke, Babraj, Fawkner, & Vollaard, 2012).

Results indicated that women increased their VO_2max by 12% and men increased by 15% with no significant differences between genders. However, though insulin sensitivity increased by 28% in males, there was no significant increase for females. Ratings of perceived exertion (RPE) were also different in men and women with males responding with values corresponding to "somewhat hard" and women responding between "somewhat hard and hard." These findings demonstrate that even interval training of a short duration, three days per week, can result in positive aerobic benefits for sedentary individuals; however, women may not obtain as many benefits as men with this protocol. This may pose an issue as women reported higher RPE values than males, potentially making the aforementioned adaptations to HIIT null if women find the protocol too challenging. The authors attributed the higher RPE values reported by women potentially to a potential metabolic difference between males and females.

Though sedentary subjects demonstrate similar cardiovascular adaptations with CT and HIIT, the cause for these adaptations differs and gives implications for training usage. While the cardiovascular improvements associated with CT were related to oxidative processes, they were associated with glycolysis, the ATP-PC system, or lactate removal in interval training (Essen et al., 1977; Gorostiaba et al. 1991). When total workload was controlled for, HIIT increased the ability for oxidative energy production (Daussin, et al., 2007). Contrary to popular belief, HIIT produced similar increases to CT in VO_2max, lactate threshold and even greater improvements in ventilatory threshold (Poole & Gaesser, 1985). It is unclear how these adaptations manifest in

women. One study (Cunningham, et al., 1979) reported that women experienced the same peripheral and central changes while another (Weber & Schneider, 2002) reported that sedentary women did not exhibit increased VO_2max or increased ability to utilize oxidative energy mechanisms. Nevertheless, no difference in improvements of anaerobic metabolism and endurance among sexes or training styles were reported (Weber & Schneider, 2002). It is possible that a training period of longer than 12 weeks is necessary to reveal differences in physiological adaptations in previously sedentary participants because doing any activity will illicit improvements.

HIIT Response in Active Individuals

Physiological adaptations to HIIT in active women. HIIT may be the optimal training mode in order for young women to obtain health benefits similar to continuous training in less time if evidence for similar adaptations in males and females exist. As mentioned previously, differing results in terms of peripheral and central changes have been noted in the literature (Cunningham, McCrimmon, & Vlanch, 1979; Weber & Schneider, 2002). The following studies shed more light on how HIIT impacts recreationally active females' muscle buffering capacity and metabolism.

Sixteen recreationally active women participated in five weeks of CT at 80 to 95% of lactate threshold or HIIT consisting of six to 10 rounds of two minutes at 120 to 140% lactate threshold with minute long rest sessions (Edge, Bishop, & Goodman, 2006). Prior to and after training, graded exercise tests and muscle biopsies were performed to determine muscle buffering, and peak respectively. With exercise volume controlled for, peak and lactate threshold increased in both groups; however interval training was optimal for improving muscle buffering capacity.

This data supports the authors' hypothesis that both five weeks of CT or interval training significantly increased aerobic measures. Furthermore, the interval training condition exceeded the continuous condition in lactate buffering improvements (Edge, Bishop, & Goodman, 2006). It is possible that differences in lactate threshold and VO_2max would be observed with different exercise volumes between CT and HIIT groups or different interval lengths. For instance, a longer rest period would likely put less stress on the lactate clearing system and induce fewer changes. The authors note that pre-training buffering ability was lower than in other studies. Low initial buffering values may be because this study utilized primarily females that may not be as trained as males in other HIIT studies (Edge, Bishop, & Goodman, 2006). Different results might occur with higher initial values.

However, Duffield et al. (2006) also demonstrated an increased lactate threshold in recreationally active women. Poole and Gaesser, (1985), found similar increases in sedentary males. Additionally, the continuous training intensity utilized by Edge, Bishop and Goodman (2006) seemed to be higher than other studies conducted with women, which may account for the decreased differences between HIIT and CT for aerobic measures between interval and continuous groups. It is also possible that as fitness increases, exercise intensity played an increased role with both training types in further increasing aerobic fitness.

HIIT at an intensity of 80-95% VO_2max is regarded as a compromise between sprint interval training which can be difficult for untrained people because it includes training intensities greater than 100%VO_2max , and moderate intensity exercise which can be time consuming (Talanian, Galloway, Heigenhauser, Bonen, & Spriet, 2006). Seven HIIT sessions were conducted to examine metabolic and hormonal changes in recreationally active women. Ten four minute bouts of exercise with two minute rest periods in addition to aVO_2max test and

a one hour bike test at 60% VO_2max were performed. A significant increase in fat oxidation, mitochondrial enzymes, and fatty acid binding proteins with HIIT was found after only two weeks. Because this adaptation was normally observed in long duration endurance training, this finding was crucial.

Increased fatty acid oxidation demonstrated how HIIT might supplement or accelerate endurance capacity and increase lipid oxidation at rest. There was no significant increase in VO_2max ; however, glycogen use during the post training moderate intensity session was decreased as was epinephrine and heart rate (Talanian, et al., 2006). A decrease in glycogenolysis can be explained by decreased epinephrine because epinephrine signals this process and the lactate response (Poole & Gaesser, 1985). There was an increase in whole body fat oxidation and muscle fat oxidation associated with the increase of long-chain fatty acid transporters (Talanian, Galloway, Heigenhauser, Bonen, & Spriet, 2006). There was no increase in hormone sensitive lipase (HSL), an enzyme associated with lypolysis. It is possible that increased skeletal muscle fat oxidation increases are characteristic of longer duration training programs. Traditional endurance training, as well as six week interval training elicited these adaptations; however, this study showed how there can be significant improvements in only two weeks.

Exercise volume in HIIT studies. Talanian, Galloway et al, (2006), Helgerud et al., (2007) and others, implied that HIIT can induce physiological adaptations similar to those of continuous or endurance training with less exercising time because of the increased lactate threshold, percent of VO_2max and other performance measures when workload was controlled. However, many of these were with untrained populations that experience physiological adaptations more quickly than more fit populations. The following research examined the extent

to which HIIT can mimic CT aerobic and anaerobic adaptations even with a much smaller training volume.

Other studies, including the aforementioned female studies, found similar physiological responses to HIIT when total work volume or work load were equated (Essen, et al. 2007; Eddy, et al., 1977, Daussin, et al., 2007; Hill-Haas, et al. 2007). Because Daussin et al. (2007) found greater physiological improvements with HIIT when exercise volume was controlled, it is logical that a low volume HIIT program could produce similar results to a long duration continuous program. Active college aged men completed low volume interval training and continuous training over two weeks. Interval training included six rounds of 30 seconds cycling at 250% VO_2max with a four minute rest interval, while continuous training involved 90 to 120 minutes of cycling at 65%VO_2max. Though group one completed 2.5 hours of HIIT including recovery over the course of two weeks, they exhibited comparable improvements to 10.5 hours of continuous training in muscle oxidative capacity via measurement of cytochrome c oxidase, muscle buffering capacity, and glycogen content (Giabla, et al., 2006).

Protein content and a high amount of the mitochondrial enzyme, cytochrome c oxidase, indicated increased oxidative properties in muscle following training (Giabla, et al., 2006). Additionally, a decrease in time trials was demonstrated and no difference in mRNA was observed. This lack of change possibly resulted due to the time the muscle biopsy was taken or an insufficient duration in exercise programs. There were also increases in muscle buffering capacity and glycogen content post training.

