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Comparing Distance-Based Vs. Time-Based Exercise Prescriptions Of Walking And Running For Improvement Of Cardiovascular Disease Risk Factors

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COMPARING DISTANCE-BASED VS. TIME-BASED EXERCISE PRESCRIPTIONS OF WALKING AND RUNNING FOR IMPROVEMENT OF CARDIOVASCULAR DISEASE RISK FACTORS

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ABSTRACT

The many benefits of participation in a regular physical activity program are well-documented (Haskell et al., 2007; Pate et al., 1995). Brisk walking and jogging are common modes of exercise that are easily measured and evaluated by a self-report method that is common in both clinical and research settings. Some research has suggested that walking for distance as opposed to walking for time may be a stronger predictor of overall amount of accumulated exercise or physical activity (Williams, 2012a). To our knowledge, research has not been conducted directly comparing a distance-based versus time-based brisk walking prescription for the improvement of cardiovascular risk factors. The primary purpose of this study was to compare walking/running for distance to walking/running for time as part of a weight loss intervention to assess similarities or differences. Another purpose was to evaluate the feasibility of a previously published regression equation in predicting energy expenditure for walking or running for a one-mile distance before and after exercise weight loss intervention. This study followed a between-subjects, repeated measures design with each participant reporting for pre-intervention as well as post-intervention testing. Twenty-one overweight, but otherwise healthy participants [10 for distance-based (DIST) group, 11 for time-based (TIME) group] were recruited but only 15 participants completed the study (9 TIME, 6 DIST). Informed consent was obtained from the participants who fit the inclusion criteria based on the physical activity readiness questionnaire and body composition measurements using DXA. Participants were required to complete four testing sessions at the beginning of intervention and three testing sessions at the completion of intervention. Each testing session was separated by 24 hours. The

TIME intervention group walked and ran for self-reported exercise time completed per day, and accumulated per week. The DIST intervention group walked and ran for self-reported exercise distance completed per day, and accumulated per week. Each participant was measured for the following postabsorptive variables: lipid panel which included (total cholesterol, low-density lipoprotein, high-density lipoprotein, and triglycerides), glucose, and resting metabolic rate (RMR). Body composition, VO_2 max, measured kcal/mile and predicted kcal/mile were also measured before and following intervention. A mixed-factor repeated- measures ANOVA (RM-ANOVA) was used to compare all cardiovascular disease risk-related dependent variables before and after intervention (body weight, body composition, blood lipids & glucose, RMR, VO_2 max) for within-subjects and between-subjects comparisons. A mixed-factor repeated-measures ANOVA was also used to compare weekly adherence rates to the exercise program. If interactions occurred, they were followed up with a Sidak adjustment for multiple pairwise comparisons. Overall, the groups adhered to the exercise programs at similar rates. Significant interactions were shown for mean body weight loss between groups as well as mean blood glucose level ($p < 0.05$). The DIST group lost an average of 4.0 kg while the TIME group gained an average of 1.1 kg. The DIST group exhibited a decline in their blood glucose level by an average of 10.5 mg/dL while the TIME group showed an increase in their blood glucose level by an average of 4.7 mg/dL. Additionally, running one-mile was significantly more expensive metabolically than walking the mile at both pre- and post-intervention. Also, excess post-exercise oxygen consumption was significantly greater in the five minutes following running compared to walking. To the best of the author's knowledge, the present study is the first to directly compare a distance-based vs. a time-based exercise program for walking and running for improvement of risk factors of CVD. The results of the particular study would suggest that a distance-based exercise prescription of walking or running should provide a clinician or

researcher with a closer estimation of overall EE and resultant weight loss and reduction of particular risk factors for CVD.

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1. CVD = cardiovascular disease

2. ACSM = American College of Sports Medicine

3. CON = continuous exercise

4. INT = intermittent (or accumulated) exercise

5. EE = energy expenditure

6. RMR = resting metabolic rate

7. EPOC = excess post-exercise oxygen consumption

8. RER = respiratory exchange ratio

9. LDL = low-density lipoprotein

10. TC = total cholesterol

11. TG = triglycerides

12. HDL = high-density lipoprotein

13. VO_2 = liters of oxygen consumed per minute

14. BMI = body mass index

15. FFM = fat-free mass

16. FM = fat mass

17. PAR-Q = physical activity readiness questionnaire

18. DXA = dual-energy x-ray absorptiometry

19. BMD = Bone mineral density

20. HRR = heart rate reserve

CHAPTER I

INTRODUCTION

One of the most important aspects of any healthy lifestyle is the inclusion of physical

activity as a regular part of a person's day-to-day life. Cardiovascular disease (CVD), in

particular coronary artery disease, is one of the leading causes of early death in developed

countries including the United States. There are a number of risk factors that can cause a person

to be at an increased risk for developing CVD and they include but are not limited to:

hyperlipidemia, hypertension, poor diet, sedentary lifestyle, and excess body fat or obesity. In

particular, obesity treatment and interventions should focus on encouragement of healthy

practices leading to reduction of risk factors and improving overall health, not necessarily

physical appearance (Donnelly, Jacobsen, Heelan, Seip & Smith, 2000; Pate et al., 1995;

Thompson, Crouse, Goodpaster, Kelley, Moyna, & Pescatello, 2001). In light of the importance

of physical activity for reducing the occurrence of CVD risk factors, it has been suggested that

exercise protocols should be developed that fit better into a person's busy lifestyle (Jakicic,

Wing, Butler, & Robertson, 1995). Current recommendations based on a position statement from

the American College of Sports Medicine (ACSM) state that in order to increase the likelihood

of experiencing positive effects on reduction of CVD risk factors, all adults should exercise at

least 3 – 5 days per week (Haskell et al., 2007; Pate et al., 1995). Exercise intensity should be

moderate and continue for at least 30 minutes (or 200 kilocalories) per day which can be accumulated in bouts of at least 10 minutes each for a total weekly energy expenditure of at least 700 – 2000 kilocalories (kcal) (Haskell et al., 2007; Pate et al., 1995). This development involving inclusion of accumulation of exercise per day or per week was based on a study by Ebisu (1985) suggesting potential cardiovascular fitness and blood plasma lipid benefits of splitting a training session up into shorter bouts. Despite this recommendation established by a well-respected body such as ACSM, the benefits and effectiveness of intermittent exercise (INT) (or accumulated) compared to the more established merits of continuous exercise (CON) bouts are often debated (Murphy, Blair, & Murtagh, 2009).

It was initially suggested by Ebisu (1985) that cardiovascular function and risk factors for cardiovascular disease could be improved if the person exercised whenever they had time to perform even a short bout as long it lasted at least 10 minutes (Haskell et al., 2007). This suggestion was supported by DeBusk, Stenestrand, Sheehan, & Haskell (1990) when it was reasoned that daily exercise regimens with multiple shortened bouts should be developed that fit conveniently into a person's busy schedule. It has been proposed that long-term adherence to an exercise regimen may be more attractive and see better results if it allows for exercise to be performed in multiple small doses rather than over one long bout (Jakicic et al., 1995; Murtagh, Boreham, Nevill, Hare, & Murphy, 2005; Murphy et al., 2009). Physical activity should be integrated into one's schedule in a way that is most beneficial to one's health and lifestyle without compromising positive effects of the exercise (Asikainen, Miilunpalo, Oja, Rinne, Pasanen, & Vuori, 2002).

One of the most important and common tactics used in any intervention aimed at improving risk factors for CVD is an exercise regimen aimed at weight loss. Put quite simply, a

person in caloric deficit will tend to lose weight, a person consuming the same amount of kcal per day as total expenditure should maintain weight, and a person expending fewer kcal than consumed will tend to gain weight. Traditionally, these exercise regimens have been prescribed as an accumulation of minutes per day or per week. Knowledge of exercise time (minutes) will certainly help towards estimating the amount of exercise actually completed. If time spent exercising is the main component prescribed, then a number of other factors must be considered and one that will play a large role is intensity of exercise. Walking for 30 minutes is certainly very different than running for 30 minutes. For instance, walking for 30 minutes at a 20 minute per mile pace (≈1.5 miles) would lead to an approximate caloric expenditure of about 150 kilocalories (kcal). Running 30 minutes at a 10 minute per mile pace (≈3.0 miles) would lead to an approximate caloric expenditure of 300 kcal. The differences in intensity are quite obvious and if intensity is not considered then the caloric expenditure estimation will be inconsistent and unreliable. Consequently, exercise intensity is important to consider with respect to exercise prescription. However, when considering that most exercise regimens are individually-based, research has shown that there tends to be a substantial difference in the actual amount of exercise performed and what is often self-reported (Luke, Dugas, Durazo-Arvizu, Cao, & Cooper, 2011; Prince et al., 2008). It is often not possible for a clinician or researcher to spend the prescribed amount of time every day with each patient or participant and often self-report of exercise (exercise log) is a common practice. Therefore, possessing a more accurate self-assessment method for determining overall energy requirements and expenditure is very important to not only weight loss plans for overweight populations but also for those simply wanting to maintain their current weight following a weight loss intervention (Mifflin, St. Jeor, Hill, Scott, Daugherty, & Koh, 1990; Williams, 2012).

The ability to correctly estimate energy expenditure (EE) is an important part of any weight loss or weight maintenance program (Browning, Baker, Herron, & Kram, 2006; Williams, 2012). The updated recommendations by the American Heart Association (AHA) and ACSM include a daily (200 kcal/day) and weekly (1000 kcal/week) accumulation of EE. But again, EE per minute is entirely dependent on intensity if the exercise prescription is based on time.

EE will also be dependent on the type of exercise performed. Walking is one of the most commonly performed exercises in not only weight loss interventions but also in exercise for those attempting to live a healthy lifestyle. Loftin, Waddell, Robinson, & Owens (2010) suggested that when comparing the EE per mile of overweight walkers, normal weight walkers, and marathon runners, groups were not significantly different from one other. Results showed that as body mass increased, EE per mile (kcal) increased but EE was not significantly different if the mile was walked or run (Loftin et al., 2010). In the published regression equation for predicting EE to walk or run a mile, it was stated that 59.1% of the variance was due to body mass with gender accounting for another 4.1% (Loftin et al., 2010). Browning et al. (2006) also showed that part of the difference in EE can be accounted for by the differences in amount of body fat a person has; though the exact location of adipose tissue was not found to be a significant factor in EE determination. Browning et al. (2006) reported that the net metabolic cost of walking for the obese walkers was about 10% greater per kg of body weight than the normal weight group. As the previously mentioned regression equation by Loftin et al. (2010) suggests, simply using a person's body weight and gender can provide a clinician or researcher with the tools needed for providing an exercise prescription focused on distance to walk or run. Body weight and gender are variables that are very easily measured by a clinician or researcher.

Establishing a caloric prediction equation to more accurately estimate EE is an important goal. In a recent study examining self-reported distances, Williams (2012) suggested that self-reported distance may provide a more accurate and reliable method estimating EE compared to self-reported time. Using self-reported time for a walking or running, exercise prescription is dependent on the pace (intensity) that the person decides to walk or run. Williams (2012) reported that estimated EE was 32% greater for women and 37% greater for men when calculated from time compared to distance; suggesting that EE estimations based on time are much more likely to overestimate EE than EE based on distance. Williams (2012) indicated that walking distance led to a much greater reduction in the odds ratio for the occurrence of unhealthy markers of obesity such as overweight status and abdominal obesity than walking time (Williams, 2012). If a clinician or researcher can calculate EE without having to use intensity estimations for the calculation, the current research suggests that would seem to be a much more repeatable and reliable method for estimating caloric expenditure. Recent research suggests that simply measuring and reporting distance walked or ran may provide a much more reliable method for evaluating EE (Loftin et al., 2010; Williams, 2012). To date, there has not been any interventional studies conducted directly comparing walking distance with walking time with regards to health aspects of CVD (Williams, 2012). The main purpose of this study was to compare a distance-based versus a time-based exercise prescription of walking and running for the improvement of CVD risk factors.

Specific Aims:

Specific Aim 1:

To investigate and compare a distance vs. time-based brisk walking intervention for improvement of cardiovascular disease risk factors.

Specific Aim 2:

To investigate if the published Loftin et al. (2010) equation can accurately predict energy expenditure per mile walked or ran following an exercise intervention aimed at eliciting weight loss.

The following null hypotheses were tested:

H_{01a}: There will be no significant difference in body weight between and within groups over time in those walking for distance compared to those walking for time.

H_{01b}: There will be no significant difference in body fat percentage between and within groups over time in those walking/running for distance compared to those walking/running for time.

H_{01c}: There will be no significant difference in total cholesterol (TC) between and within groups over time in those walking/running for distance compared to those walking/running for time.

H_{01d}: There will be no significant difference in high-density lipoprotein (HDL) between and within groups over time in those walking/running for distance compared to those walking/running for time.

H_{01e}: There will be no significant difference in low-density lipoprotein (LDL) between and within groups over time in those walking/running for distance compared to those walking/running for time.

H_{01f}: There will be no significant difference in triglycerides (TG) between and within groups over time in those walking/running for distance compared to those walking/running for time.

H_{01g}: There will be no significant difference in blood glucose between and within groups over time in those walking/running for distance compared to those walking/running for time.

H_{01h}: There will be no significant difference in resting metabolic rate (RMR) between and within groups over time in those walking/running for distance compared to those walking/running for time.

H_{01i}: There will be no significant difference in estimated VO_2 max between and within groups over time in those walking/running for distance compared to those walking/running for time.

H_{01j}: There will be no significant difference in adherence to prescribed exercise between and within groups over time in those walking/running for distance compared to those walking/running for time.

H_{02a}: There will be no significant difference in kcal/mile for the one-mile walk and one-mile run between and within-subjects over time.

H_{02b}: There will be no significant difference in the predicted kcal/mile versus the measured kcal/mile for the one-mile walk between and within-subjects over time.

H_{02c}: There will be no significant difference in the predicted kcal/mile versus the measured kcal/mile for the one-mile run between and within-subjects over time.

H_{02d}: There will be no significant difference in preferred walk pace between and within-subjects over time.

H_{02e}: There will be no significant difference in the excess post-exercise oxygen consumption for the one-mile walk (pre & post) versus excess post-exercise oxygen consumption for the one-mile run (post).

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CHAPTER II

LITERATURE REVIEW

Time vs. Distance Prescription of Walking and CVD Risk Factors

The Role of Physical Activity in Weight Loss

Physical inactivity has become an increasingly complex problem in developed countries; consequently, the simple task of brisk walking may provide a safe and effective means of reducing the risk of all-cause mortality related to a sedentary lifestyle (Haskell et al., 2007). There have been a number of reported benefits of an exercise program which includes brisk walking such as improvements in body composition, blood pressure, cognitive function and reduction in risk of overall all-cause mortality (Moreau et al., 2001; Tanasescu, Leitzmann, Rimm, Willett, Stampfer, & Hu, 2002; Weuve, Kang, Manson, Breteler, Ware, & Grodstein 2004). Participating in regular physical activity such as walking can elicit weight loss as well as play a role in weight maintenance to provide a means to help prevent against weight regain (Gordon-Larsen et al., 2009; Williams, 2005). Oftentimes, heavier adults may express difficulty with strenuous or vigorous intensity exercise and walking may be a good initiator of consistent exercise habits (Gordon-Larsen et al., 2009). Obese/overweight as well as older adults may be

more likely to engage in brisk walking for exercise than more lean or younger individuals and may actually see a greater overall benefit from this type of moderate-intensity exercise (Williams, 2005; Williams, 2008). The reason for prescribing brisk walking for exercise is not that it is a mode of exercise that is preferable physiologically to running or creates a greater caloric expenditure, but that walking may be a more practical mode of exercise and likely to be adhered to for most individuals (Gordon-Larsen et al., 2009).

For any overweight or obese individuals, weight loss is often a common prescription to reduce risk factors for CVD. While the more extreme weight losses are the ones that are more highly publicized, even a modest weight loss of 5 – 10% of original body weight can lead to positive health benefits (Blackburn, 1995; Goldstein, 1992). There are a number of different weight loss intervention styles and recommendations, some supported by well-controlled research and others are only supported by anecdotal reports or are purely speculative. Typically, most weight loss regimens include some type of alterations or improvements in diet, exercise, or some combination of both. Nicklas, Huskey, Davis, & Wee (2012) reported that those attempting to lose weight using liquid diets, non-prescription diet pills, or other popular diets alone were significantly less likely to lose 10% of their original body weight or more than those who did not employ that method. Sciamanna et al. (2011) reported that for a modest weight loss to be attained, widely accepted styles of weight loss including choosing healthy (but not extreme) food options and portion sizes combined with performing habitual exercise were most likely to lead to successful weight loss. Generally, those individuals that choose to combine modest changes in dietary habits along with increases in habitual physical activity instead of one of those methods alone tend to see the greatest improvements (Klem, Wing, McGuire, Seagle, & Hill, 1997).

With so many different highly-publicized weight loss regimens popularized by media or promoted by celebrities, it is important for an individual to consider the risks and benefits of engaging in any weight loss regimen prior to choosing one. More attention must be placed on the dietary and physical activity variables within successful methods that strengthen adherence to the program, reduce weight regain, and show the strongest overall improvements (Blackburn, 1995). Klem et al. (1997) reported that of their sample that used exercise to elicit their weight loss, 92% of them chose to exercise at home rather than exercising at a group or in a gym. While gym memberships or group fitness classes may certainly improve the chances for healthy lifestyle choices, not everyone has the ability or the means to afford this type of exercise so it's important to continue to research methods which can be done at home or with minimal equipment to meet the same weight loss and healthy lifestyle improvement goals. Generally, higher frequencies and self-adherence to regular physical activity, such as daily brisk walking should lead to improvements in self-monitored weight loss and long-term weight maintenance (Gordon-Larsen et al., 2009; Klem et al., 1997). In particular, the greater the amount of consistent brisk walking that is performed is associated with a stronger ability to reduce the chance of weight regain in the years following weight loss (Gordon-Larsen et al., 2009).

Continuous and Intermittent Exercise

One of the many complaints that is often expressed with why a person experiences a problem with staying with an exercise regimen is the time that must be dedicated to exercise. A traditionally prescribed exercise regimen involves prolonged continuous aerobic exercise of bouts lasting at least 20 – 30 minutes that must be performed on a minimum of 3 – 5 days per week (Linke, Gallo, & Norman, 2011). An intermittent (INT) exercise routine often consists of a

modified regimen which consists of breaking that 20 – 30 minute daily exercise into 10 – 15

minute bouts that are performed multiple times throughout the day to achieve the same amount

of prescribed time (Linke et al., 2011). Haskell et al. (2007) updated the previously published

physical activity and public health recommendations to include a new recommendation that

exercise did not have to be performed all at once, but could be performed in accumulated bouts

throughout the day to reach the recommended physical activity dose. Some have even proposed

that long-term adherence to an exercise regimen may be more attractive and actually see better

results if it allows for exercise to be performed in multiple small doses rather than over one long

bout (Jakicic, Wing, Butler, & Robertson, 1995; Murtagh, Boreham, Nevill, Hare, & Murphy,

2005; Murphy, Blair, & Murtagh, 2009). Accumulation of activity over an entire day rather than

all at once may be a strategy that strongly benefits populations that have trouble exercising for

prolonged periods of time such as those who are considered obese or just beginning an exercise

regimen, elderly, or those who are not far removed from surgical procedures (Murphy et al.,

2009; Quinn, Klooster, & Kenefick, 2006). Obese or out-of-shape persons may find INT exercise

more attractive in that it allows for their exercise routine to have some flexibility around their

already busy day-to-day schedule as well as potentially being less physically taxing initially

while they adjust to starting the routine (Linke et al., 2011).

    A number of studies have compared continuous (CON) vs. INT exercise to consider

whether one method leads to substantially greater benefits than the other. Comparisons of the

two methods have shown that both CON and INT exercise can lead to substantial improvements

in body weight or composition with no significant differences noted between methods as long as

time or absolute EE is equal between the two methods (Asikainen, Miilunpalo, Oja, Rinne,

Pasanen, & Vuori, 2002; DeBusk, Stenestrand, Sheehan, & Haskell, 1990; Murphy, Nevill,

Neville, Biddle, & Hardman, 2002; Schmidt, Biwer, & Kalscheur, 2001). Researchers have also

attempted to assess whether an isolated bout of CON exercise or a single day of INT exercise can

lead to acute alterations in a person's resting metabolic rate (RMR) as well as oxygen uptake.

The concept of excess post-exercise oxygen consumption (EPOC) is known as the body's

elevated oxygen consumption and energy expenditure following the cessation of an exercise bout

above what would be expected at rest. This is a key component of studying the effect that

different exercise bouts and durations have on recovery ability. Almuzaini, Potteiger & Green

(1998) studied the effect that splitting one 30 minute bout of exercise into two 15 minute bouts

separated by 6 hours had on EPOC. It was reported that the measured EPOC was greater

following combining the EPOC of the two 15 minute sessions compared to the single 30 minute

bout (Almuzaini et al., 1998). However, the authors did point out that the EPOC trends were

similar in the fact that the majority of the post-exercise O_2 consumption occurred during the first

several minutes of recovery (Almuzaini et al., 1998). It is possible that differences that were

reported were more a result of the additive nature of the two sessions than any overall difference

in recovery response. RMR was not reported to be significantly different between exercise days,

suggesting no carryover effect on overall changes in metabolic rate for the multiple daily

sessions (Almuzaini et al., 1998). Some researchers have reasoned that since more fat is used as

substrate at low-to-moderate intensity exercise and with fat balance being considered one of the

strongest contributors to weight balance, even just 30-minutes of brisk walking performed all-at-

once or over the span of a day can lead to improvements in weight regulation (Goto, Tanaka,

Ishii, Uchida, & Takamatsu, 2011; Murphy, Nevill, & Hardman 2000).

As has been well-documented, one of the primary risk factors for cardiovascular disease

are elevated levels of blood lipids, including low-density lipoprotein (LDL), total cholesterol

(TC), triglycerides (TG), combined with low levels of high-density lipoprotein (HDL). Most studies have shown that both INT and CON exercise interventions have led to significant improvements in plasma lipid levels while not seeing a significant difference between intervention styles as long as the EE was similar (Donnelly, Jacobsen, Heelan, Seip & Smith, 2000; Murphy et al., 2002; Woolf-May et al., 1999). Still others have reported the INT exercise group produced significantly greater effects than did the CON group (Ebisu, 1985; Quinn et al., 2006). In particular, Ebisu (1985) reported that all groups improved in level of plasma HDL, but only the INT exercise group that performed the prescribed exercise three times per day showed a significant result.

The many acute effects of exercise have been well-established; however, acute effects of a daily plan of CON or INT exercise are still being investigated. To date, research is inconclusive as to whether one method may be more beneficial than the other. Murphy et al. (2000) were one of the first to compare the response of postprandial lipidemia to either CON or INT exercise though no significant differences between INT and CON days were seen. The researchers concluded that whether a 30-min exercise prescription was performed as one bout or three bouts led to significant improvements in lipid balance but there was not sufficient evidence to suggest that one method was more beneficial than the other (Murphy et al., 2000). They also suggested that further research needed to assess whether the duration of exercise or the actual amount of energy expended was a greater influence on lipid balance (Murphy et al., 2000). This data has been supported elsewhere (Altena, Michaelson, Ball, & Thomas, 2004; Miyashita, Burns, & Stensel, 2006).

Most studies have used time as their way to measure the exercise intervention, but as previously mentioned there may be somewhat of a caloric threshold that may be important to

cross in order to actually see any significant effect. Mestek et al. (2006) used a finite value for caloric expenditure to establish completion of a bout rather than time exercised. Each participant was assessed in the lab on four separate days: one control (no exercise) day, one CON exercise day (one 500 kcal bout), one 2-INT day (two 250 kcal bouts), and one 3-INT day (three 167 kcal bouts) (Mestek et al., 2006). While no significant differences were reported for amount of time, ensuring the caloric expenditure was even was an important step in determining whether caloric expenditure or time was more important of a factor to lipid balance and exercise (Mestek et al., 2006). Results showed that the 3-INT exercise day produced a significantly greater increase in HDL (7 mg/dL) than the CON exercise day (2 mg/dL) from baseline to 48-hours post-exercise (Mestek et al., 2006). The researchers concluded that not only was 500 kcal of exercise sufficient to cause alterations in plasma lipid values, but that performing exercise in several smaller bouts over the span of a day was more effective for increasing HDL levels than performing one single long-bout of exercise in a day (Mestek et al., 2006). These results were supported in analysis performed by Campbell, Moffatt, & Kushnick (2011). Further, LDL particle size was also assessed and no significant differences were found in any groups from baseline to 48-hours post-exercise and it was concluded that 450 kcal, while enough to elicit alterations in HDL values, was not enough to lead to acute changes in TC levels, LDL levels, or LDL particle size (Campbell et al., 2011).

Adherence to Exercise Programs

An important consideration for any exercise prescription is to consider what factors may influence the adherence to the exercise regimen. This is especially true when evaluating self-measurement and self-reporting of exercise. In many populations, frequent vigorous intensity or

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high volume exercise may actually lead to eventual cessation of that exercise program (Swain &
Franklin, 2002). It has been suggested that exercise regimens that involve crossover designs of
previously sedentary participants are more likely to see them adhere to a regimen that is initially
less physically demanding such as moderate-intensity INT exercise or walking program and
gradually increases to exercise involving one long bout (Jakicic et al., 1995; Linke et al., 2011;
Murphy et al., 2002). Accumulation of activity over an entire day rather than all at once may be a
strategy that strongly benefits populations that have trouble exercising for prolonged periods of
time such as those who are considered obese or just beginning an exercise regimen, elderly, or
those who are not far removed from surgical procedures (Murphy et al., 2009; Quinn et al.,
2006). As noted earlier, obese or out-of-shape persons may find INT exercise more attractive in
that it allows for their exercise routine to have some flexibility around their already busy day-to-
day schedule as well as potentially being less physically taxing initially while they adjust to
starting the routine (Linke et al., 2011).

Role of Intensity of Exercise in Weight Loss Programs

Saris et al. (2003) suggests that a crucial point of emphasis that should be considered with
any exercise recommendation is how much physical activity is considered enough to promote
weight loss or avoid weight gain. Swain and Franklin (2002) reported that severely
deconditioned individuals are likely to experience greater gains at lower intensities of exercise
than more highly conditioned individuals who require greater challenges and workloads to elicit
improvements in aerobic ability. It was shown that exercise training intensities as low as 28 –
32% of VO_2 Reserve was enough to promote improvements in VO_2 max in those who were
considered deconditioned (Swain & Franklin, 2002). This finding suggests that if a very

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deconditioned overweight or obese individual can begin an exercise regimen with habitual low-to-moderate intensity walking that it may be enough to potentially see improvements. Williams (2005) reported that degree of obesity per increase in unit distance walked declined to a greater degree for larger women than for leaner women. Again, this suggestion does not challenge the widely held belief that running should elicit greater gains physiologically than walking, but provides a scenario in which overweight or obese individuals who are attempting to alter their sedentary lifestyle can see improvements from an alternative exercise regimen that includes more manageable or tolerable moderate-intensity exercise (Gordon-Larsen et al., 2009).

Both moderate intensity and vigorous intensity exercise can complement each other to provide the greatest possible benefit and the viewpoint that exercise must be vigorous to be beneficial has been challenged (Haskell et al., 2007; Jakicic, Marcus, Gallagher, Napolitano, & Lang, 2003; Swain & Franklin, 2002; Wannamethee & Shaper, 2001). As it applies to running and walking, it would perhaps be of the greatest benefit for someone who is considered overweight/obese or highly deconditioned to initially adopt an exercise program focused on more moderate-intensity exercise (such as walking) and then progress to more vigorous-intensity exercise (such as running) as tolerated (Jakicic et al., 2003). In fact, it has been reported that neither duration nor intensity of exercise is as strong of a predictor of risk of CVD as is total EE of exercise (Lee, Sesso & Paffenbarger, 2000). Prince et al. (2008) reported that self-reporting of vigorous-exercise tended to show a greater percent difference from actual amount of exercise performed than light or moderate-intensity exercise.

Walking and Running for Time or Distance

For walking and running, intensity and distance traveled per unit time is a direct product of pace. The greater the distance a person travels, the greater the EE. Within a range of about 1.9 – 3.7 mph the energetic cost of walking is not necessarily dependent on speed as any increases in speed within this range should lead to the distance traveled in a shorter amount of time (Bassett, Cureton, & Ainsworth, 2000). There has been some suggestion that when EE is accounted for, knowledge of typical duration of exercise does not influence risk of CVD (Lee et al., 2000). Most exercise prescriptions are centered around time-based estimations of EE and some researchers have suggested that the generally accepted recommendation of 30 minutes per day of physical activity may not be enough to see real benefits (Saris et al., 2003). These same researchers stated that the minimal threshold is probably closer to 60 min/day and could be as high as 80 – 90 min/day of moderate intensity exercise (Saris et al., 2003).