Because the data suggesting that high volume CT and low volume HIIT is comparable is profound, Burgomaster, Howarth et al., (2007) found similar changes in metabolism not only after continuous and HIIT, but during exercise. These data by Burgomaster, Howarth et al.,

(2007) and Giabla, et al., (2006) are more extreme than the same findings by Gaitanos, et al., (1993), Talanian, et al., (2006), and Edge et al., (2006) because there was a much larger discrepancy in training volume. HIIT induces comparable physiological changes in significantly less time according to this study.

One six week study that controlled for the volume of exercise between the HIIT and the CT group found that the increased intensity in the HIIT group may have contributed to the larger improvements in VO_2max (Gormley, et al., 2008). Participants were healthy middle aged individuals and were separated into a CT moderate intensity group, exercising at 50% $VO_2reserve$ for 60 minutes four days per week, or the CT vigorous intensity group, exercising at 75% $VO_2reserve$ for 40 minutes four days per week. There was also HIIT group, exercising at 95% $VO_2reserve$ for five minutes, alternated with five minutes at 50% $VO_2reserve$ for 3 days per week. No changes were found in any group for RHR or BP. Similarly, a study in which active young men and women completed six HIIT sessions consisting of repeated Wingate tests over the course of two or three weeks (Astorino, Allen, Roberson, & Jurancich, 2012). Findings indicated a significant improvement in VO_2max, oxygen pulse, and power output, while there was no change in BP, RHR, or force production. Shorter term HIIT protocols may not be adequate to produce blood pressure changes in healthy individuals. This might have been a result of the shorter study duration because other studies using HIIT of a longer duration demonstrated significant BP improvements (Nybo, et al., 2010; Schjerve, et al., 2008; Tjonna, et al., 2008).

Though this gives implications for the potential use of HIIT to increase fitness and lipid utilization, it also emphasizes that in order to obtain fitness gains comparable to 90 minutes of continuous training, one must be exercising at a supramaximal intensity if a one to eight work to rest interval is utilized as in the study by Giabla, et al., (2006). Hazel et al., (2010) did not

demonstrate similar results with the 10 second work four minute rest group. It was likely that the stimulus was not sufficient. Edge, Bishop, & Goodman, (2006) only found improvements in muscle buffering ability in their HIIT group which included six to 10 rounds of two minute sprints at 120-140% lactate threshold with one minute rest intervals. Their continuous training group trained was matched for work and exercised at 80-95% lactate threshold. This was the first study that demonstrated lactate threshold improvements in previously untrained females. Longer rest periods do not produce the same results for improving aerobic fitness (Harmer, et al., 2000). These studies are relatively short in duration and suggest that these adaptations in both continuous and interval training are made rapidly when the right dose for a given population is completed.

In summary, HIIT provides many of the same benefits as CT; however, it taxes both the aerobic and anaerobic energy systems (Gorostiaga, Walter, Foster, & Hickson, 1991). Though most of the studies on HIIT were conducted on males, women demonstrate similar increases to men in , stroke volume, cardiac output and muscle buffering capacity (Cunningham, McCrimmon, & Vlanch, 1979). These adaptations can be achieved in less time with HIIT because 2.5 hours of HIIT training over the course of 2 weeks produced comparable muscular biomechanical adaptations to 10.5 hours of continuous training (Giabla, et al., 2006). Another study found that young women in the HIIT group had an average fat loss of 4.3% which was significantly greater than the continuous group regardless of the lesser exercise time. The evidence proposes that HIIT is a viable option for fat loss in an obese population if this population can sustain the high intensities, and if the population is likely to adhere to exercise because fat loss was nine times greater in the HIIT group than the CT group (Tremblay, Simoneau, & Bouchard , 1994).

Due to these findings, the present study employed 15 to 25 minutes of body weight interval training in an open air conditioned group aerobics class environment. The HIIT consisted of work intervals ranging between 20 seconds and one minute with rest periods equal to or less than the work duration. Therefore, the largest work-to-rest ratio was one to one while the smallest was one to five. These work-to-rest ratios allowed the development of both aerobic and anaerobic adaptations while eliminating the need to exercise at supramaximal intensities (Hazell, MacPherson, Gravelle, & Lemon, 2010). The strong stimulus would likely be enough to induce physiological adaptations with decreased training volume if participants exercised a third time per week to meet minimum activity recommendations.

Causes of Weight Gain

Gender differences in physical activity and weight gain. In 2008, only 18.2% of American's met the aforementioned minimum guidelines for cardiovascular and muscular fitness (Carlson, Fulton, Schoenborn, & Loustalot, 2010). This is particularly important as a college lifestyle may leave young adults with little time for exercise. Increased screen time has been suggested as a potential explanation for decreased exercise behavior. The displacement hypothesis proposes a zero sum relationship between screen time and physical activity. Researcher's utilized the displacement theory in their survey of 461 males and 275 females in a college setting (Fountaine, Liguori, Mozumdar, & Schuna, 2011). In comparison to females, males had higher BMI, more days of aerobic exercise, strength training, screen time and television watching, while females reported more time spent on homework. Homework was considered a sedentary behavior but was not included in the screen time category. Therefore, males had more recreational time. The researchers concluded that more females were classified as insufficiently active and may have had little time for physical activity. It is this demographic

that may benefit most from a short high intensity interval training session due to inherently shorter duration of activity.

Similar levels of low activity levels and subsequent weight issues were demonstrated by Donnelly, Jacobsen, et al., 2003. Among participants in this study, women in the exercise group maintained weight and women in the control group gained weight. Furthermore, a two-part study examining weight gain in college throughout the freshman and sophomore years found that 77% of students in study one and 70% of students in study two gained a significant amount of weight (Lloyd-Richardson, Baily, Fava, & Wing, 2009). These increases in weight resulted in a 14.4% increase in overweight/ obesity in study one and a 3.1% increase in study two. Taken together, the results of these studies suggest that a potential reason for females having an increased ratio of weight gain compared to males of the same age may be related to decreased time set aside for physical activity.

Prevention of weight gain and motivational factors for health behaviors. In addition to increased time dedicated to studying, Cluskey & Grobe (2009) suggest that in terms of perceptions of health related behaviors, many college students described challenges in healthy eating and changes in activity patterns. In order to further examine these specific challenges that females face, researchers utilized a qualitative approach in studying 50 students at a large Midwestern university (Nelson, Kocos, Lytle, & Perry, 2009). Among the students studied, themes that emerged relating to physical activity included negative experiences with recreation facilities, poor weather, and lack of time, motivation, and social support. These findings suggest that universities could offer interventions that address these issues. A body weight HIIT program may alleviate concerns with time restraints, issues with recreation facilities and restrictions posed by the weather because the workout requires little time and space. Therefore, determining an

effective time efficient strategy to assist in maintaining activity may be important to prevent weight gain in normal weight females, while a convenient workout may be necessary for health improvements in overweight and obese females.

Another study reported that in order for women to prevent weight gain, 80 minutes of moderate intensity or 35 minutes of vigorous intensity activity five days per week should be completed (Schoeller, Shay, & Kushner, 1997). In contrast, Kavouras et al. (2007) found that people engaging in 30 minutes of activity five days per week decreased their BMI. Still, both these studies exhibit more training than the previously mentioned recommendations for health and show that exercise length to prevent weight gain is more than halved with the use of high intensity training. A study that examined the role of resistance training in weight maintenance determined that though energy expenditure was not large in a single bout of resistance training, an increase in lean muscle mass may increase metabolic rate (Donnelly, Blair, Jakcic, Manore, Rankin, & Smith, 2009). Because the primary step to preventing obesity is reducing weight gain prevalence and these recommendations to prevent weight gain are time consuming for women it would benefit women to engage in HIIT that incorporates resistance training to save time while obtaining benefits of increasing lean body mass. This is especially important as the obesity prevalence in college students is only 4.9% compared to the 35% of the general population, indicating that young adults are at a crucial point in terms of exercise habits (Huang, Harris, Lee, Nazir, Born, & Kaur, 2003).