If there is such potential variance in time-based exercise prescriptions and EE estimations, it is important to potentially consider other methods to evaluate or prescribe exercise. When considering walking or running as the exercise modality, distance-based estimations may provide an alternative means of prescribing exercise. Research is suggesting that knowledge of distance walked or run has a significant association with improvements in body composition (Williams, 2005; Williams, 2008). If this is the case, prescription of walking or running by distance rather than time may provide a better means for weight loss or weight maintenance (Williams, 2012a). In fact, Williams (2012a; 2012b) reported that the declines observed in body mass index (BMI) and circumference measurements in their cross-sectional data were twice as large when calculated from distance EE estimations compared to EE estimations based on time and intensity. Further, it was shown that estimated EE by distance

walked rather than by time led to a significant reduction in the odds of a person reporting that they were obese or possessed an unhealthy amount of excess abdominal weight (Williams, 2012a). It was also suggested that time-based EE estimations may overestimate physical activity and EE by somewhere between 32 – 43% (Williams, 2012a; Williams, 2012b). If so, then individuals could be potentially falling well short of daily physical activity guidelines (Williams, 2012a). Knowing the distance traveled provides a much closer estimate of EE than does time-based EE estimates that must consider not only the time but also the intensity. If intensity is not reported, then time estimations could be even further from the true EE.

While some may choose to follow exercise regimens based on time, it may be prudent to seek alternative ways to prescribe exercise that allow closer estimations of total EE. Especially if it is true that individuals grossly overestimate total exercise performed as a product of time or intensity as has been reported previously (Luke, Dugas, Durazo-Arvizu, Cao, & Cooper, 2011; Williams, 2012a). Prince et al. (2008) reported that correlation between directly measured exercise and the amount that is self-reported tends to be weak. Some instances show participants to over-report while other cases report under-reporting of exercise (Prince et al., 2008). Prince et al. (2008) concluded that to date, no clear pattern between amount of exercise directly measured and amount self-reported could be distinguished. Williams (2012a; 2012b) suggests that a simple reworking of exercise guidelines for walking and running to promote distance traveled rather than time spent walking or running could provide a better estimate of total EE and therefore a better evaluator of EE for weight control programs. Williams (2012a) stated there is currently not any study that has been reported to compare walking distance and walking time and their effect on risk factors for cardiovascular disease. One of the main purposes of this study will be to compare a distance-based versus time-based walking and running prescription to evaluate

whether either method encourages a greater adherence to the exercise and if that adherence then leads to improvement in risk factors of CVD.

Walking or Running Energy Expenditure Prediction & Evaluation

Gait and Energy Expenditure

The act of walking or running is the body's means of propelling itself forward in order to move the body to its intended location. Locomotion of the body, regardless of whether the person is walking or running, involves the attempt at a coordinated progression of the body through space in the most efficient way possible that limits overall EE (Waters & Mulroy, 1999). During gait, one lower extremity provides support for the rest of the body while the other lower extremity advances the body forward. During normal walking, body weight is transferred when both feet are in contact with the ground during double limb support. Gait is a series of repeating double limb support, swing leg advancement (during opposite single limb support), and then double limb support again. The support limb during gait must be constantly maintaining upright stability of the body while attempting to minimize energetic cost. One of the mechanical responsibilities of the leg and hip musculature is to propel the body forward by generating a horizontal propulsive force (Gottschall & Kram, 2003). Generally, it has been reported that this need to generate horizontal propulsion results in about half of the metabolic cost related to walking (Gottschall & Kram, 2003). For running, it has been reported that generating horizontal propulsive force makes up about a third the required EE to run (Chang & Kram, 1999). Compared to walking, the body must generate a larger vertical propulsive force in response to the greater ground reaction force (GRF) experienced during running to overcome the friction

and braking involved with initial contact (Gottschall & Kram, 2003). This should result in greater muscular force production and therefore metabolic cost (Gottschall & Kram, 2003). Also, towards the completion of the swing phase of gait, the hamstring musculature becomes more active than previously to prepare for initial contact of the heel by slowing the forward progression of the swing leg (Waters & Mulroy, 1999). The knee flexes in an attempt to provide the base to absorb some of the GRF experienced by the leg. During running, the degree of flexion tends to increase as a result of increased stride length as well as providing the base for absorption of the GRF (Gottschall & Kram, 2003).

Regarding pace, there tends to be a speed which must lead to a decision by the person as to whether it is more mechanically efficient to walk or run. It has been reported that at a speed of approximately 3.7 mph, this decision to walk or run typically must be made (Waters & Mulroy, 1999). In their research on a number of different types of animals, Heglund & Taylor (1988) reported that the speeds that an animal must transition from a trot to a gallop are strongly related to body size. However, it was concluded that the relative increases in stride frequency and speed of locomotion was fairly constant over the span of the large group of animals which varied greatly in body size (Heglund & Taylor, 1988). Therefore, if taking this information into consideration as it may relate to humans, it could be reasonably assumed that as a person's body size or frame increases, their stride frequency and speed of preferred pace should mirror the relative increase in size. So while 3.7 mph may be a typical transition pace for most people, there may be some variation as it relates to body size with smaller body sizes having to make the decision at a slower speed while larger body sizes may be able to make the decision at a faster speed. A speed at or below 3.7 mph tends to favor walking for metabolic efficiency while speeds at or above 4.9 mph tend to favor running (Gonelli, Gimenez Filho, Carraro, Montebelo, &

Cesar, 2011). A transition speed can fall anywhere between 3.7 to 4.4 mph (Gonelli et al., 2011).

If a walking speed is forced upon a person that they would be more mechanically efficient

running at, metabolic rate may increase disproportionately (Browning & Kram, 2005).

Therefore, it is very important to take preferred pace (or speed) of walking or running into

account in any attempts at determining EE at paces which a participant is comfortable and

successful performing at.

Comparing Walking versus Running

For the most part, research comparing walking versus running the same distance has

reported that running produces the greater EE when completing the same distance as walking. A

number of studies have supported this viewpoint (Bhambani & Singh, 1985; Cesar et al., 2013;

Fellingham, Roundy, Fisher, & Bryce, 1978; Gonelli et al., 2011; Hall, Figueroa, Fernhall, &

Kanaley, 2004; Howley & Glover, 1974; Verlengia et al., 2012; Wilkin, Cheryl, & Haddock,

2012). Some have reported gender differences even within running with males showing greater

EE per unit distance than females (Bhambani & Singh, 1985; Hall et al., 2004; Loftin et al.,

2010). When only referring to walking, for the most part it has not reported to have a

significantly different EE per unit distance between genders (Bhambani & Singh, 1985; Loftin et

al., 2010; Morris et al., 2014) while others have reported a significant difference mirroring

running (Hall et al., 2004). When the EE per unit distance was compared against amount of fat-

free mass (FFM), any significant differences that existed between genders disappeared (Hall et

al., 2004; Loftin et al., 2010; Morris et al., 2014). This could be due to females generally as a

whole having a higher portion of body mass that is made up of fat mass (FM), and therefore are

carrying a relatively larger amount of extra weight (Hall et al., 2004). As it pertains to recovery

EE and EPOC, both modes of exercise performed for the same distance show EPOC generally to end and return to resting levels within 10 minutes (Cesar et al., 2013). Wilkin et al. (2012) reported EPOC to return to resting EE around 10 minutes when walking and 15 minutes when running. Another potentially key similarity that has been reported within a few of these same studies is that RER has not been significantly different between walking and running (Cesar et al., 2013; Gonelli et al., 2011). These reports of walking and running the same distance and having significantly different EE contrast with the previous theories and data presented by Kram & Taylor (1990).

While no data has been reported showing walking to elicit a higher EE per unit distance than running, some recent research has reported that walking may not be significantly different than running when performing the exercise at one's preferred pace rather than a forced pace. When walking or running around the transition speed (such as the range mentioned earlier), there have been reports that running does not elicit a significantly higher EE per unit distance than walking (Monteiro & de Araújo, 2009; Verlengia et al., 2012). Creatine kinase levels (which would suggest an increase in intensity) were also not reported to be significantly higher while running at the transition speed compared to walking (Verlengia et al., 2012). Loftin et al. (2010) suggested that when comparing the EE per mile of overweight walkers, normal weight walkers, and marathon runners, groups were not significantly different from one other. Results showed that as body mass increased, EE per mile increased but EE was not significantly different if the mile was walked or run (Loftin et al., 2010). In the published regression equation for predicting EE to walk or run a mile, it was stated that 59.1% of the variance was due to body mass with gender accounting for another 4.1% (Loftin et al., 2010). Browning, Baker, Herron, & Kram (2006) also showed that part of the difference in EE can be accounted for by the differences in

amount of body fat a person has; though the exact location of adipose tissue was not found to be a significant factor in EE determination. Browning et al. (2006) reported that the net metabolic cost of walking for the obese walkers was about 10% greater per kg of body weight than the normal weight group. This data was supported by Morris et al. (2014) but the authors also suggested that further research needs to be conducted to confirm full validation of the published equation by Loftin et al. (2010). As the previously mentioned regression equation by Loftin et al. (2010) and support by Morris et al. (2014) suggests, simply using a person's body weight and gender can provide a clinician or researcher with the tools needed for providing an exercise prescription focused on distance to walk or run.

Walking, Running, and Obesity

Many exercise prescriptions for general populations are targeted for weight management purposes. Especially as it pertains to an overweight or obese population, it is very important to determine modes of exercise which may limit unnecessary pain or other uncomfortable situations which may influence the likelihood for that person to engage in or remain with an exercise program. As a whole, those who are trained (regardless of overweight or obesity status), tend to be much more metabolically efficient when performing an exercise that they are comfortable with (Hall et al., 2004; Morgan, Bransford, Costill, Daniels, Howley, & Krahenbuhl, 1995). Additionally, the less extra weight or adipose tissue that a person carries tends to lower EE and improve efficiency (Hall et al., 2004). Heglund & Taylor (1988) suggest that no matter the size of a mammal's body, the same relative ratio of muscle mass to body mass is employed to perform any particular task.

As previously mentioned, carrying extra weight which is not aiding in propulsion of the body could potentially create some complex challenges as it relates to metabolic efficiency (Ekkekakis & Lind, 2006). As it relates to exercise for overweight or obese populations, it is important for exercise prescription purposes to determine to what effect excess body weight influences overall EE. Despite significant differences in body weight and body composition, some recent research has reported a lack of significant difference among normal weight walkers, overweight walkers, and distance runners when purely assessing EE over a defined distance such as kcal/mile (Loftin et al., 2010; Morris et al., 2014). This data is comparable to findings which reported assessing gross EE between normal weight and overweight individuals over an absolute distance or time (Browning et al., 2006; Loftin et al., 2010; Welle, Forbes, Statt, Barnard, & Amatruda, 1992). It has been suggested by some that when only evaluating the gross caloric expenditure to walk or run one mile, caloric expenditure will be similar whether walking or running (Browning et al., 2006; Loftin et al., 2010; Morris et al., 2014; Welle et al., 1992). This is a stark difference to what has been reported previously when considering a within-subject design (Bhambani & Singh, 1985; Cesar et al., 2013; Fellingham et al.; 1978; Gonelli et al., 2011; Hall et al., 2004; Howley & Glover, 1974; Verlengia et al., 2012; Wilkin et al., 2012). Echoing previously reported data, when the EE per defined distance were compared against the participant's FFM, any significant differences in EE disappeared (Browning et al., 2006; Loftin et al., 2010; Morris et al., 2014; Treuth, Figueroa-Colon, Hunter, Weinsier, Butte, & Goran, 1998). If it were true that the EE over a defined measureable distance such as a mile were not substantially different, an individual beginning an exercise program would expend similar kcal either running or walking for a given distance (Morris et al., 2014). At the very beginning of an exercise regimen when an individual is attempting to alter their lifestyle drastically from a

previously sedentary lifestyle, this ability to begin with a walk and progressively increase intensity as desired at their own pace could potentially decrease the risk for injury related to overexertion or poor form. Unnecessary increases in pain or discomfort could lead to decreases in adherence to exercise and failing to complete what has been prescribed to them (Ekkekakis & Lind, 2006). Loading the body with additional weight should increase the overall EE in a manner relative to how much extra weight is considered inactive (Waters & Mulroy, 1999).

Loftin et al. (2010) and Morris et al. (2014) also reported that when overweight walkers and normal weight walkers were allowed to walk at their preferred pace, they performed at similar relative percentages of their VO_2 max. This suggestion differs substantially from previous studies (Browning & Kram, 2005; Ekkekakis & Lind, 2006). Groups performing only walking, regardless of overweight/obesity or normal weight status, were both found to prefer to walk at similar speeds (Browning & Kram, 2005; Ekkekakis & Lind, 2006; Loftin et al., 2010 Morris et al., 2014). If one of the main goals with any weight management program is improved body composition, then it has been suggested that the peak fat oxidation rate at lower relative exercise intensities should be considered (Bogdanis, Vangelakoudi, & Marikadi, 2008). These researchers reported that the peak fat oxidation of sedentary and overweight adults occurred at about 40% of relative VO_2 max, suggesting that even if running is not well tolerated then brisk walking could be employed to achieve the same end-goal (Bogdanis et al., 2008). There has been some difference in the exact differences between overweight and normal weight performances of walking as a percentage of aerobic capacity. Some researchers have reported that overweight individuals tend to walk at a higher percentage of aerobic capacity (about 50-55% for overweight versus 35-40% for normal weight) (Browning & Kram, 2005, Ekkekakis & Lind, 2006). Morris et al. (2014) reported that overweight and normal weight walkers both preferred to walk at a

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similar percentage of aerobic capacity (35-37% of VO$_2$ max). As previously mentioned, it must

be considered that training status and familiarity with the exercise demanded will certainly play a

role. However, if walking is around this 35-55% of aerobic capacity mark which is considered

low-to-moderate intensity exercise according to ACSM guidelines (2010), this reduced intensity

of exercise compared to running (which may still be considered vigorous for some overweight

adults) may potentially improve overall ability to maintain an exercise regimen and improve

adherence.

An important aspect of walking or running is that limited equipment is needed. Many

other exercise modalities can become quite expensive when equipment or gym membership is

considered. A person desiring to live a healthy lifestyle can walk or run outdoors without the

need for a gym membership or expensive equipment. This especially comes into play when the

fact that a large number of Americans who are considered low-income are much less likely to

participate in physical activity and also don't have the same access to gyms or equipment that

others may have (Siegel, Brackbill, & Heath, 1995). Despite this statistic, those who are

considered overweight or obese were just as likely as healthy weight people to choose walking

when they did in fact choose to exercise (Siegel et al., 1995). Walking tends to be an exercise

modality that can encourage adherence to exercise and physical activity promotion compared to

other more challenging or vigorous intensity exercise types (Siegel et al., 1995). Both regular

walking and vigorous intensity exercise have been reported to be associated with decreases in

risk of CVD episodes to similar degrees (Manson et al., 1999). In fact, it was also shown that

women who participated in both regular walking and vigorous intensity exercise experienced

fewer CVD episodes overall than compared to either exercise modality alone (Manson et al.,

1999; Manson et al., 2002). Walking pace was also stated to be an important factor to CVD risk

reduction. It was report that with each 1.0 mph increase in walking pace up to a very brisk pace around 4.0 mph, CVD risk reduction decreased accordingly (Manson et al., 1999; Manson et al., 2002). So while walking can certainly be an important aspect of any exercise regimen, pace is certainly important in that it influences not only the intensity but the actual absolute amount of work that is completed (or distance that is covered).

Exercise Prescriptions Relying on Self-reporting of Exercise

For exercise prescription that relies on self-reporting of exercise, it's important that prediction equations be accurate and that expectations of the client or participant are reasonable. Ekkekakis and Lind (2006) propose a causal chain which states that the intensity of the exercise, perceived exertion, and adherence are strongly related. The more likely that the exercise that is prescribed is based on self-selection of intensity or walk/run pace, then the greater chance exists that the person will consider the exercise as tolerable or enjoyable and be more likely to continue in the exercise regimen (Ekkekakis & Lind, 2006). The more wide-ranging positive benefits of exercise should be emphasized over solely focusing on amount of weight lost (Larsson & Mattsson, 2003). It has been suggested by some that walking for a self-selected or preferred pace for a defined distance rather than an imposed pace may be a more appropriate exercise prescription for overweight and obese adults and encourage a greater degree of self-reliance and adherence with the exercise (Browning & Kram, 2005; Ekkekakis & Lind, 2006; Loftin et al., 2010). While there may certainly be some differences with walking and running EE, it will be important to further consider potential improvements in CVD risk factors when total EE is not substantially different between modes (Manson et al., 1999). Walking and running are both acceptable exercise modalities for a promotion of a healthy lifestyle and the EE per mile

prediction equation published by Loftin et al. (2010) can be potentially useful in exercise prescription by simplifying the prescription to achievement of a particular distance rather than focusing on intensity and time which can be highly variable.

Weight Loss and Energy Expenditure Estimations

There are a number of benefits that can be experienced with weight loss. Some are better publicized than others. In particular, even just a 10% loss of original body weight (especially if that 10% loss is considered fat mass) could lead to improvements in body composition, ability to perform exercise, and aerobic capacity (Larsson & Mattsson, 2003). Walking and running may become less painful and feel less strenuous than before weight loss due to less overall loading on the joints from reduced carrying of excess weight (Larsson & Mattsson, 2003). Some research has shown improvements in ability to walk comfortably at a faster pace than before the weight loss (Foster, Wadden, Kendrick, Letizia, Lander, & Conill, 1995; Larsson & Mattsson, 2003; Öhrstöm, Hedenbro, & Ekelund, 2001).

Any weight loss, especially if using exercise as the means to elicit the loss, is going to involve some continuous re-evaluation of tactics throughout the process. With regards to exercise prescription, not only is it important to consider changes that may need to be made to duration, intensity, or type of exercise but also the clinician or researcher must keep track of what effect the lost weight is having on EE. Leibel, Rosenbaum, and Hirsch (1995) reported that forced weight gain of 10% of original body weight from initial body weight led to an increase in total 24-hour EE of about 9 kcal per kg of FFM in those who had never been considered obese. Those participants who were already obese prior to the weight gain experienced an increase in total 24-hour EE of about 8 kcal per kg of FFM (Leibel et al., 1995). A forced weight loss of

10% of original body weight from initial body weight led to a decrease in total 24-hour of about 6 kcal per kg of FFM in those who had never been considered obese and a decrease of about 8 kcal per kg of FFM in those who had previously been considered obese (Leibel et al., 1995). This data illustrates the effect that substantial fluctuations in body weight can have on the total EE of a person throughout the day as well as when performing exercise. This would be an important consideration for weight loss in particular in that if the total EE is falling in response to their weight loss, the previously prescribed exercise will most likely not be eliciting the same EE as before the weight loss. This would be an important point to consider re-evaluating the exercise prescription in order to limit plateauing of improvements in body composition. Perhaps the most telling statistic has been described by Foster et al. (1995) in their data showing that the degree of weight loss was not reflected in the change in overall standing EE and walking EE. It was reported that with a significant reduction in body weight over the span of a weight loss regimen, the overall EE and exercise EE during walking did not decrease proportionally to weight loss (Foster et al., 1995). In fact, the EE during walking was reduced much more than the degree to be expected by the loss in weight; suggesting that overweight and obese individuals who lose weight will end up having a much lower EE than to be expected for activity (Foster et al., 1995). The researchers speculated that this could be due to potentially greater mechanical efficiency after the weight loss due to carrying less uncomfortable weight (Foster et al., 1995).

Öhrstöm, Hedenbro, and Ekelund (2001) employed a surgically imposed weight loss through vertical banded gastroplasty (also known as stomach stapling) and had opposite results as Foster et al. (1995). However, Öhrstöm et al. (2001) based their EE determinations from a comfortable walking speed and suggested that the increase in EE they reported at the comfortable walking speed could potentially be due to the significant increase in comfortable

walking speed and therefore leading to more actual work being performed than before weight loss. This would play a substantial role in their EE calculations. Despite the debate about what exactly happens with EE with weight loss, it is clear that it is important to consider a person's current body weight and overall performance of work when attempting to reassess exercise prescriptions. If there are potentially to be changes in pace and aerobic ability to go along with improvements in body composition which may greatly vary, it would be prudent to try to limit complex factors such as intensity and duration and solely concern oneself with the actual EE. If this is the case, perhaps the simplest way to do that would be to make exercise prescriptions based on a defined distance or overall EE.

If a researcher or clinician can make exercise prescriptions or recommendations based upon an easily measurable exercise mode such as walking or running distance, then perhaps some of the guesswork related to intensity and duration can be limited. As previously stated, the equation published by Loftin et al. (2010) and supported by Morris et al. (2014) could potentially provide a useful prediction of EE over a defined distance which in this case is a mile. An important evaluation for further validation of the equation would be to determine if the equation (which includes body weight and gender as factors) can still accurately predict EE per mile following weight loss. One of the main purposes of this study will be to elicit weight loss through a walking for exercise regimen and evaluate whether the equation can accurately predict EE per mile following the weight loss.

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CHAPTER III

MANUSCRIPT 1

COMPARING DISTANCE-BASED VS. TIME-BASED EXERCISE PRESCRIPTIONS OF
WALKING AND RUNNING FOR IMPROVEMENT OF CARDIOVASCULAR DISEASE
RISK FACTORS

INTRODUCTION

One of the most important aspects of any healthy lifestyle is the inclusion of physical activity as a regular part of a person's day-to-day life. Cardiovascular disease (CVD) and coronary artery disease together are the leading causes of early death in developed countries like the United States. There are a number of risk factors that can cause a person to be at an increased risk for developing CVD and they include but are not limited to: hyperlipidemia, hypertension, poor diet, sedentary lifestyle, and excess body fat or obesity. In particular, treatment and interventions for obesity should focus on encouragement of healthy practices leading to reduction of CVD risk factors and improving overall health, not necessarily physical appearance (Donnelly, Jacobsen, Heelan, Seip & Smith, 2000; Pate et al., 1995; Thompson, Crouse, Goodpaster, Kelley, Moyna, & Pescatello, 2001). In light of the importance of physical activity for reducing the occurrence of CVD risk factors, it has been suggested that exercise protocols should be developed that fit better into a person's busy lifestyle (Jakicic, Wing, Butler, & Robertson, 1995). Current recommendations based on a position statement from the American College of Sports Medicine (ACSM) state that in order to increase the likelihood of experiencing positive effects on reduction of CVD risk factors, all adults should get at least 3 – 5 days per week of moderate intensity exercise for at least 30 minutes (or 200 kilocalories) per day that can be accumulated in bouts of at least 10 minutes each for a total weekly energy expenditure of at least 700 – 2000 kilocalories (kcal) (Haskell et al., 2007; Pate et al., 1995). This development for inclusion of accumulation of exercise per day or per week was based on a study by Ebisu (1985)

suggesting potential cardiovascular fitness and blood plasma lipid benefits of splitting a training session up into shorter bouts.

One of the most important and common tactics used in any intervention aimed at improving risk factors for CVD is an exercise regimen aimed at weight loss. Put quite simply, a person in caloric deficit will tend to lose weight, a person consuming the same amount of kcal per day as total expenditure should maintain weight, and a person expending fewer kcal than consumed will tend to gain weight. Traditionally, these exercise regimens have been prescribed as an accumulation of minutes per day or per week. While knowing exercise time will certainly help towards estimating the amount of exercise actually done, time alone doesn't paint the entire picture. If time spent exercising is the main component prescribed, then a number of other factors must be considered and one that will play a large role is intensity of exercise. Walking for 30 minutes is certainly very different than running for 30 minutes. For instance, walking for 30 minutes at a 20 minute per mile pace would lead to an approximate caloric expenditure of about 150 kcal resulting from travelling 1.5 miles while running 30 minutes at a 10 minute per mile pace would lead to an approximate caloric expenditure of 300 kcal resulting from travelling 3.0 miles. The differences in intensity are quite obvious and if intensity is not considered then the caloric expenditure estimation will be inconsistent and unreliable. So that is why knowing intensity is important to these traditional exercise prescriptions and why it is a part of the recommendations recognized by the ACSM based on previous research (Haskell et al., 2007; Pate et al., 1995). However, when considering that most often exercise regimens are done individually, there has been research that has shown that there tends to be a substantial difference in the actual amount of exercise performed and what is often self-reported to a researcher or clinician (Luke, Dugas, Durazo-Arvizu, Cao, & Cooper, 2011; Prince et al., 2008). Possessing a

more accurate self-assessment method for determining overall energy requirements and expenditure is very important to not only weight loss plans for overweight populations but also for those simply wanting to maintain their current weight following a weight loss intervention (Mifflin, St. Jeor, Hill, Scott, Daugherty, & Koh, 1990; Williams, 2012).

There have been a number of reported benefits of an exercise program which includes brisk walking such as improvements in body composition, blood pressure, cognitive function and reduction in risk of overall all-cause mortality (Moreau et al., 2001; Tanasescu et al., 2002; Weuve et al., 2004). Participating in regular physical activity such as walking can elicit weight loss as well as play a role in weight maintenance to provide a means to help prevent against weight regain (Gordon-Larsen et al., 2009; Williams, 2005). Obese/overweight as well as older adults may be more likely to engage in brisk walking for exercise than more lean or younger individuals and may actually see a greater overall benefit from this type of moderate-intensity exercise (Williams, 2005; Williams, 2008). The reason for prescribing brisk walking for exercise is not that it is a mode of exercise that is preferable physiologically to running or creates a greater caloric expenditure, but that walking may be a more practical mode of exercise and likely to be adhered to for most individuals (Gordon-Larsen et al., 2009).

Mestek et al. (2006) used a finite value for caloric expenditure to establish completion of a bout rather than time exercised. Each participant was assessed in the lab on four separate days: one control (no exercise) day, one continuous (CON) exercise day (one 500 kcal bout), one 2-bout intermittent (INT) day (two 250 kcal bouts), and one 3-INT day (three 167 kcal bouts) (Mestek et al., 2006). While no significant differences were reported for amount of time, ensuring the caloric expenditure was equivalent was an important step in determining whether caloric expenditure or time was more important of a factor to lipid balance and exercise (Mestek

et al., 2006). Results showed that the three-bout per day exercise day produced a significantly greater increase in high-density lipoprotein (HDL) (7 mg/dL) than the CON exercise day (2 mg/dL) from baseline to 48-hours post-exercise (Mestek et al., 2006). The researchers concluded that not only was 500 kcal of exercise sufficient to cause alterations in plasma lipid values, but that performing exercise in several smaller bouts over the span of a day was more effective for increasing HDL levels than performing one single long-bout of exercise in a day (Mestek et al., 2006). These results were supported in analysis performed by Campbell, Moffatt, & Kushnick (2011).

Williams (2005) reported that degree of obesity per increase in unit distance walked declined to a greater degree for larger women than for leaner women. Again, this suggestion does not challenge the widely held belief that running should elicit greater gains physiologically than walking, but provides a scenario in which overweight or obese individuals who are attempting to alter their sedentary lifestyle can see improvements from an alternative exercise regimen that is includes more manageable or tolerable moderate-intensity exercise (Gordon-Larsen et al., 2009). For walking and running, intensity and distance traveled per unit time is a direct product of pace. The greater the distance a person travels, the greater the EE. Within a range of about 1.9 – 3.7 mph the energetic cost of walking is not necessarily dependent on speed as any increases in speed within this range should lead to the distance traveled in a shorter amount of time (Bassett, Cureton, & Ainsworth, 2000). There has been some suggestion that when EE is accounted for, knowledge of typical duration of exercise does not influence risk of CVD (Lee, Sesso, & Paffenbarger, 2000). Most exercise prescriptions are centered on time-based estimations of EE and some researchers have suggested that the generally accepted recommendation of 30 minutes per day of physical activity may not be enough to see real

benefits (Saris et al., 2003). These same researchers stated that the minimal threshold is probably closer to 60 min/day and could be as high as 80 – 90 min/day of moderate intensity exercise (Saris et al., 2003).

If there is such potential variance in time-based exercise prescriptions and EE estimations, it is important to potentially consider other methods to evaluate or prescribe exercise. When considering walking or running as the exercise modality, distance-based estimations may provide an alternative means of prescribing exercise. Research has suggested that knowledge of distance walked or run had a relationship with improvements in body composition (Williams, 2005; Williams, 2008). If this is the case, prescription of walking or running by distance rather than time may provide a better means for weight loss or weight maintenance (Williams, 2012a). In fact, Williams (2012a; 2012b) reported that the declines observed in body mass index (BMI) and circumference measurements in their cross-sectional data were twice as large when calculated from distance EE estimations compared to EE estimations based on time and intensity. Further, it was shown that estimated EE by distance walked rather and by time led to a significant reduction in the odds of a person reported that they were obese or possessed an unhealthy amount of excess abdominal weight (Williams, 2012a). It was also suggested that time-based EE estimations may overestimate physical activity and EE by somewhere between 32 – 43% (Williams, 2012a; Williams, 2012b). If so, then individuals could be potentially falling well short of daily physical activity guidelines (Williams, 2012a). Knowing the distance traveled provides a much closer estimate of EE than does time-based EE estimates that must consider not only the time but also the intensity. If intensity is not reported, then time estimations could be even further from the true EE.