In accordance with the aforementioned studies, one study determined that college freshman and sophomore students are at critical points for health behavior changes (Lerner, Burns, & Roiste, 2011). A questionnaire revealed that Irish males, like Americans, were more likely to engage in organized physical activity, and females were more likely to engage in

unorganized physical activity. Intrinsic factors relating to motivation to exercise were crucial in physical activity participation. This is an important finding which indicates that in order for young adults to see HIIT as a viable method of exercise, they need to possess some intrinsic factors such as enjoyment, or interest in order to engage in it. Similar to previously mentioned studies, young adults felt inhibited by coursework, lack of time, and lack of interest. These findings suggest that young women might adhere to programs to which they are intrinsically motivated to engage in, and to programs that are non-competitive. It may be a challenge to make an organized program appeal to women. HIIT programs may be viable for this population because females may become intrinsically motivated towards it if they perceive the program to meet their expectations. This may occur because the only competition potentially involved included striving to improve one's own repetitions for a given time work interval, in addition to confounding motivation sources.

In a nationwide study among college students, women were more likely to have a higher moderate to vigorous activity (MVPA) scores if they were in good health, had a lower body mass index (BMI), engaged in weight loss behavior, and had higher social support (Dowda, Ainsworth, Addy, Saunders, & Riner, 2003). Additionally, having a large family, a job, or being from the south was related to lower MVPA scores for women. One potential reason for this may be related to a difference in responsibility or values. Moreover, data revealed that walking and calisthenics were the main activities for all ethnicities of adult women. However, nearly 28 miles of walking per week may be necessary to prevent weight gain (Donnelly, Blair, Jakcic, Manore, Rankin, & Smith, 2009). Women gravitating towards this mode of CT could be related to the low number of Americans meeting the recommended levels of exercise due to the increased amount of time required to meet those recommendations.

Grubbs and Carter (2002) examined perceived benefits and barriers to exercise in undergraduate students in relation to their current exercise habits. This may shed light on what activities females are more likely to engage in. Like Fountaine et al. (2011), this study found that 92% of males were categorized as exercisers while only 63% of females were classified as exercisers. For some items on the Exercise Benefits/Barriers Scale (EBBS), there were discrepancies between those who regularly exercised, and those who did not. For example those who exercised perceived more benefits to exercise than barriers and scored lower on the item that stated "exercise takes too much time", as well as, "I'm too embarrassed to exercise" and "exercise takes too much time from my family responsibilities." Yet, there was no relationship between employment and exercise habits. This finding suggests that time restraints were not related to work in this population. This contrasted with Dowda et al. (2003) though family related barriers were unanimous. Lack of time due to school work was one of the most important perceived barriers to exercise by women (Grubbs & Carter, 2002). The highest mean scores for perceived benefits to exercise related to physical performance and appearance. These findings support previous studies finding that college students are short on time but also suggest that those who do not exercise might have some insecurities relating to an exercise bout. It is possible that those in the current study perceived HIIT differently depending on their previous exercise experience or motivation status.

Self- Determination Theory and Long Term HIIT Participation

Previous literature notwithstanding, a question remains as to whether specific characteristics of motivation will promote long term participation in HIIT. The aforementioned studies suggest that body composition and cardiovascular measures are significantly improved with HIIT in a time efficient manner. Due to this, figures in popular culture such as Jillian

Michaels and Tony Horton have implemented this type of training in their workout programs. Still, it is unknown whether those of a high body fat percentage would be motivated by this exercise form. Self-determination theory (SDT; Deci & Ryan, 1985) is often utilized to determine the root of individual motivation and has been widely utilized in the exercise domain (Ryan & Deci, 2007). SDT posits that motivation exists on a continuum of behavioral regulations ranging from amotivation (absence of motivation) to intrinsic motivation (motivation is internal and regulated by interest, enjoyment, and inherent satisfaction) (Ryan & Deci, 2000).

Between these two extremes exists extrinsic motivation which contains four types of behavioral regulations: External regulation (regulated by compliance and external rewards and punishments), introjected (regulated by ego and internal rewards and punishments), identified regulation (regulated by conscious valuing), and integrated (regulated by awareness and synthesis with self). As opposed to intrinsic motivation, an extrinsically motivated person engages in a behavior due to an environmental or outside influence (Ryan & Deci, 2000). Three psychological needs, including competence, autonomy and relatedness are thought to be crucial to supporting intrinsic motivation and individual well-being. Through these levels of motivation and psychological needs, SDT may help explain what factors facilitate or inhibit likelihood to engage in physical activity because when a person demonstrates higher levels of competence, autonomy, and relatedness, and is thus more intrinsically motivated, they are more likely to adhere to exercise (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). This relationship will be utilized specifically with HIIT to determine motivation towards this exercise form and exercise adherence.

Though a portion of human tendency is a result of genetics, the vast array of human dispositions, especially activity propensities, suggests that social contexts influence motivation.

For example, if an elementary student is picked last to participate in a sport in physical education class, their feelings of competence for that task may be diminished and they might become more extrinsically motivated. In contrast, a person who is given the option to choose their favorite exercises when working with a personal trainer would experience higher levels of autonomy. Additionally, someone who attends yoga classes and enjoys the shared experience is feeling more social relatedness. SDT helps to explain likelihood of exercise participation by suggesting that these three psychological needs are what abets or thwarts the naturalistic experiences of intrinsic motivation, self-regulation, and well-being (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). Therefore, an extrinsically motivated individual is less likely to possess as much attentiveness, eagerness, and self-reliance for an activity than an intrinsically motivated person. This can result in decreased participation, self-determination, and inspiration for that activity (Deci & Ryan, 1991; Sheldon, Ryan, Rawsthorne, & Illardi, 1997).

Deci and Ryan (2000) suggest that societal pressures are increasingly imposed as childhood progresses, resulting in a decrease in true intrinsic motivation. One retrospective study that examined 4453 adolescents (10 to 12 years of age) determined that 58.2% of adolescents were sedentary and that being a female with a high family income at birth, high maternal education at birth, and low birth order were all predictors of a sedentary lifestyle (Hallal, Wells, Reichert, Anselmi, & Victoria, 2006). Additionally, a higher self-reported physical activity score when the child was four years of age was related to decreased rates of sedentary activity at adolescence. These factors may be related to a shift from the natural tendency for a child to be inclined to be curious and active to extrinsic motivations of physical activity. Additionally, females may be more susceptible to environmental factors that thwart exercise participation. This notion is supported by Fountaine, et al. (2011) and Grubbs & Carter, (2002) in that many women

are not participating in exercise due to the influence of a potential external embarrassment and are inclined to less organized activity.

Alternatively, increased intrinsic motivation may lead to increased exercise participation in females, and thus improve overall health related behaviors. Among a group of 239 obese women, an intervention focused on increasing physical activity and internal motivation for exercise using SDT (Mata, et al., 2009). Mata et al. also found that exercise and diet were the main focuses of most weight loss attempts. Other findings indicated that exercise was linked with weight management due to physiological processes, but, mood, self-efficacy, and most importantly, intrinsic motivation was correlated with exercise participation. Fortier et al. (2007) also demonstrated this principle by providing autonomy support counseling to one group and comparing it to a control. The experimental group increased intrinsic motivation and perceived competence from baseline which significantly predicted physical activity participation at week 13.