While some may choose to follow exercise regimens based on time, it may be prudent to seek alternative ways to prescribe exercise that allow closer estimations of total EE. Especially if it is true that individuals grossly overestimate total exercise performed as a product of time or intensity as has been reported previously (Luke et al., 2011; Williams, 2012a). Williams (2012a; 2012b) suggests that a simple reworking of exercise guidelines to promote distance walking or running rather than time spent walking or running could provide a better estimate of total EE. Therefore, Williams (2012a; 2012b) contends that this change may potentially provide a better evaluator of EE for weight control programs. Williams (2012a) stated there is currently not any study that has been reported to compare walking distance and walking time and their effect on risk factors for cardiovascular disease. The purpose of this study was to compare a distance-based versus time-based walking prescription to evaluate whether either method encouraged a greater adherence to the exercise and if that adherence then leads to improvement in risk factors of CVD.

MATERIALS AND METHODS

Participant Recruitment

The study attempted to recruit up to 24 participants (12 per group) from the University of Mississippi and Oxford, MS communities. This sample size of 24 would meet the median and mode group size employed in previous weight loss interventions outlined by Miller, Koceja, and Hamilton (1997). The desired participants were to be sedentary adults between the ages of 18 – 44 (males) and 18 – 54 (females). The participants were assigned to the two treatment groups in a counter-balance design to attempt to limit any unintended substantial differences in gender and aerobic capacity between the groups at baseline. One group was prescribed an aerobic exercise regimen based on an accumulated walking time per week (TIME) and another group was prescribed an aerobic exercise regimen based on an accumulated walking distance (DIST) per week. The Physical Activity Readiness Questionnaire (PAR-Q) (Thomas, Reading, & Shephard, 1992) was used during pre-screening in order to screen for any potential contraindications to exercise. Participants completed a 7-day physical activity questionnaire to determine physical activity status (Sallis, Haskell, & Wood, 1985). Self-reported height and weight was also obtained prior to arrival for calculating BMI for appropriateness of potential participants. Potential participant recruitment was aimed at recruiting an overweight but otherwise healthy adult population. A participant was considered for the study if they were considered overweight but otherwise healthy as determined by answers to the PAR-Q. Participants with a BMI greater than 25.0 kg/m^2 were initially considered for inclusion in the study, but in order to be selected

body fat percentage was the final determinant and would override BMI if necessary. Each participant's body composition was evaluated using dual energy x-ray absorptiometry (DXA) as measured by a Hologic Delphi, QDR series (Bedford, MA) apparatus and height and body mass were measured by standard scales upon arrival. Body fat percentage ranges for consideration in the study were determined using previously published recommendations based on gender and age (ACSM, 2010). Overweight but otherwise healthy males were considered if their body fat percentage was greater than 22% and overweight but otherwise healthy females were considered if their body fat percentage was greater than 32% (ACSM, 2010).

Pre-Intervention Procedures – Day 2

Prior to any exercise intervention beginning, all participants underwent baseline testing. Once the pre-screening (Day 1) was completed and the participant met the inclusion standards, the participant was asked to return for resting baseline measurements. The participants were required to be fasting from any food or alcohol for at least eight hours as well as abstaining from moderate-intensity exercise for at least two hours and vigorous-intensity exercise for at least 14 hours prior to any Day 2 data collection. The participants were required to also have abstained from caffeine for at least four hours and nicotine for two hours. Day 2 data collection involved resting blood levels of HDL cholesterol, LDL cholesterol, triglycerides (TG), total cholesterol (TC), and blood glucose using a Cholestech LDX system by Alere (Waltham, MA). The use of this analyzer in measurement methodology has been previously validated (Carey, Markham, Gaffney, Boran, & Maher, 2006). Following completion of this test each participant then had their resting metabolic rate (RMR) evaluated using indirect calorimetry. Each participant was asked to rest quietly while lying reclined at a 45° angle on a padded exercise bench with feet

propped up for 20 minutes prior to any data collection beginning. The room in which measurements were made was kept in a comfortable temperature range. The measurement of RMR took approximately 30 – 40 minutes to complete (including the previously mentioned 20 minute rest period). All laboratory metabolic data (oxygen uptake, carbon dioxide production, pulmonary ventilation) related to RMR was measured using a ParvoMedics TrueOne 2400 (Sandy, Utah) measurement system and accompanying mouthpiece and nose-clamp system. Before any metabolic testing was conducted, the system was calibrated against standard gases (O_2 = 16.0%, CO_2 = 1.0%). Once the mouthpiece and nose-clamp was in place and breath-by-breath analysis commenced, data collection continued for at least 10 minutes. The first five minutes of data collection was not considered for analysis and was discarded. The remaining five minutes of data was used for the RMR measurement as long as the coefficient of variation was no greater than 10%. RMR measurement was ended at this point if this criteria was met. If not, evaluation continued until the previously mentioned criteria were met. The described RMR protocol is based on previously published recommendations (Compher, Frankenfield, Keim, & Roth-Yousey, 2006). Following completion of the RMR measurement, the participant was then permitted to leave and schedule a time for Day 3 measurements.

Pre-Intervention Procedures – Day 3

Day 3 involved a number of exercise tests and evaluations. Indirect calorimetry was employed to measure EE during treadmill walking or running using the ParvoMedics TrueOne 2400 measurement system. Before any metabolic testing was conducted, the system was calibrated against standard gases (O_2 = 16.0%, CO_2 = 4.0%). Following a number of other walking tests, each participant performed a submaximal treadmill test to predict VO_2 max using

a modified Balke protocol (Froelicher, Brammell, Davis, Noguera, Stewart, & Lancaster, 1974).

Exercise continued until heart rate (HR) reached 60% of predicted heart rate reserve (HRR).

Independent regression equations were used to examine the VO_2 – HR association and VO_2 max

was estimated at the extrapolated HR_{max}. Following completion of the submaximal VO_2 test,

participants were permitted to leave.

Exercise Pre-Intervention Procedures – Day 4

Each participant returned for their next visit when the intervention was ready to begin and

they were available to meet with the primary investigator (PI). Prior to arrival, the PI had

assigned the participant to one of the two groups: TIME or DIST using a counterbalance design

mentioned previously. The PI informed the participant of their baseline testing results and where

it related to population norms. The PI then outlined and discussed the exercise each participant

needed to perform each day or week. Participants were informed about the difference between

daily physical activity (such as walking from one class to another) and the planned exercise

program to be followed and reported. All participants were instructed to correspond with the PI

through use of a Qualtrics online survey to give a weekly self-report update on the exercise that

had been performed that week. The PI requested that participants refrain from other strenuous

exercise and resistance training during the span of the intervention and to try to adhere to the

prescribed exercise as closely as they could. Each participant was also asked to report weekly

exercise as honest and truthfully as possible and to not purposely over or underestimate time or

distance. Each participant kept a weekly journal logging the amount of walking and running

completed each bout. At the end of each week, each participant was given access to the online

survey which they then returned to the PI within the next week. Each participant was shown how

to download and use the Nike Plus Running App (Beaverton, OR) which uses the GPS possessed

by their smart phone to measure distance of each walk/run in addition to measuring time and

pace data. The DIST group participants were informed that they only needed to keep up with

their distances that were prescribed that week; the accumulation of the mileage was the main

concern. The participants in the TIME group reported all of their exercise as time which was

measured by the Nike Plus Running App, a wristwatch, or by a timer possessed by their smart

phone.

Exercise Intervention

Intervention styles are presented in Tables 1.1 & 1.2 (page 57). Intervention was to be

aimed at eliciting a weight loss of at least 5% of starting body mass and lasted for 10 weeks

which exceeded the minimum intervention length for a physical activity program employing self-

report data as outlined in a review by Bravata et al. (2007). Adherence statistics to each exercise

regimen were compiled and contrasted following completion of the intervention. Only those

participants that completed the intervention and were able to return for post-testing data

collection were included in the analysis. Since the participants were considered previously

sedentary, a low level of exercise was needed to be initially prescribed and steadily increased as

the participants adjusted. Each participant was to report during Week 5 for a one-bout monitored

exercise period (Day 5) to ensure and encourage accuracy in reporting of exercise data. The

participant walked for a five-minute period at their preferred pace (evaluated as previously

described) and was monitored using indirect calorimetry. The participants were allowed the

opportunity to ask any questions about the exercise program that they had to that point and

suggestions were given if it was determined that the participant was unintentionally misreporting

exercise amount. Each participant was also given a 3-day food recall at baseline (Week 0), Week 5 (mid-point), and Week 10 (end-point) and was asked to submit it to the PI for evaluation. All participants were informed of the benefits of a healthy diet and dietary recall information was kept for evaluation. Each participant's dietary recall was evaluated using the Nutrient Data System (NDS; Minneapolis, MN, version 2011), a nutrient analysis software program designed for research. This software was provided by the NHM Nutrition Assessment Clinic at the University of Mississippi. Participants were requested to report intake for consumption on a typical three day period. Those participants who report atypical consumption were asked to complete an additional 3-day record in order to allow assessment of a more "usual consumption" pattern. If necessary, participants were asked to meet with one of the researchers for a verification interview. Specific nutrients of interests that were assessed included but were not limited to: energy (kcal), protein (g), carbohydrates (g), saturated fat (g), unsaturated fat (g), polyunsaturated fat (g), trans fat (g), iron (mg), calcium (mg), and vitamin D.

Following completion of the 10-week intervention, participants returned individually to the lab to have post-testing completed. Post-test procedures mirrored pre-test procedures nearly exactly to evaluate effect of intervention. Exceptions included the following: Day 1 and Day 2 were combined for post-intervention evaluation (Day 6) and Day 7 involved all exercise procedures as before (Day 3).

Table 1.1 – Exercise prescription for TIME group

Week	Days/Week	Time/Day	Type	Minimum Kcal/Week
1	3 – 4	30 min	Walk	500
2	3 – 4	30 min	Walk	700
3	4 – 5	30 min	Walk	800
4	5	35 min	Walk	900
5	5	40 min	Walk	1000
6	4 – 5	40 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1100
7	4 – 5	45 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1200
8	4 – 5	50 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1300
9	4 – 5	55 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1500
10	4 – 5	60 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1750

Table 1.2 – Exercise prescription for DIST group

Week	Miles/Week	Minimum Kcal/Week
1	5	500
2	7	700
3	8	800
4	9	900
5	10	1000
6	11	1100
7	12	1200
8	13	1300
9	15	1500
10	17.5	1750

STATISTICS

A one-way ANOVA was used to compare baseline values (body mass, body composition, blood lipids & glucose, RMR, VO_2 max) between groups to evaluate whether the groups were significantly different for any of the variables at baseline. Additionally, a Brown-Forsythe test was used to evaluate homogeneity of variance for the two groups. An independent t-test was used to compare overall adherence to exercise rates between the two intervention styles. A mixed-factor repeated- measures ANOVA (RM-ANOVA) was used to compare all other dependent variables before and after intervention (body weight, body composition, blood lipids & glucose, RMR, VO_2 max) for within-subjects and between-subjects comparisons. A mixed-factor RM-ANOVA was also used to compare weekly adherence rates to the exercise program. If interactions occurred, they were followed up with a Sidak adjustment for multiple pairwise comparisons

All analyses were conducted using SPSS software (Version 20, SPSS, Inc., Chicago, IL). Statistical significance was defined as a p-level less than 0.05 and eta squared was calculated to determine effect sizes.

RESULTS

Participant Characteristics Prior to Beginning Exercise Intervention

The study aimed to recruit at least 24 participants and was able to initially enroll 20 participants (10 in DIST group, 11 in TIME group) in the study. Of those 20, five participants did not complete the intervention and post-testing portions of the study and were thus not included in any analysis. Of those five drop-outs, one participant (from DIST group) dropped out due to sickness unrelated to the study not allowing them to continue with the program, three participants dropped out due to previous commitments which prevented them from fully investing their time to the program and chose to end their inclusion with the study (two from DIST group, one from TIME group), and another participant moved out-of-state prior to finishing the program and was unable to return for any post-testing (from DIST group). This left the total number of participants who completed the study at 15 (9 from TIME group, 6 from DIST group) and these were the participants that were eligible for data analysis. Of those nine participants in the TIME group, six were female and three were male. Of those six participants in the DIST group, three were female and three were male.

Table 1.3 (page 58) shows baseline physical characteristics of the study sample. There were no significant differences ($p > 0.05$) in physical characteristics between the two groups at baseline (age, height, body mass, body fat percentage, fat-mass (FM), fat-free mass (FFM), bone mineral density). The mean baseline age of the participants (in years) was 23.5 years (23.7 years for TIME group, 23.3 years for DIST group). The mean baseline height of the participants was 1.70 m (1.69 m for TIME group, 1.72 m for DIST group). The mean baseline body mass of the

participants was 94.1 kg (87.5 kg for TIME group, 103.9 kg for DIST group). The mean baseline

body fat percentage was 35.9% (34.7% for TIME group, 37.8% for DIST group). The mean

baseline FM was 33.6 kg (30.4 kg for TIME group, 38.5 kg for DIST group). The mean baseline

FFM was 60.4 kg (57.1 kg for TIME group, 65.5 kg for DIST group). The mean baseline bone

mineral density (BMD) was 1.30 g/cm^3 (1.30 g/cm^3 for TIME group, 1.30 g/cm^3 for DIST

group).

Table 1.3 - *Physical characteristics of participants (baseline)*

Variable	Group	Mean	SD	Min	Max	Gender	Mean	SD	Min	Max
Age (years)	TIME	23.7	5.6	20	34	M	24.7	7.2	20	33
						F	23.2	5.4	20	34
	DIST	23.3	4.1	19	31	M	24.0	6.3	19	31
						F	22.7	1.5	21	24
Height (m)	TIME	1.69	0.12	1.52	1.90	M	1.83	0.07	1.77	1.90
						F	1.62	0.05	1.52	1.67
	DIST	1.72	0.09	1.60	1.81	M	1.80	0.01	1.79	1.81
						F	1.64	0.05	1.60	1.69
Body Mass (kg)	TIME	87.5	19.2	61.2	119.2	M	109.1	11.2	97.0	119.2
						F	76.7	10.9	61.2	88.8
	DIST	103.9	18.7	71.4	126.9	M	109.8	14.8	100.9	126.9
						F	98.0	23.4	71.4	115.5
Body fat %	TIME	34.7	4.7	25.8	41.3	M	31.2	5.5	25.8	36.7
						F	36.4	3.7	32.3	41.3
	DIST	37.8	7.0	26.1	45.6	M	33.1	7.1	26.1	40.2
						F	42.4	2.8	40.6	45.6
Fat mass (kg)	TIME	30.4	6.9	21.8	40.7	M	34.3	8.2	25.0	40.7
						F	28.5	6.0	21.8	36.7
	DIST	38.5	10.2	26.4	51.0	M	37.0	12.7	26.4	51.0
						F	39.9	9.6	29.0	46.9
Fat-free mass (kg)	TIME	57.1	14.5	36.3	82.0	M	74.7	6.3	70.3	82.0
						F	48.2	6.4	36.3	52.6
	DIST	65.4	12.2	42.4	75.9	M	72.8	4.2	68.0	75.9
						F	58.1	3.8	42.4	68.5
Bone Mineral Density (g/cm^3)	TIME	1.30	0.13	1.16	1.56	M	1.37	0.03	1.35	1.40
						F	1.26	0.15	1.16	1.56
	DIST	1.30	1.00	1.14	1.45	M	1.30	0.03	1.27	1.32
						F	1.30	0.16	1.14	1.45

* Indicates $p < 0.05$

Table 1.4 (page 59) shows baseline fasting blood lipid panels and blood glucose levels of the study sample. There were no significant differences ($p > 0.05$) in blood lipids (TC, LDL, HDL, TG) or blood glucose between the two groups at baseline. The mean baseline TC level was 169.3 mg/dL (171.9 mg/dL for TIME group, 165.3 mg/dL for DIST group). The mean baseline LDL level of the participants was 95.7 mg/dL (95.3 mg/dL for TIME group, 96.4 mg/dL for DIST group). The mean baseline HDL level of the participants was 50.4 mg/dL (50.4 mg/dL for TIME group, 50.3 mg/dL for DIST group). The mean baseline TG level was 113.9 mg/dL (127.9 mg/dL for TIME group, 92.8 mg/dL for DIST group). The mean baseline blood glucose level was 87.9 mg/dL (84.6 mg/dL for TIME group, 92.8 mg/dL for DIST group).