Autonomy also appears to be a crucial aspect of exercise adherence. Standage, Sebire, and Loney (2008) determined if exercise motivations predicted moderate intensity exercise behavior by gathering data concerning motives towards exercise. They then monitored activity using a heart rate monitor and accelerometer. After seven days of data collection were completed, results demonstrated a link between autonomous motivations and participation in $\leq$10 minutes, $\leq$ 20 minutes and meeting ACSM minimum physical activity recommendations. Additionally, when controlling for gender and BMI, multiple regression analysis revealed the predictive property of self-motivation for increased physical activity participation. These findings support the utilization of SDT to explain exercise behaviors. Because prediction was

demonstrated with a moderate intensity activity, it is possible that autonomous motivations may also help to predict behavior with vigorous activity.

These findings are relevant because the current intervention involved an exercise program and various class requirements which may contribute to increases in competence and autonomy for HIIT for all participating young women regardless of previous experience based upon the findings demonstrated by Mata et al. (2009). Conversely, the class requirements associated with the exercise program deter continued activity participation potentially due to external rewards or punishments being offered toward completing physical activity (i.e., course grades). These class requirements are not associated with intrinsic motivation and thus activity participation (Ryan & Deci, Self- determination theory and the facilitation of intrinsic motivation, social development, and well-being, 2000).

From the aforementioned studies, it may be concluded that intrinsic motivation, support, and perceived competence are all factors influencing activity level (Fountaine, Liguori, Mozumdar, & Schuna, 2011;Grubbs & Carter, 2002; Mata, et al., 2009). Whether a person is amotivated, intrinsically motivated, or extrinsically motivated may factor into their physical activity patterns. Similar to the aforementioned study, Edmunds, Ntoumanis and Duda (2007) administered a 49 item questionnaire before and after a three month exercise program that addressed autonomy support, psychological need satisfaction and self-determined motivation. They found that overweight/obese participants that had increased adherence also demonstrated increased perceived autonomy support, psychological need satisfaction and self-determined motivation. These factors were related to greater self-efficacy for overcoming exercise barriers and improved wellbeing. Therefore self-efficacy for an exercise task is especially important in an overweight/obese group. It is possible that HIIT may be feasible for young adult females

depending upon their perceived autonomy and need satisfaction. No specific type of exercise was mentioned for this study.

All of these studies emphasized the importance of examining the motivational focus of participants. For the purpose of the present study, the motives for participating in HIIT in a young adult female population were examined due to the reduced exercise participation in this population and the prevalence of obesity. It is also important to note that the participants' motives were examined prior to and after being exposed to HIIT for 9 weeks, and those motives may change over time. Despite the hypothesis that those with higher appearance motives would have decreased intentions to continue HIIT, it is possible that the exercise programming and self-efficacy development over the course of the study overshadows effects of previous inexperience with exercise or appearance issues (Edmunds, Ntoumanis, & Duda, 2007; Mata, et al., 2009).

In order to further explain adherence to exercise, researchers have utilized the Motivation for Physical Activity Measure (MPAM-R), which outlines 5 potential categories of motives: fitness, appearance, competence, enjoyment, and social factors (Schoeller, Shay, & Kushner, 1997). In addition to intrinsic motivation towards an activity, someone may also be inclined to participate due to social motives because they may help bolster participation and enjoyment of the task. Ryan, et al. (1997) hypothesized that participants would indicate body related motives as the most important reasons for exercising, however, they did not indicate that these motives would aid adherence. In accordance with the previous studies, they predicted that intrinsic motivation, marked by increased enjoyment or competence scores, would be positively correlated with adherence.

When comparing motives for an aerobics versus Tae Kwon Do class, Tae Kwon Do participants had higher enjoyment and competence based scores while aerobics participants'

scores were higher on body related motives. Scoring higher on body related motives was associated with decreased rates of attendance. Similarly, a study by Frederick-Recascino and Schuster- Smith (2003) who found that competition was associated with enjoyment and increased adherence in contrast with other exercisers where adherence was not increased. Due to increased intrinsic enjoyment, people are more likely to participant in sports than fitness classes (Ryan & Deci, 2007).

Another study that utilized the MPAM-R examined the motives of new registrants to a gym at a university after each of their workout sessions (Ryan, Frederick, Lepes, Rubio, & Sheldon, 1997). Results indicated that females had significantly higher ratings of fitness and appearance motives than males. No differences were reported on enjoyment or challenge. Multiple regression demonstrated that all subscales contributed to a significant model, however, competence was the only variable that approached significance on a univariate level. Competence, enjoyment, social interaction, and fitness were positively associated with increased attendance and adherence while appearance was not. A study examining physical activity motives in a rural area also found a positive association between increased attendance and higher enjoyment scores (Withall, Jago, & Fox, 2011). In contrast to the findings from the previously mentioned study, there was a negative correlation between social related and appearance motives. Interestingly, those participating in dance or strength/flexibility classes high higher scores for enjoyment and social motives while the aerobics class scored higher on appearance motives.

Though the fitness and appearance motives are more extrinsic in nature, it is important to consider the interplay of intrinsic and extrinsic motives because some forms of extrinsic motivation may be autonomous and will contribute to increased adherence (Ryan & Deci, 2007).

Due to this, the enjoyment motive is especially important because "even though most people engage in exercise for extrinsic reasons (e.g. improved fitness, appearance or health), if they do not enjoy the activity (HIIT), or do not discover its inherent satisfactions, they are unlikely to persist at it." If a majority of participants score low on the four measures associated with increased adherence or if a majority of exercise inexperienced individuals score low on these measures, HIIT may not be the best option for meeting ACSM exercise guidelines nor weight reduction in a young female population.

Theory of Planned Behavior

The Theory of Planned Behavior (TPB) is also useful in order to determine future intentions to an exercise task by examining the link between attitude and behavior (Ajzen, 1991). This theory maintains that behavior beliefs, normative beliefs and control beliefs determine human behavior. Behavioral beliefs concern the thoughts about consequences of a certain behavior and result in an attitude toward the behavior. Normative beliefs are about the expectations of others and cause a perception of a social norm. Lastly, control beliefs are about the existence of benefits and barriers to participating in the activity and cause a perceived behavioral control. Typically, when a person displays more positive attitudes, subjective social norms, and perceived control, the intention to engage in a behavior also increases. For example, if a undergraduate female believes that HIIT will help them reach their fitness goals, believes that it is a socially acceptable form of exercise, and perceives it to be a easily accessible exercise form, then they will also have an intention to engage in the behavior. Increased control over their behavior usually results in an increased likelihood of engaging in the behavior given the opportunity. Therefore, the intention must precede the behavior; however, challenging behaviors can manipulate determination to engage in it.

One study utilized the TPB to determine the extent that behavior beliefs, normative beliefs and control beliefs predicted exercise intentions over the course of a exercise program. Results showed that 69% of the variance in intention to be physically active could be explained by attitude alone. This finding is in agreement with Hausenblas, Corron and Mack (1997) who also found that attitude was the most important predictor of exercise behavior. Subjective norms contributed least when predicting exercise behaviors. Due to this, the present study will examine if a change in the subscales of motives on the MPAM-R will influence behavioral intention to engage in HIIT. The intentions to participate in HIIT will provide insight into future participation in this type of exercise.