Table 1.4 - *Fasting blood lipid panel & blood glucose level (baseline)*

Variable	Group	Mean	SD	Min	Max	Gender	Mean	SD	Min	Max
Total Cholesterol (mg/dL)	TIME	171.9	29.5	125.0	220.0	M	161.3	34.7	125	194
						F	177.2	28.5	133	220
	DIST	165.3	37.2	108.0	218.0	M	158.7	55.5	108	218
						F	172.0	15.6	154	182
LDL Cholesterol (mg/dL)	TIME	95.3	22.3	62.0	131.0	M	94.0	28.0	62	114
						F	96.0	21.9	79	131
	DIST	96.4	36.5	56.0	138.0	M	97.0	31.4	62	124
						F	96.0	31.4	62	124
HDL Cholesterol (mg/dL)	TIME	50.4	21.2	24.0	78.0	M	32.0	13.9	24	48
						F	59.7	18.3	35	78
	DIST	50.3	17.9	28.0	80.0	M	40.0	10.8	28	49
						F	60.7	19.0	42	80
Triglycerides (mg/dL)	TIME	127.9	58.6	45.0	203.0	M	180.0	36.4	138	203
						F	101.8	50.2	45	186
	DIST	92.8	41.6	45.0	159.0	M	108.3	58.1	45	159
						F	77.3	15.6	61	92
Glucose (mg/dL)	TIME	84.6	8.8	72.0	97.0	M	85.3	11.6	72	92
						F	84.2	8.4	74	97
	DIST	92.8	7.1	83.0	101.0	M	94.7	5.5	91	101
						F	91.0	9.2	83	101

* Indicates p < 0.05 for between groups comparison.

Table 1.5 (page 60) shows baseline estimated RMR and VO_2 max of the study sample. There were no significant differences ($p > 0.05$) between the two groups at baseline for either variable. The mean baseline RMR was 1758.9 kcal/day (1692.2 kcal/day for TIME group, 1858.8 kcal/day for DIST group). The mean baseline VO_2 max of the participants was 34.5 mL/kg/min (34.5 mL/kg/min for TIME group, 34.7 mL/kg/min for DIST group).

Table 1.5 - *Estimated RMR & VO2 max (baseline)*

Variable	Group	Mean	SD	Min	Max	Gender	Mean	SD	Min	Max
RMR	TIME	1692.2	415.0	889.0	2264.0	M	2046.7	231.6	1803	2264
(kcal/day)						F	1515.0	375.5	889	2009
	DIST	1858.8	203.2	1514.0	2100.0	M	1945.3	158.1	1784	2100
						F	1772.3	236.1	1514	1977
VO2 Max	TIME	34.5	6.0	25.0	42.2	M	37.7	4.4	33.5	42.2
(mL/kg/min)						F	32.9	6.3	25.0	40.1
	DIST	34.7	6.1	27.1	43.0	M	34.2	8.1	27.1	43.0
						F	35.1	5.2	30.1	40.5

* Indicates p < 0.05 for between groups comparison.

Adherence to Exercise Program

Table 1.6 (page 61) shows descriptive statistics pertaining to the overall adherence to the separate exercise programs. There was not a significant difference in adherence rates between groups ($p = 0.949$). The mean overall adherence rate was 89.8% (89.33% for TIME group, 90.5% for DIST group). Pertaining to the weekly adherence rate, RM-ANOVA showed that there was a significant difference in mean weekly adherence rate to the intervention at the following time points: Week 1 mean adherence for TIME group = 55.9%, DIST group = 139.07% ($F_{1,14} = 6.283$, $p = 0.026$) and Week 7 mean adherence for TIME group = 132.5%, DIST group = 81.33% ($F_{1,14} = 8.706$, $p = 0.011$). There was not shown to be a significant difference in weekly

adherence rate between groups for all other weeks (Week 2: $p = 0.766$; Week 3: $p = 0.476$; Week 4: $p = 0.916$; Week 5: $p = 0.663$; Week 6: $p = 0.766$; Week 8: $p = 0.252$; Week 9: $p = 0.575$; Week 10: $p = 0.593$). Table 1.7 (page 62) displays the descriptive statistics for each week by group and time-point and Figure 1.1 (page 63) displays this trend data.

Table 1.6 - *Overall adherence rates to exercise program*

Variable	Group	Mean	SD	Min	Max	Gender	Mean	SD	Min	Max
Overall	TIME	89.3	34.7	40.7	167.0	M	77.7	32.0	40.7	97.8
Adherence						F	95.2	37.3	67.1	167.0
Rate (%)	DIST	90.5	29.1	40.7	117.4	M	75.0	36.0	40.7	112.4
						F	105.9	10.2	98.0	117.4

* Indicates $p < 0.05$ for between-groups comparison.

Table 1.7 - *Weekly adherence rates to exercise program*

Variable	Week	Group	Mean	SD	Min	Max
Adherence	1	TIME	55.9 [a]	58.7	0.0	150.0
Rate (%)		DIST	139.1 [b]	69.3	82.0	256.8
Adherence	2	TIME	96.0	59.2	0.0	200.0
Rate (%)		DIST	88.5	10.4	76.1	100.0
Adherence	3	TIME	78.6	57.8	0.0	135.0
Rate (%)		DIST	99.4	56.5	25.0	190.1
Adherence	4	TIME	84.0	35.2	17.1	143.4
Rate (%)		DIST	86.5	52.9	0.0	146.0
Adherence	5	TIME	81.8	44.6	0.0	140.0
Rate (%)		DIST	92.1	42.5	40.0	134.2
Adherence	6	TIME	111.5	74.6	0.0	234.3
Rate (%)		DIST	91.9	44.9	27.3	132.5
Adherence	7	TIME	132.5 [b]	37.5	75.0	195.0
Rate (%)		DIST	81.3 [a]	23.8	54.2	116.2
Adherence	8	TIME	113.6	49.5	25.0	185.0
Rate (%)		DIST	87.8	20.8	61.0	106.2
Adherence	9	TIME	78.6	58.3	0.0	179.5
Rate (%)		DIST	63.8	34.6	0.0	103.7
Adherence	10	TIME	60.6	51.6	0.0	125.0
Rate (%)		DIST	74.3	39.1	0.0	106.5

Different letters indicate significant difference ($p < 0.05$) for
between-groups comparison.

Figure 1.1 – Self-reported Adherence to Exercise Program Rate Per Week
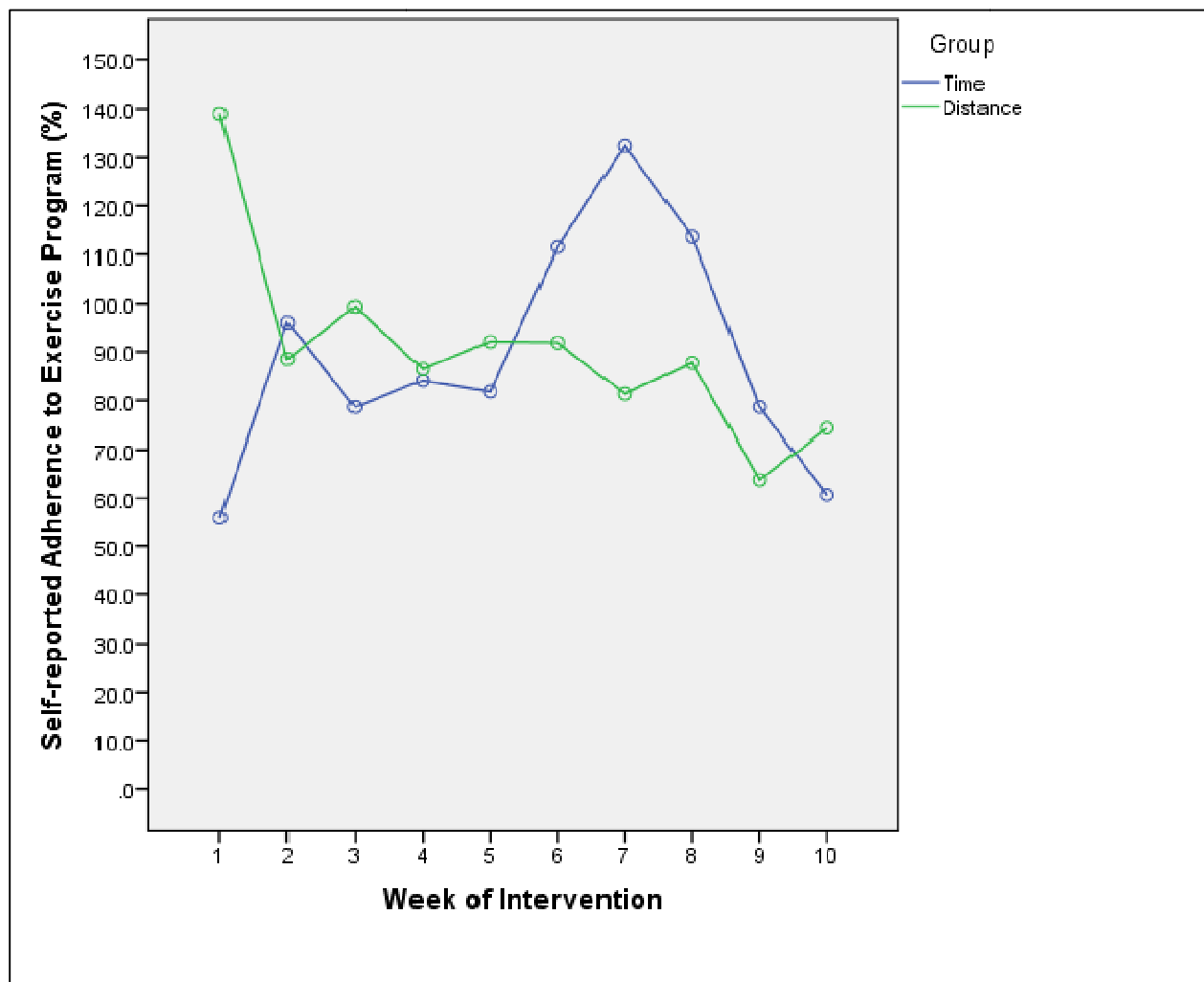
Participant Physical Characteristics Following Completion of Exercise Intervention

Table 1.8 (page 64) shows physical characteristics of the study sample following

completion of the exercise intervention. RM-ANOVA did not show evidence of a significantly

different value from pre-to-post or between groups for the following dependent variables: body

fat percentage ($p = 0.605$), FFM ($p = 0.322$), FM ($p = 0.410$), or BMD ($p = 0.284$). RM-ANOVA

also showed that there was not a significant difference for main effect pre-to-post in mean body

mass following the intervention ($p = 0.187$), however there was a significant interaction between

pre-to-post between groups $F_{1,13} = 6.337$ ($p = 0.026$, $\eta^2 = 0.328$). Pairwise multiple comparison

procedures were conducted to identify significant differences in simple effects due to the

existence of a significant interaction; $F_{1,13} = 6.375$ ($p = 0.025$, $\eta^2 = 0.329$). This significant

interaction is illustrated in Figures 1.2 & 1.3 (page 65) as the DIST group declined in mean body

mass by -4.0 kg while the TIME group increased their mean body mass by 1.1 kg.

Table 1.8 - *Physical Characteristics of participants (result of exercise intervention)*

| Variable	Group		Mean	SD	Min	Max
Age (years)	TIME	Pre	23.7	5.6	20	34
		Post	23.8	5.6	20	34
	DIST	Pre	23.3	4.1	19	31
		Post	23.7	4.5	19	32
Height (m)	TIME	Pre	1.69	0.12	1.52	1.90
		Post	1.69	0.12	1.52	1.90
	DIST	Pre	1.72	0.09	1.60	1.81
		Post	1.72	0.09	1.60	1.81
Body Mass (kg)	TIME	Pre	87.5 [a]	19.2	61.2	119.2
		Post	88.6 [a]	22.2	59.8	120.8
	DIST	Pre	103.9 [a]	18.7	71.4	126.9
		Post	99.9 * [b]	17.9	68.5	122.9
Body fat %	TIME	Pre	34.7	4.7	25.8	41.3
		Post	35.0	3.8	26.9	39.3
	DIST	Pre	37.8	7.0	26.1	45.6
		Post	37.0	6.8	26.1	45.2
FM (kg)	TIME	Pre	30.4	6.9	21.8	40.7
		Post	30.9	7.7	20.9	43.1
	DIST	Pre	38.5	10.2	26.4	51.0
		Post	37.0	10.4	25.1	49.0
FFM (kg)	TIME	Pre	57.1	14.5	36.3	82.0
		Post	57.8	16.0	38.9	81.8
	DIST	Pre	65.4	12.2	42.4	75.9
		Post	62.8	12.0	40.9	73.9
BMD (g/cm^3)	TIME	Pre	1.30	0.13	1.16	1.56
		Post	1.30	0.14	1.11	1.54
	DIST	Pre	1.30	1.00	1.14	1.45
		Post	1.28	0.09	1.14	1.42

* Indicates significant change ($p < 0.05$) from baseline for within-groups comparison.

Different letters indicate significant interaction present ($p < 0.05$) for between-groups comparison.