Dr. Mary Jung's lab at the University of British Columbia examined intentions and enjoyment following bouts of HIIT, continuous moderate intensity (CMI), and continuous vigorous intensity (CVI) exercise (Jung M. , 2013). They utilized a randomized counterbalanced design. Inactive adults with a mean age of 32 exercised for 40 minutes at 65% heart rate max for the CMI trail, CVI included 20 minutes at 90% heart rate max and HIIT included the practical model of 10 intervals. They utilized the feeling scale, a measure developed to determine affect during exercise, RPE, and heart rate (Hardy & Rejeski, 1989). They assessed intentions and enjoyment after the bouts of exercise. CVI and HIIT induced a significantly higher blood lactate than the CMI group with no significant differences between CVI and HIIT (Jung M. , 2013). Self-reported perceived exertion scores demonstrated that because of the recovery interval, participants perceived HIIT to be similar to the CMI condition. The malleable constructs with respect to HIIT in terms of affect showed that the CMI bout was perceived as significantly more pleasurable than CVI or HIIT and there was no significant difference between CVI and HIIT.

A randomized study that evaluated how interval intensity influences affect compared intervals performed at 60%, 90%, and 120% peak power found a main group effect between the intervals performed at 60% and at 120% (Jung M. , 2013). This is in accordance with the dual mode model which proposed that the more intense the interval, the more aversive response that would occur (Ekkekakis & Acevedo, 2005). It also seems that interval length influences affect. Dr. Kilpatrick's lab at the University of South Florida demonstrated a significant main group effect between the HIIT group performing 30 second intervals as compared to 60 seconds, 120 seconds, and between CVI exercise with the 30 second intervals being perceived as the most pleasurable. The present study employed interval lengths of no longer than 50 seconds to decrease aversive affect while still supporting training adaptations.

With respect to affective attitudes, participants completed a 2 week training protocol. They were then followed 2 weeks after their last bout of exercise and asked how likely they were to participate in HIIT, VHIIT (very high intensity interval training), or CMI during their leisure time, taking into account work, and family. At all recorded time points, those who engaged in HIIT or CMI both perceived it much more positively than those who engaged in VHIIT. Similarly, a randomized counterbalanced designed study of 40 participants at the University of British Columbia demonstrated a significant difference between CVI and HIIT (Jung M. , 2013). Those who had just experienced HIIT reported it as significantly more enjoyable than those in the CVI group. Interestingly, there was no difference between CMI and CVI in terms of enjoyment. After all participants completed all modalities of training, they were asked again how enjoyable they thought each type of exercise was. Again, HIIT and CMI were perceived as more enjoyable than CVI, but there was no difference between HIIT and CMI in terms of enjoyment. A follow up study included HIIT, CMI, and CVI being prescribed three times a week over the

course of four weeks and again participants regarded HIIT as more enjoyable than CVI with no significant difference between CVI and HIIT.

Dr. Kipatrick at the University of South Florida then sought to determine differences in in-task enjoyment for the different exercise types (Jung M. , 2013). All groups, the CMI group, the moderate IT group which was performed around ventilatory threshold, and the HIIT group which was performed at threshold plus 20%, were regarded as more enjoyable than the CVI condition. So when comparing HIIT to CVI design in determining what people prefer to engage in, results indicated that most preferred to engage in HIIT even though intensity was equated. A potential reason for this would be that the HIIT condition involves working for less time. However, when exercise bout time was taken into account, there was no difference in affect between HIIT and CT.

One study examined the effect of exercise time on in-task feelings in moderately fit women in a mandatory exercise class at a university (Rejeski, Gauvin, Hobson, & Norris, 1995). There was no dose response effect for 10, 25, or 40 minutes of exercise on feeling states. All groups had significantly higher revitalization scores compared to the control. Post test feeling scores were mediated by scores in the last few seconds of exercise. HIIT of a short duration likely produces similar positive affect as longer duration CT making it potentially comparable in terms of peoples' likelihood of engagement. However, it might be the individuals' perceived competence for the task that influences their enjoyment. One study compared those with high self-efficacy to those with lower self-efficacy scores and found that those with higher self-efficacy reported increased energy in-task and increased positive affect post-task (Bozoian, Rejesji, & McAuley, 1994).Whether examining affective attitudes in terms of in-task enjoyment,

post-task enjoyment, post training enjoyment, or participant self-reported exercise preference; the data shows an overall promising trend towards people liking HIIT.

In terms of post-task enjoyment Bartlett et al. (2011) assessed general enjoyment using the paces measure after participants who were young fit, healthy adults, engaged in six by three minutes at 90%VO_2max. or CMI which included 50 minutes at 70%VO_2max. They saw greater enjoyment in the HIIT condition. This HIIT condition was repeated in Dr. Jung's labs in individuals who had prediabetes, type II diabetes, or those who were previously inactive and middle aged. Participants were unable to perform that type of intensity continuously very long. Therefore, in diseased populations, lower intensities and shorter durations would be considered CVI. Still, after engaging in a 4 weeks training protocol of Tabata, Jung found that enjoyment of tabatta type intervals was significantly higher (Jung M. , 2013). However, other work out of Jung's lab showed no difference in post-task enjoyment for between HIIT and CMI. A two week training study by Dr. Zballa and Little looked at enjoyment after participants engaged in two weeks of training. There was a significant main effect for both enjoyment for HIIT and CMI with HIIT enjoyment increasing and CMI enjoyment decreasing over the two weeks. Therefore there might be a time or training component to enjoyment for HIIT.

To conclude, in regard to affective responses there seems to be a tendency, though not significant all of the time, for HIIT to be lower than CMI (Jung M. , 2013). The effect on affect during the length of each interval varies based upon the intensity and time for each interval. There might be something happening in terms of training effects to affect for HIIT. Dr. Geron demonstrated after 6 weeks of HIIT training with participants exercising at 65%, 90% and 120% during the intervals, the researchers demonstrated that there tends to be more displeasure in the

extreme intense condition, but that this displeasure decreases over the course of the intervention (Jung M. , 2013).

Purpose of the Study. Previous research established that the female college-aged population is time restricted and could benefit from HIIT due to its ability to induce similar training adaptations to CT with less training time in addition to the preliminary evidence suggesting it might be enjoyable if interval length is short (Giabla, et al., Short-term sprint interval versus traditional endurance training; similar intitial adaptations in human skeletal muscle and exercise performance, 2006; Helgerud, et al., 2007; Jung M. , 2013; Talanian, Galloway, Heigenhauser, Bonen, & Spriet, 2006). Given the inherent benefits of HIIT training, the purpose of this study is to determine feasibility of HIIT in this population by examining motives prior to and after a HIIT program along with physiological variables, as well as to determine if these variables predict exercise intentions among a college-aged female population participating in HIIT.

APPENDIX C

Table 1

Participants demographics (N=57)

Race	**N**
Caucasian	27
African American	27
Hispanic	2
Multiracial	1
Year in School	**N**
1	9
2	22
3	18
4	6
5+	2
Weight Category	**N**
Underweight (below 18.5)	3
Normal Weight (18.5-24.9)	30
Overweight (25.0-29.9)	16
Obese (over 30)	9
Average Age	19.98+-1.38

Table 2

Descriptive Statistics for Pre Intervention Measurements

	N	Min	Maximum	Mean	SD
Systolic	57	93.00	155.00	119.09	12.14
Diastolic	57	60.00	95.00	73.74	8.08
BMI	57	15.52	47.73	24.91	5.46
RHR	54	50.00	93.00	68.95	8.58
Enjoyment					
it's fun	55	1.00	7.00	3.96	1.77
like to do activity	55	1.00	7.00	3.96	1.79
makes me happy	55	1.00	7.00	4.75	1.77
think it's interesting	55	1.00	7.00	4.22	1.80
I enjoy this	55	1.00	7.00	4.16	1.80
I find it stimulating	55	1.00	7.00	4.58	1.81
excitement	55	1.00	7.00	3.98	1.94
Competence					
physically challenge me	55	1.00	7.00	4.29	1.73
obtain new skills	55	1.00	7.00	4.80	1.43
improve existing skills	55	1.00	7.00	4.74	1.62
like the challenge	55	1.00	7.00	4.73	1.69
keep up current skill	55	1.00	7.00	4.53	1.88

like physically challenging activities	55	1.00	7.00	4.36	1.86
want to get better at it	55	1.00	7.00	5.25	1.71
Appearance					
maintain weight look better	55	3.00	7.00	6.50	.90
define muscles to look better	55	1.00	7.00	6.18	1.23
improve appearance	55	3.00	7.00	6.29	1.10
be attractive to others	55	1.00	7.00	5.75	1.51
improve body shape	55	2.00	7.00	6.47	.98
I will feel unattractive if i don't	55	1.00	7.00	4.13	2.12
Fitness					
want to be physically fit	55	4.00	7.00	6.60	.87
want to have more energy	55	1.00	7.00	6.07	1.39
improve cardiovascular fitness	55	2.00	7.00	6.01	1.16
maintain physical strength	55	1.00	7.00	6.34	1.21
maintain well being	55	4.00	7.00	6.47	.88
Social					
want to be with friends	55	1.00	7.00	2.38	1.64
be w others who are interested	55	1.00	7.00	3.44	1.84
meet new people	55	1.00	7.00	3.35	1.98
Friends want me to	55	1.00	7.00	2.09	1.52
enjoy spending time with others	55	1.00	7.00	3.64	1.92

Table 3

Descriptive Statistics for Post Intervention Measurements

	N	Minimum	Maximum	Mean	SD
Blood Pressure					
Systolic	52	92.00	130.00	111.50	9.70
Diastolic	52	59.00	85.00	69.44	7.00
BMI	52	17.96	46.38	25.34	5.39
RHR	52	41.00	125.00	66.56	13.17
Enjoyment					
Because it's fun	51	1.00	7.00	3.96	1.78
Because I like to do this activity	51	1.00	7.00	4.04	1.94
Because it makes me happy	51	1.00	7.00	4.90	1.91
Because I think it's interesting	51	1.00	7.00	4.16	1.95
Because I want to enjoy this activity	51	1.00	7.00	4.24	1.84
Because I find this activity stimulating	51	1.00	7.00	4.55	1.70
Because I like the excitement of	51	1.00	7.00	3.67	1.90
Competence					
Because I like engaging in...	51	1.00	7.00	4.65	1.85
Because I want to obtain new skills	51	2.00	7.00	5.02	1.53
Because I want to improve my existing skills	51	2.00	7.00	5.00	1.57

Because I like the challenge	51	1.00	7.00	4.71	1.99
Because I want to keep up my current skill	51	1.00	7.00	4.78	1.77
Because I like activities which are	51	1.00	7.00	4.29	1.91
Because I want to get better at my activity	51	2.00	7.00	4.98	1.68
Appearance					
Because I want to look or maintain	51	3.00	7.00	6.41	1.04
Because I want to define my muscles	51	1.00	7.00	6.02	1.27
Because I want to improve my appearance	51	1.00	7.00	5.96	1.44
Because I want to be attractive to others	51	1.00	7.00	5.37	1.68
Because I want to improve my body shape	51	1.00	7.00	6.19	1.37
Because I will feel physically unattractive	51	1.00	7.00	4.22	2.10
Fitness					
Because I want to be physically fit	51	4.00	7.00	6.49	.83
Because I want to have more energy	51	4.00	7.00	6.16	.90
Because I want to improve my	51	1.00	7.00	5.98	1.32

cardiovascular					
Because I want to maintain my physical strength	51	4.00	7.00	6.55	.67
Because I want to maintain my physical health	51	4.00	7.00	6.45	.90
Social					
Because I want to be with my friends	51	1.00	21.00	3.03	3.13
Because I like to be with others who	51	1.00	7.00	3.24	1.92
Because I want to meet new people	51	1.00	7.00	3.61	1.93
Because my friends want me to	51	1.00	6.00	1.65	1.09
Because I enjoy spending time with others	51	1.00	7.00	3.10	1.76
Intentions					
Intention1	48	1.00	5.00	3.71	1.24
Intention2	48	1.00	5.00	3.71	1.18
Intention3	48	1.00	5.00	4.44	.85

Table 4

RPE Descriptive Results for Each Workout

	N	Minimum	Maximum	Mean	SD
RPEday1	50	3.00	8.50	6.37	1.29
RPEday2	46	4.00	10.00	6.87	1.43
RPEday3	48	3.00	10.00	6.56	1.38
RPEday4	46	1.00	10.00	7.01	1.81
RPEday5	46	4.00	10.00	7.37	1.42
RPEday6	51	3.00	10.00	6.92	1.58
RPEday7	47	4.00	10.00	7.05	1.56
RPEday8	52	3.00	10.00	7.13	1.62
RPEday9	48	4.00	10.00	7.32	1.53
RPEday10	51	4.00	10.00	7.32	1.43
RPEday13	47	4.00	10.00	7.15	1.50
RPEday14	51	4.00	10.00	6.94	1.68
RPEday15	49	4.00	10.00	7.07	1.50
RPEday16	50	3.00	10.00	6.88	1.55
RPEday17	54	3.60	9.00	7.41	1.43
RPEday19	52	4.00	10.00	7.68	1.53

Table 5
Correlations Among All Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Intentions	1												
2. Interest	.423**	1											
3. Competence	.520**	.865**	1										
4. Appearance	.258	.157	.271	1									
5. Fitness	.570**	.526**	.639**	.523**	1								
6. Social	.133	.520**	.312*	.348*	.283*	1							
7. Weight Category	-.097	.036	-.044	.255	-.033	.298*	1						
8. BMI	-.119	.031	-.057	.239	-.016	.249	.876**	1					
9. Systolic	-.196	-.073	-.114	-.055	-.104	-.067	.343**	.367**	1				
10. Diastolic	-.143	.131	.182	.029	.168	.056	.346**	.432**	.576**	1			
11. Systolic Post	-.130	-.242	-.238	.043	-.001	-.112	.248	.271	.522**	.402**	1		
12: Diastolic Post	-.135	-.078	-.109	-.023	.026	-.066	.161	.204	.325*	.530**	.675**	1	
13. Average HR %	.096	.169	.148	.281*	.108	.130	.380**	.555**	.352**	.462**	.288*	.303*	1

Table 6

Prediction of Intention to Engage in HIIT

Variable	B	Std. Error	Beta	t	Sig.
Fitness	.844	.179	.570	4.7	.000

APPENDIX D

RESEARCH COMPLIANCE COVER PAGE

<table>
<tr><td colspan="2">Georgia Southern University

Application for Research Approval</td><td></td></tr>
<tr><td colspan="3">Investigator Information:</td></tr>
<tr><td>Name of Principal Investigator:

Sarah Joseph</td><td>Phone: 860-328-5309</td><td rowspan="3">For Office Use Only:

Protocol ID:
_____

Date Received:</td></tr>
<tr><td>Email: sarahkjoseph@gmail.com</td><td>Faculty; Doctoral;
Specialist;
Masters
Undergraduate</td></tr>
<tr><td>Department Name and PO Box: Health and Kinesiology</td><td></td></tr>
</table>