Figure 1.2 – Body Mass (kg) Following Exercise Intervention
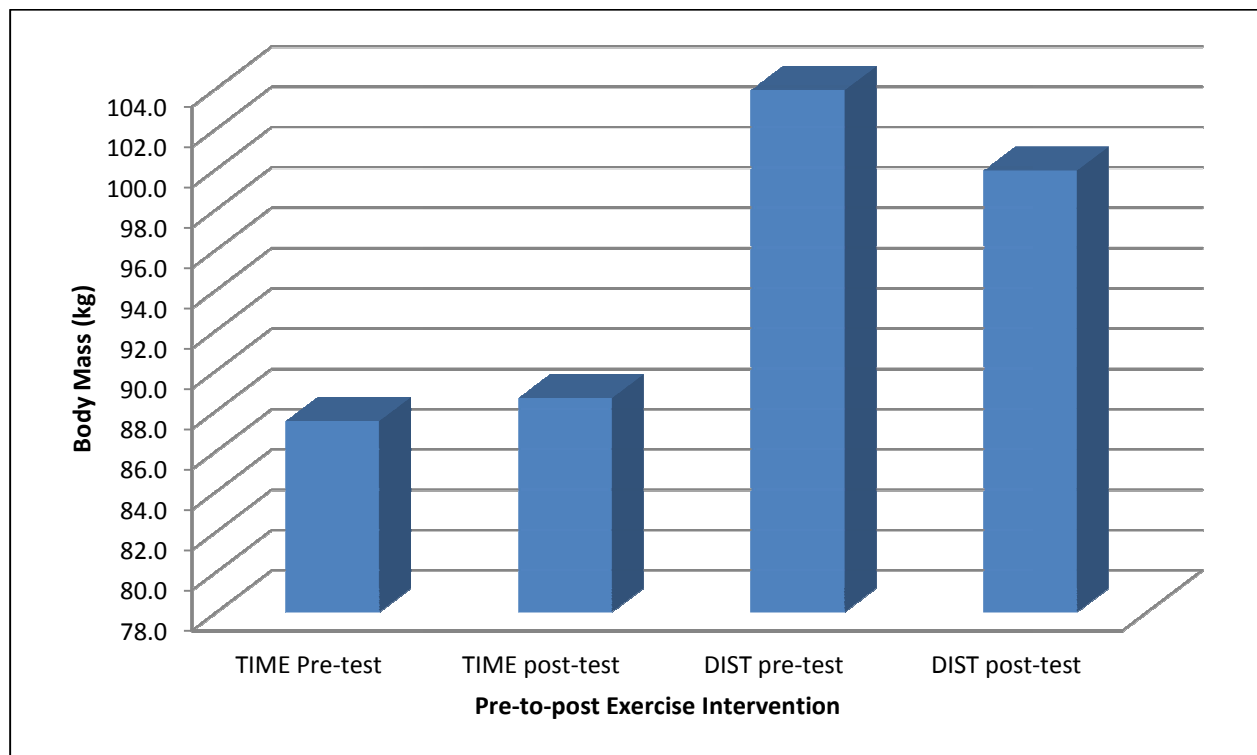
Figure 1.3 – Change in Body Mass (kg) Following Exercise Intervention
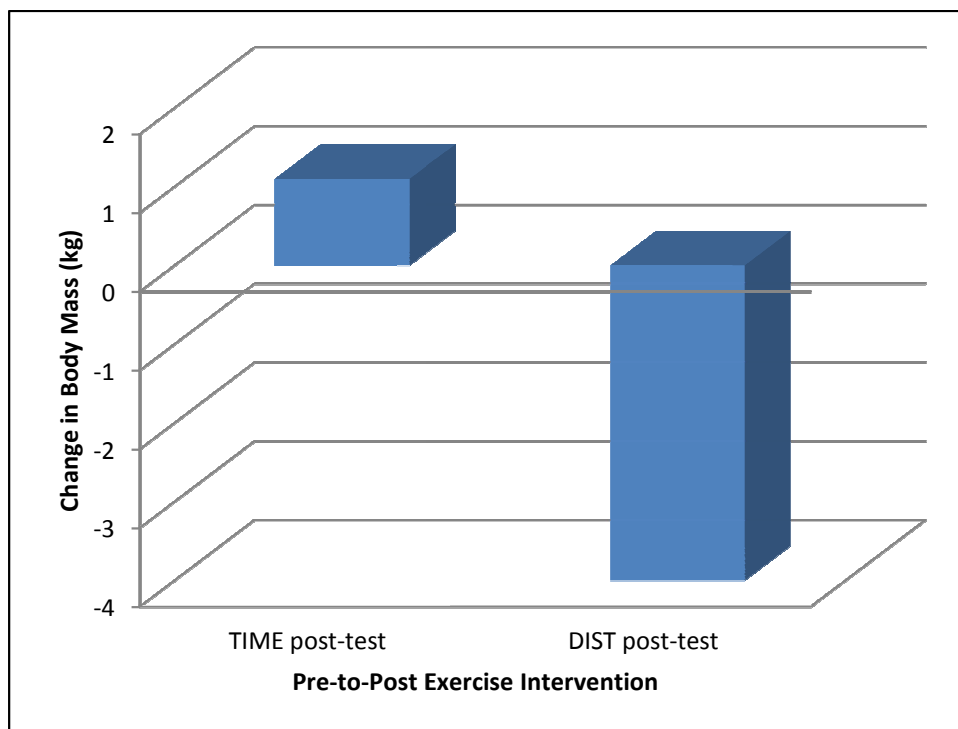
Participant Blood Lipid Panel & Glucose Levels Following Completion of Exercise Intervention

Table 1.9 (page 67) shows fasting blood lipid panel and blood glucose levels of the study sample following completion of the exercise intervention. RM-ANOVA showed that the following dependent variables did not show evidence of a significant differently value from pre-to-post or between groups: TC ($p = 0.536$), LDL ($p = 0.771$), HDL ($p = 0.597$), or TG ($p = 0.666$). RM-ANOVA also showed that there was not a significant difference for main effect pre-to-post in mean blood glucose following the intervention ($p = 0.306$), however there was a significant interaction between pre-to-post between groups $F_{1,13} = 7.681$ ($p = 0.016$, $\eta^2 = 0.371$). Pairwise multiple comparison procedures were conducted to identify significant differences in simple effects due to the existence of a significant interaction; $F_{1,13} = 6.136$ ($p = 0.028$, $\eta^2 = 0.321$). This significant interaction is illustrated in Figures 1.4 & 1.5 (page 68) as the DIST group declined in mean blood glucose by -10.5 mg/dL while the TIME group showed an increase in their mean blood glucose by 4.7 mg/dL.

Table 1.9 - *Fasting blood lipid panel & blood glucose level (result of intervention)*

Variable	Group		Mean	SD	Min	Max
TC	TIME	Pre	171.9	29.5	125	220
(mg/dL)		Post	163.3	24.1	141	221
	DIST	Pre	165.3	37.2	108	218
		Post	167.2	42.4	104	229
LDL	TIME	Pre	95.3	22.3	62	131
(mg/dL)		Post	92.1	25.2	45	138
	DIST	Pre	96.4	36.5	56	138
		Post	95.5	27.2	64	137
HDL	TIME	Pre	50.4	21.2	24	78
(mg/dL)		Post	45.3	17.3	23	69
	DIST	Pre	50.3	17.9	28	80
		Post	53.0	24.7	28	99
TG	TIME	Pre	127.9	58.6	45	203
(mg/dL)		Post	124.8	63.2	45	218
	DIST	Pre	92.8	41.6	45	159
		Post	82.8	50.6	47	182
Glucose	TIME	Pre	84.6 [a]	8.8	72	97
(mg/dL)		Post	89.2 [a]	10.5	78	109
	DIST	Pre	92.8 [a]	7.1	83	101
		Post	82.3 [b]	4.0	78	88

* Indicates significant change ($p < 0.05$) from baseline for within-groups comparison.

Different letters indicate significant interaction present ($p < 0.05$) for between-groups comparison.

Figure 1.4 – Blood Glucose (mg/dL) Following Exercise Intervention
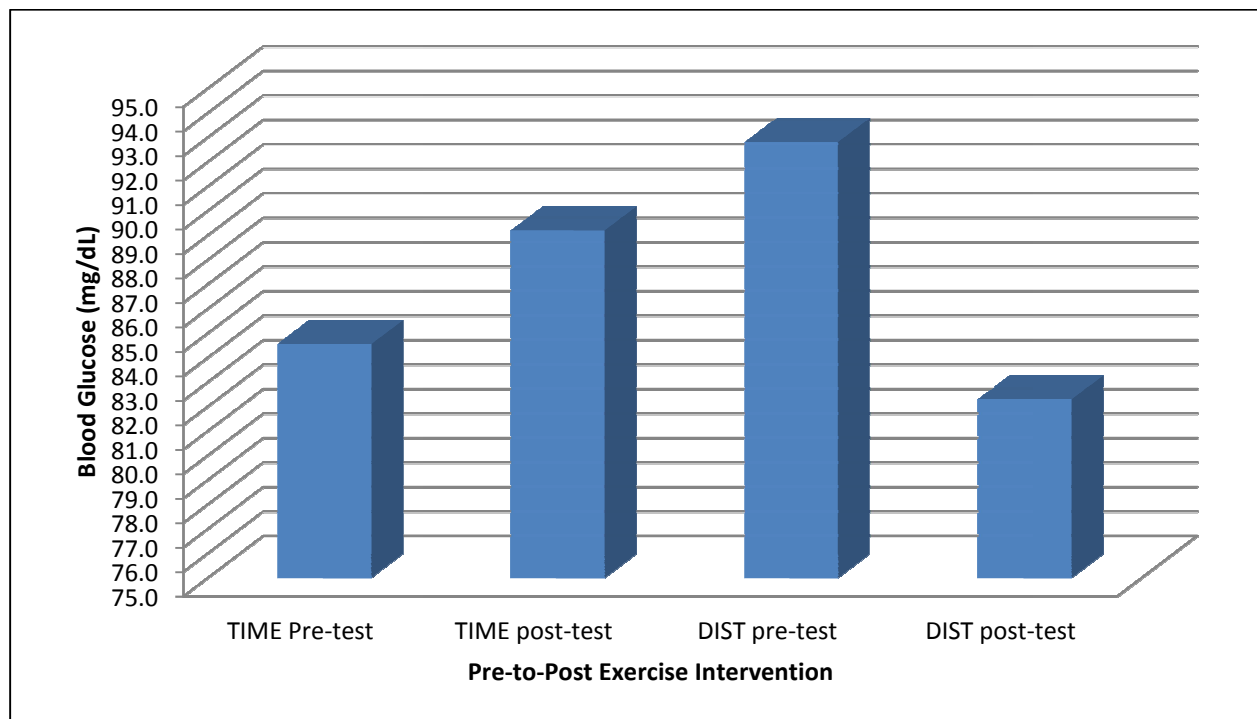
Figure 1.4 – Change in Blood Glucose (mg/dL) Following Exercise Intervention

Participant Estimated Metabolism Following Completion of Exercise Intervention
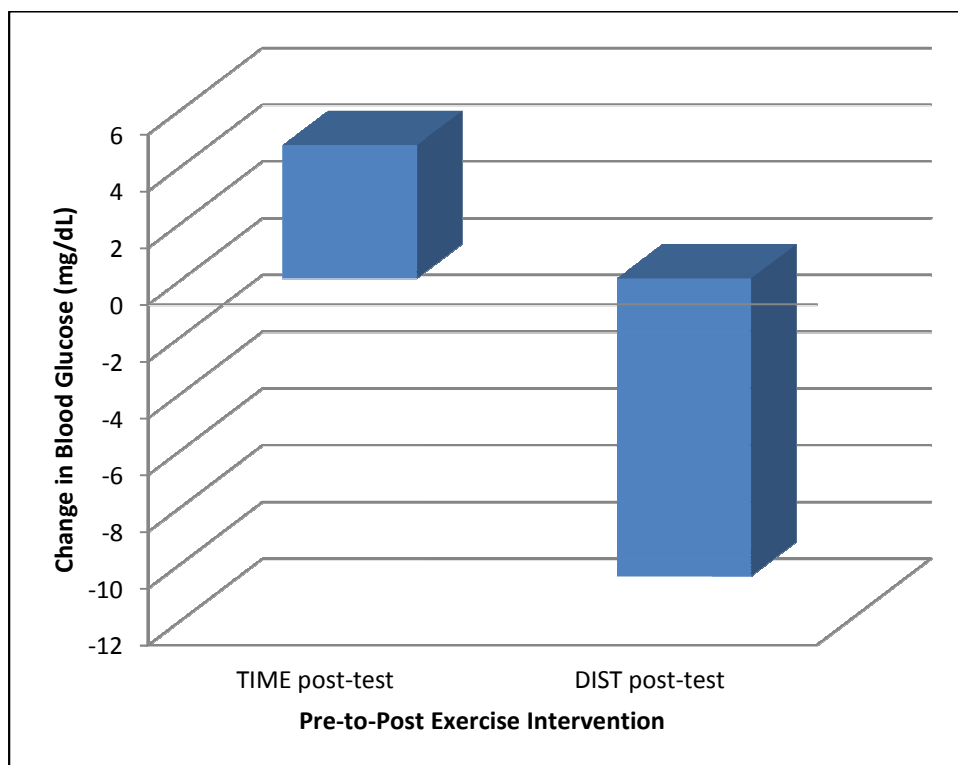
Table 1.10 (page 69) shows estimated RMR and VO_2 max of the study sample following

completion of the exercise intervention. RM-ANOVA showed that neither of these dependent

variables showed evidence of a significant differently value from pre-to-post or between groups;

RMR ($p = 0.710$), VO_2 max ($p = 0.127$).

Table 1.10 - *Estimated RMR & VO_2 max (result of intervention)*

Variable	Group		Mean	SD	Min	Max
RMR	TIME	Pre	1692.2	415.0	889	2264
(kcal/day)		Post	1828.6	345.2	1417	2333
	DIST	Pre	1858.8	203.2	1514	2100
		Post	1765.7	220.7	1368	1984
VO_2 Max	TIME	Pre	34.5	6.0	25.0	42.2
(mL/kg/min)		Post	35.2	3.9	26.3	40.2
	DIST	Pre	34.7	6.1	27.1	43.0
		Post	40.4	10.8	30.7	57.1

* Indicates $p < 0.05$ for within-groups comparison.

Different letters indicate significant interaction present ($p < 0.05$) for between-groups comparison.