Name(s) of Co-Investigators: Dr. Langdon, Dr. Kendall, Dr. Harris, Dr. McMillan	Phone:	
Email addresses: jlangdon@GeorgiaSouthern.edu, kkendall@GeorgiaSouthern.edu jmcmillan@GeorgiaSouthern.edu, bharris@georgiasouthern.edu	Faculty; Doctoral; Specialist; Masters Undergraduate *(If multiple: identify by initial letter behind name. E.g., F for faculty)*	
Department Name and PO Box: Health and Kinesiology		
Personnel and/or Institutions Outside of Georgia Southern University involved in this research (Attach training certification):		
Project Information: (Note: funded project titles must match grant title)		
Title: Motives for Physical Activity and Body Composition as Predictors of Exercise Intentions Following a High Intensity Interval Training Protocol in College-Age Females		
Brief (less than 50 words) Project Summary: The purpose of this study is to determine if there is a correlation between body fat percentage, adherence and motives of HIIT classes in asymptomatic young women. Because this population is at risk for gaining weight due to sedentary activities like studying and lack of time for exercise, HIIT may be the optimal type of exercise for this population because of its time effective properties.		
Compliance Information:		

Please indicate which of the following will be used in your research: (application may be submitted simultaneously)	
Human Subjects (Complete *Section A: Human Subjects* below) Care and Use of Vertebrate Animals (Complete *Section B: Care and Use of Vertebrate Animals* below) Biohazards (Complete *Section C: Biohazards* below)	
Project Start Date: 10/3/2012 End Date: 11/18/2012 (no more than 1 year) Anticipated renewals year 2 year 3	**Check one: Student** **Faculty/Staff**
Funding Source: Federal State Private Internal GSU Self funded	
Funding Agency: Health and Kinesiology Department Not Applicable	

Section A: Human Subjects Not Applicable	
Number of Subjects (Maximum) 90	Date of IRB education completion:9/15/2011 **(attach copy of completion certificate)**
Purpose of Research: (Check all that apply)	*Please indicate if the following are included in the study (Check all that apply)***:**

Publication/use in thesis/dissertation Publication (journal, book, etc.) Poster/presentation to a scientific audience Completion of a class project Presentation to GSU audience only Presentation in outside of GSU Results will **not** be published Other	Informed Consent Document Greater than minimal risk Research Involving Minors Deception Generalizable knowledge (results are intended to be published) Survey Research At Risk Populations (prisoners, children, pregnant women, etc) Video or Audio Tapes Medical Procedures, including exercise, administering drugs/dietary supplements, and other procedures

Section B: Care and Use of Vertebrate Animals Not Applicable	
Purpose of use/care of animals:	*Please indicate if the following are included in the study***:**

Research Teaching Demo only Student participation in faculty work Class Project Exhibition Display	Physical intervention with vertebrate animals Housing of vertebrate animals Euthanasia of vertebrate animals Use of sedation, analgesia, or anesthesia Surgery Farm animals for biomedical research (e.g., diseases, organs, etc.) Farm animals for agricultural research (e.g., food/fiber production, etc.) Observation of vertebrate animals in their natural setting

Section C: Biological Research Not Applicable Submitted Separately	
Biosafety Level:	*Please indicate if the following are included in the study***:**

Exempt BSL 1 BSL 2 BSL 3	Use of rDNA Non native/invasive plant species Last EHS lab safety inspection date: _Attach Report_____ Last IBC biosafety lab inspection date: __Attach Report_____

Signature of Applicant(s): (PI, CoPI) Date: 12/13/2012 XSarah Joseph	
If student project please complete research advisor's information below *(note that advisor signature must be received before application will be reviewed.):*	
Research Advisor's Name: Dr. Langdon	Advisor's E-mail: JLangdon@GeorgiaSouthern.edu
Advisor's Phone (912) 478-5378	Advisor's Department: Health and Kinesiology P.O. Box:
If student project - Signature of faculty member who is responsible for the student conducting research. If faculty project – Signature of department head or chair.	

By signing this cover page I acknowledge that I have reviewed and approved this protocol for scientific merit, rational and significance. I further acknowledge that I approve the ethical basis for the study.
Signature of Committee Chair/Research Advisor (if student) Department Chair(if faculty): Date: X

Please submit this protocol to the Georgia Southern University Research Compliance Office, c/o The Office of Research Services & Sponsored Programs, P.O. Box 8005. The application should contain all required documents specific to the committee to which you are applying. Questions or comments can be directed to (912)478-5465 or IRB@georgiasouthern.edu Fax 912-478-0719.

For optional email submission: Save the application forms to your computer. Complete the forms and name them beginning with your last name and first initial. Email the entire submission package to **IRB@georgiasouthern.edu** in a single email. Original signature pages may follow by mail or fax. (Signatures located on cover page, certification of investigator responsibilities and last page of application where certifications required.)

APPENDIX E

QUESTIONNAIRES

Health History Questionnaire

Please answer the following questions to the best of your ability. For the following questions, unless otherwise indicated, circle the single best choice for each question. As is customary, all of your responses are completely confidential and may only be used in group summaries and/or reports. All information collected is subject to the Privacy Act of 1974. If you have any physical handicaps or limitations that would require special assistance with this questionnaire, please let your trainer know. This form is in accordance with the American College of Sports Medicine guidelines for risk stratification when followed correctly by your trainer. Your trainer should be certified with a national organization in order to use these forms correctly.

Name:_____ Ht.:_____ Wt.:_____

Gender:_____ Age:_____ Birthdate:_____

Address: _____

City:_____ State:_____ ZIP:_____ Phone:_____

Emergency Contact:_____ Phone: _____

Personal Physician:_____ Phone:_____

E-mail:_____

1. Have you ever had a definite or suspected heart attack or stroke? . . . . . Yes No

2. Have you ever had coronary bypass surgery or any other type of heart surgery? . . . . . Yes No

3. Do you have any other cardiovascular or pulmonary (lung) disease (***other than*** asthma, allergies, or mitral valve prolapse)? . . . . . Yes No

4. Do you have a history of: diabetes, thyroid, kidney, liver disease. . . . . Yes No **(circle all that apply)**

5. Have you ever been told by a health professional that you have had an abnormal resting or exercise (treadmill) electrocardiogram (EKG)? . . . . . Yes No

6. If you answered YES to any of Questions 1 through 5, please describe:

_____

_____

_____

_____

7. Do you currently have any of the following:

a. pain or discomfort in the chest or surrounding areas that occurs when you engage in physical activity? ..... Yes No

b. shortness of breath ..... Yes No

c. unexplained dizziness or fainting ..... Yes No

d. difficulty breathing at night except in upright position ..... Yes No

e. swelling of the ankles (recurrent and unrelated to injury) ..... Yes No

f. heart palpitations (irregularity or racing of the heart on more than one occasion) ..... Yes No

g. pain in the legs that causes you to stop walking (claudication) ..... Yes No

h. known heart murmur ..... Yes No

Have you discussed any of the above with your personal physician? ..... Yes No

8. Are you pregnant or is it likely that you could be pregnant at this time? ..... Yes No
If yes, what is your expected due date?_____

9. Have you had surgery or been diagnosed with any disease in the past 3 months? ..... Yes No
If yes, please list date_____ and surgery/disease_____

10. Have you had high blood cholesterol or abnormal lipids within the past 12 months or are you taking medication to control your lipids? ..... Yes No

11. Do you currently smoke cigarettes or have quit within the past 6 months? ..... Yes No

12. Have your father or brother(s) had heart disease prior to age 55 OR mother or sister(s) had heart disease prior to age 65? ..... Yes No

13. Within the past 12 months, has a health professional told you that you have high blood pressure (systolic ≥ 140 OR diastolic ≥ 90)? ..... Yes No

14. Currently, do you have high blood pressure or within the past 12 months, have you taken any medicines to control your blood pressure? ..... Yes No

15. Have you ever been told by a health professional that you have a fasting blood glucose greater than or equal to 110 mg/dl? ..... Yes No

16. Describe your regular physical activity or exercise program:

type:_____
frequency: _____ days per week
duration: _____ minutes
intensity: *low* *moderate* *high* **(circle one)**
BMI: _____

17. If you have answered YES to any of questions 7-16, please describe:

_____

_____

_____

18. Are you currently under any treatment for any blood clots? ..... Yes No

19. Do you have problems with bones, joints, or muscles that may be aggravated with exercise? ..... Yes No

20. Do you have any back/neck problems? ..... Yes No

21 Have you been told by a health professional that you should not exercise? ..... Yes No

22. Are you currently being treated for any other medical condition by a physician? ..... Yes No

23. Are there any other conditions (mitral valve prolapse, epilepsy, history of rheumatic fever, asthma, cancer, anemia, hepatitis, etc.) that may ***hinder*** your ability to exercise? ..... Yes No

24. During the past six months, have you experienced any ***unexplained*** weight loss or gain (greater than ten pounds for no known reason)? ..... Yes No

25. If you have answered YES to any of questions 18-24, please describe:

_____

_____

_____

26. Please list below all prescription and over-the-counter medications you are currently taking:

Medicine:	Reason for taking:	Dosage:	Amount/Frequency:

27. Are there any medicines that your physician has prescribed to you in the past 12 months which you are currently not taking? ..... Yes No
If so, please list:

_____

_____

_____

I have answered the Health History Questionnaire questions accurately and completely. I understand that my medical history is a very important factor in the development of my fitness/wellness program. I understand that certain medical or physical conditions which are known to me, but that I do not disclose to my trainer, may result in serious injury to me. If any of the above conditions change, I will immediately inform my trainer of those changes. I, knowingly and willingly, assume all risks of injury resulting from my failure to disclose accurate, complete, and updated information in accordance with the attached questionnaire. I also understand that in order to properly risk stratify my Health History Questionnaire, my trainer should have a minimum of a national certification as a personal trainer. My trainer also verbally explained this statement to me to my understanding.

Client's Signature:_____ Date:_____

Trainer's Signature:_____ Date:_____

For Use by the Personal Trainer ONLY

Check the identified ACSM major coronary risk factors below:

_____ Lipids (TCH ≥ 200 OR HDL < 35)
_____ Family History
_____ Diabetes/glucose ≥ 110 mg/dl
_____ BMI ≥ 30
_____ Metabolic Disease
_____ Signs or Symptoms of Cardiovascular Disease_____
_____ Cardiovascular Disease_____

_____ Cigarette Smoking (or quit within the past 6 months)
_____ High Blood Pressure/Blood Pressure Medications
_____ Sedentary
_____ Pregnancy
_____ Respiratory Disease (asthma, emphysema, chronic bronchitis)

Risk Stratification	Factors
_____ Apparently Healthy	One or No Risk Factors (No medical clearance required)
_____ Apparently Healthy Male ≥ 45; Female ≥ 55	One or No Risk Factors (Initial medical clearance required)
_____ High Risk, No Signs or Symptoms	Two or More Risk Factors (medical clearance required)
_____ High Risk, with Signs and Symptoms	One or More Signs/Symptoms With or Without Risks (medical clearance required)
_____ Known Disease	Diagnosed Cardiopulmonary/Metabolic Disease (annual medical clearance required)
_____ Pregnancy	Medical Clearance Required

All clients needing written medical clearance from their personal physician must give it to their trainer prior to beginning their exercise program.

Additional Comments: _____

revised 11/18/03
P04-020

Health History Questionnaire follows the American College of Sports Medicine recommendations for risk stratification. This must be performed on all clients in order to determine the need for medical clearance and/or exercise modifications. Any trainer or those making exercise recommendations should be certified in the proper use of the risk stratification process through a national organization.

If a client has a YES response to anything on page 1, he/she has KNOWN DISEASE, and must have medical clearance prior to beginning exercise.

If he/she has a YES response to anything on #7 a-h on page 2, your client is HIGH RISK WITH SIGNS/SYMPTOMS and must have medical clearance prior to exercise. If your client has a YES response to questions # 8 or 9, he/she must have medical clearance.

YES responses to two or more on questions 10-16 on page 2, your client is HIGH RISK WITHOUT SIGNS OR SYMPTOMS and must have medical clearance (unless he/she also has a YES answer in question #7 making them still HIGH RISK WITH SIGNS/SYMPTOMS).

All other questions on page 3 are at your own discretion. Remember, **when in doubt, refer out.** Please also refer to the most recent edition of *ACSM's Guidelines for Exercise Testing and Prescription* (Williams & Wilkins) as well as the most recent edition of the *ACE Personal Trainer Manual* (American Council on Exercise) for more explanations on the risk stratification. It is your responsibility as a trainer to remain updated on all changes or modifications for risk stratification in determining the need for medical clearance and exercise modifications/recommendations.

Premier Performance, Inc.
1457 Cambridge Common
Decatur, Georgia 30033
404-406-2873
pperform@bellsouth.net

American Council on Exercise
4851 Paramount Dr.
San Diego CA 92123
800-825-3636
www.ACEfitness.org

The Scale

Motives for Physical Activities Measure – Revised (MPAM-R)

The following is a list of reasons why people engage in physical activities, sports and exercise. Keeping in mind your High Intensity Interval Training (HIIT), respond to each question (using the scale given), on the basis of how true that response is

for you.

1	2	3	4	5	6	7
not at all true for me						very true for me

___ 1. Because I want to be physically fit.

___ 2. Because it's fun.

___ 3. Because I like engaging in activities which physically challenge me.

___ 4. Because I want to obtain new skills.

___ 5. Because I want to look or maintain weight so I look better.

___ 6. Because I want to be with my friends.

___ 7. Because I like to do this activity.

___ 8. Because I want to improve existing skills.

___ 9. Because I like the challenge.

___ 10. Because I want to define my muscles so I look better.

___ 11. Because it makes me happy.

___ 12. Because I want to keep up my current skill level.

___ 13. Because I want to have more energy

___ 14. Because I like activities which are physically challenging.

___ 15. Because I like to be with others who are interested in this activity.

___ 16. Because I want to improve my cardiovascular fitness.

___ 17. Because I want to improve my appearance.

___ 18. Because I think it's interesting.

___ 19. Because I want to maintain my physical strength to live a healthy life.

___ 20. Because I want to be attractive to others.

___ 21. Because I want to meet new people.

___ 22. Because I enjoy this activity.

___ 23. Because I want to maintain my physical health and well-being.

___ 24. Because I want to improve my body shape.

___ 25. Because I want to get better at my activity.

___ 26. Because I find this activity stimulating.

___ 27. Because I will feel physically unattractive if I don't.

___ 28. Because my friends want me to.

___ 29. Because I like the excitement of participation.

___ 30. Because I enjoy spending time with others doing this activity.

Scoring Information

Interest/Enjoyment: 2, 7, 11, 18, 22, 26, 29

Competence: 3, 4, 8, 9, 12, 14, 25

Appearance: 5, 10, 17, 20, 24, 27

Fitness: 1, 13, 16, 19, 23

Social: 6, 15, 21, 28, 30