DISCUSSION

The current study investigated whether a distance-based exercise prescription of walking and running may improve risk factors for CVD to a greater degree than a more traditional method of prescribing walking or running exercise by time. While an attempt was made to recruit at least 24 participants, only 20 volunteered. Five participants were not able to complete 10-week intervention program. This represents a 25% dropout rate which is fairly comparable to drop-out rates reported by other researchers in similar short-term exercise programs which have employed self-reports of brisk walking for previously sedentary results. In an 18-week study, Woolf-May et al. (1999) had a drop-out rate of 29.1%. In their 16-week study, Coleman et al. (1999) experienced a drop-out rate of 11%. A 12-week study by Murphy, Nevill, Neville, Biddle, and Hardman (2002) reported a drop-out rate of 42.9%. Another 12-week study reported a drop-out rate of 29% (Murtagh, Boreham, Nevill, Hare, & Murphy 2005). Regarding the intended sample size, with the intended 12 participants per group (24 total), the trial should have had at least 80% power to detect a decrease in body mass of 5% of original body mass as a result of the exercise intervention at the 0.05 significance level. This a priori analysis was conducted using G*Power 3.1.7 (Dusseldorf, Germany) using RM-ANOVA within-between interaction. The observed power was 0.646 for the significant change in body weight experienced by the DIST group. While some implications can be made regarding this data set, based on the sample size issues it may be difficult to make some conclusions with absolute certainty. However, taking the

sample size issues into account, it does appear that the distance-based program led to some substantial improvements in a few of the risk factors for CVD.

The DIST group saw an improvement in their body mass with an average weight loss of 4.0 kg while the TIME group actually showed an increase in their body mass up 1.1 kg. Figures 1.2 & 1.3 (page 65) illustrates that the difference between the baseline body masses of the groups, though not significant, could have possibly masked any significant improvements experienced by the DIST group as is suggested by the significant interaction that was reported. Regarding body composition measures, a fairly consistent trend emerged with the DIST group exhibiting a small decline in body fat percentage which led to decreases in both FFW and FW. The opposite was true of the TIME group showing small increases in body fat percentage, FFW, and FW. Being that this was a 10-week intervention solely employing predominantly moderate-intensity exercise (with some small amounts of vigorous-intensity) alone rather than exercise plus diet suggests that any improvements experienced within this relatively short amount of time would be minimal. As mentioned previously, more extreme weight losses are often the ones who receive the greater bulk of the attention and acclaim, but even a modest weight loss as little as 5% of previous body weight can lead to positive health benefits (Blackburn, 1995; Goldstein, 1992). The DIST group showed a weight loss of about 3.8% during this 10-week period, which doesn't quite reach that previously mentioned 5% threshold, but certainly suggests that the members of this group are well on their way to seeing the improvements in body weight that would be considered successful as suggested by previous research (Blackburn, 1995; Goldstein, 1992). The data in this study would indicate that the members of this DIST group are trending in the right direction.

Blood cholesterol and glucose levels are certainly dependent on day-to-day dietary habits, but possible small improvements experienced by the participants in the study can potentially be suggestive of success of the exercise program as well. Regarding TC and LDL, there is not previous evidence to support a short-term exercise program such as this one producing substantial changes with those two variables (Durstine et al., 2001). The results of this study for these two variables supports what has been reported previously showing minimal, if any, improvements in TC and LDL following a short-term exercise program centered on predominantly moderate-intensity exercise, regardless of body weight changes (Barr, Costill, Fink, & Thomas, 1991; Durstine et al., 2001; Halbert, Silagy, Finucane, Withers, & Hamdorf, 1999; Kiens et al., 1980; Kokkinos, Holland, Narayan, et al., 1995; Kokkinos, Holland, Pittaras, et al., 1995; Martin, Haskell, & Wood, 1977; Raz, Rosenblit, & Kark, 1988; Superko, 1991; Wood, Haskell, Stern, Lewis, & Perry, 1977; Wood et al., 1988). Regarding TG levels, both groups showed small, minimal improvements, suggesting that the exercise program (even without the mass loss in the case of the TIME group) led to small improvements (non-significant) in blood lipid results. Previous literature has suggested a minimal threshold EE of at least 1000 – 1200 kcal/week to possibly see any improvements in TG levels (Durstine et al., 2001; Huttunen et al., 1979; Kiens et al., 1980; Lampman et al., 1985; Raz et al., 1988; Wood et al., 1988; Wynne, Frey, Laubach, & Glueck, 1980). Considering the low levels of exercise training that was initially prescribed, it's plausible that the exercise completed was not sufficient to observe substantial changes (due to overweight status and low levels of prescribed exercise). Examination of HDL levels revealed that the TIME group actually declined by 5.11 mg/dL and increased for the DIST group by 2.67 mg/dL. Previous literature suggests that a minimal threshold of 1200 – 2200 kcal/week must be reached in order to experience substantial

improvements in HDL levels (Blumenthal et al., 1991; Durstine et al., 2001; Grandjean, Crouse, O'Brien, Rohack, & Brown, 1998; Farrell & Barboriak, 1980; Hinkleman & Nieman, 1993; Huttunen et al., 1979; Lamarche et al., 1992; Marti et al., 1990; Nieman et al., 1993; Santiago, Leon, & Serfass, 1995; Stein et al., 1990; Thomas, Adeniran, & Etheridge, 1984). HDL levels can vary by approximately 1.5 mg/dL day-to-day so this would suggest these changes are accurate measurements of change rather than simply from day-to-day variability (Pererira et al., 2004). While this difference was not considered significant, taking the obvious limitations from sample size and lower levels of exercise in making conclusions into account, it's possible that the DIST group showed an improvement over the TIME group in this risk factor for CVD.

Main effect changes in blood glucose levels were also masked in the same manner as body mass changes as described earlier. The DIST group improved their blood glucose by an average decline of 10.5 mg/dL while the TIME group saw an increase in their blood glucose by an average of 4.7 mg/dL. In a very similar fashion to pre-to-post body mass, the significant interaction present between the two groups illustrates that the difference between the baseline blood glucose of the groups, though not significant, could have possibly masked any significant improvements experienced by the DIST group as is illustrated in Figures 1.4 & 1.5 (page 68). This improvement in blood glucose occurring alongside a loss in body mass would seem to support previous research which would suggest these two factors tend to coincide with weight loss programs and overall improvement of risk factors for CVD (Lindström et al., 2003; Sigal, Kenny, Wasserman, Castaneda-Sceppa, & White, 2006; Tuomilehto et al., 2001). Therefore, the loss of weight for the DIST group would also lead one to expect to see an improvement in blood glucose to occur simultaneously. This would suggest that not only was the distance-based program more successful than the time-based program at leading to a loss in body mass, but also

lead to an improvement in blood glucose levels which is essential for overall risk for CVD as well as prevention of Type II Diabetes Mellitus (Sigal et al., 2006).

The changes in RMR were not considered significant but did mirror the changes that would be expected by one group losing weight and showing a small decline in RMR (DIST group) and the other group gaining weight and exhibiting a small increase in RMR (TIME group). Small improvements in VO_2 max were experienced by both groups. Neither of these improvements were considered significant improvements from baseline VO_2 max, but is possibly suggestive of improvement in aerobic capacity and tolerance to moderate-intensity exercise as a result of participation in the 10-week exercise program. The difference in pre-to-post VO_2 max for DIST group was an increase of 5.8 mL/kg/min and 0.7 mL/kg/min for the TIME group. This difference in levels of improvement between the groups, while not significant, could also be partially explained by the expression of VO_2 max to body mass. If a loss in body mass is experienced even without an improvement in absolute aerobic capacity, relative aerobic capacity would increase purely as a result in the change in body mass. Additionally, VO_2 max was estimated from measurement from a submaximal test rather than being quantified from a maximal test. So while there was a greater (though not significant) increase in aerobic capacity for the DIST group, it's possible that these greater increases could be tied to the improvement in body mass that was experienced by the DIST group.

The overall adherence rates were not significantly different between the two groups with the DIST group reporting an average of 90.5% while the TIME group reported an average of 89.3%. Despite only seeing a significant improvement in two variables for the DIST group (body mass and blood glucose), this 90.5% adherence rate seems to support the thought process that significantly improving those two variables requires a strong adherence rate such as this in a

short-term 10-week period. However, it is somewhat surprising for the TIME group in particular that such a high level of adherence to the program was reported while actually seeing the overall body mass and blood glucose increase. The question must be asked, if the TIME group adhered so well to the program, then why did they gain weight? The answer may partially be found in previous work by Williams (2012a; 2012b). Williams reported that estimated EE was between 32 – 43% greater when calculated from time compared to distance; suggesting that EE estimations based on time are much more likely to overestimate EE than EE based on distance (Williams, 2012a; Williams, 2012b). The data also suggested that walking distance led to a much greater reduction in the odds ratio than walking time for the occurrence of unhealthy markers of obesity such as overweight status and abdominal obesity (Williams, 2012a; Williams, 2012b). If the self-reported exercise for the TIME group in this study is closer to around 47 – 57% as the research by Williams (2012a; 2012b) would suggest, this may partially explain why the TIME group saw minimal, if any, improvements in overall risk factor reduction and actually gained weight as a result of the intervention. The exercise program was designed to gradually increase weekly accumulated exercise by a previously sedentary individual into a moderate-intensity exercise program. If the TIME group participants participated in closer to half of the program as Williams' (2012a; 2012b) research suggests, they may not have performed enough exercise to really lead to any substantial changes in their body composition or other related CVD risk factors.

As it relates to TG levels, considering the minimal 1000 – 1200 kcal/week threshold mentioned earlier, this amount wasn't even prescribed until at least week 5 and misreported adherence rates could play a role here as well. If the TIME group's self-reported exercise is actually on average 40% lower as Williams (2012a; 2012b) would suggest, the members of this

group would have on average only exceeded the minimal 1000 kcal/week threshold once (Week 7) and would have never once come close to reaching or exceeding 1200 kcal/week. The DIST group, based on their reported adherence, wouldn't have reached the 1000 kcal/week level until Week 6 and would have barely exceeded this level in Week 8 but only exceeded 1200 kcal/week once (Week 10). Considering the larger, though not significant, decrease in TG for the DIST group (10.0 mg/dL vs. 3.11 mg/dL for TIME group), this would seemingly support the notion that a greater level of exercise was performed by that group. The lack of a significant result for this variable would seem to support previous research (Durstine et al., 2001; Huttunen et al., 1979; Kiens et al., 1980; Lampman et al., 1985; Raz et al., 1988; Wood et al., 1988; Wynne, Frey, Laubach, & Glueck, 1980). A similar approach can be taken with the non-significant changes in HDL levels. The previously mentioned 1200 – 2200 kcal/week threshold was hardly, if ever, reached and the lack of significant findings in this variable would seem to support previous research (Blumenthal et al., 1991; Durstine et al., 2001; Grandjean et al., 1998; Farrell & Barboriak, 1980; Hinkleman & Nieman, 1993; Huttunen et al., 1979; Lamarche et al., 1992; Marti et al., 1990; Nieman et al., 1993; Santiago et al., 1995; Stein et al., 1990; Thomas et al., 1984).

To the best of the author's knowledge, the present study is the first to directly compare a distance-based vs. a time-based exercise program for walking and running for improvement of risk factors of CVD. The results of the particular study would suggest that a distance-based exercise prescription of walking or running should provide a clinician or researcher with a closer estimation of overall EE and resultant weight loss and reduction of particular risk factors for CVD. The sample sizes achieved with this particular study are lower than what was intended but being that this study is a novel design, future research should attempt to recruit a larger sample

size carried out to a longer duration, allowing the weekly prescribed EE to be increased to see if the same trends hold true that have been suggested in this study. Also, inclusion of another measure of physical activity such as accelerometer use along with the GPS app that was used by the participants may provide a better overall assessment of adherence to the program.

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CHAPTER IV

MANUSCRIPT 2

EVALUATION OF THE ACCURACY OF A PREVIOUSLY PUBLISHED EQUATION TO
PREDICT ENERGY EXPENDITURE PER UNIT DISTANCE FOLLOWING WEIGHT LOSS

INTRODUCTION

The act of walking or running is the body's means of propelling itself forward in order to move the body to its intended location. Locomotion of the body, regardless of whether the person is walking or running, involves the attempt at a coordinated progression of the body through space in the most efficient way possible that limits overall energy expenditure (EE) (Waters & Mulroy, 1999). Walking is one of the most commonly performed exercises in not only weight loss interventions but also in exercise for those attempting to live a healthy lifestyle. The ability to correctly estimate EE is an important part of any weight loss or weight maintenance program (Browning, Baker, Herron, & Kram, 2006; Williams, 2012).

EE will be dependent on the type of exercise performed. Loftin, Waddell, Robinson, & Owens (2010) suggested that when comparing the EE per mile of overweight walkers, normal weight walkers, and marathon runners, groups were not significantly different from one other. Results showed that as body mass increased, EE per mile (kcal) increased but EE was not significantly different if the mile was walked or run (Loftin et al., 2010). In the published regression equation for predicting EE to walk or run a mile, it was stated that 59.1% of the variance was due to body mass with gender accounting for another 4.1% (Loftin et al., 2010). This data was supported by Morris et al. (2014) but was also suggested that further research needs to be conducted to confirm validation of the published equation by Loftin et al. (2010). These reports of walking and running the same distance and having significantly different EE contrast with the previous theories and data presented by Kram & Taylor (1990). As the previously mentioned regression equation by Loftin et al. (2010) and support by Morris et al. (2014) suggests, simply using a

person's body weight and gender can provide a clinician or researcher with the tools needed for providing an exercise prescription focused on distance to walk or run.

During gait, one lower extremity provides support for the rest of the body while the other lower extremity advances the body forward. During normal walking, body weight is transferred when both feet are in contact with the ground during double limb support. Gait is a series of repeating double limb support, swing leg advancement (during opposite single limb support), and then double limb support again. The support limb during gait must be constantly maintaining upright stability of the body while attempting to minimize energetic cost. One of the mechanical responsibilities of the leg and hip musculature is to propel the body forward by generating a horizontal propulsive force (Gottschall & Kram, 2003). Generally, it has been reported that this need to generate horizontal propulsion results in about half of the metabolic cost related to walking (Gottschall & Kram, 2003). For running, it has been reported that generating horizontal propulsive force makes up about a third the required EE to run (Chang & Kram, 1999). Compared to walking, the body must generate a larger vertical propulsive force in response to the greater ground reaction force (GRF) experienced during running to overcome the friction and braking involved with initial contact (Gottschall & Kram, 2003). This should result in greater muscular force production and therefore metabolic cost (Gottschall & Kram, 2003). Also, towards the completion of the swing phase of gait, the hamstring musculature becomes more active than previously to prepare for initial contact of the heel by slowing the forward progression of the swing leg (Waters & Mulroy, 1999). The knee flexes in an attempt to provide the base to absorb some of the GRF experienced by the leg. During running, the degree of flexion tends to increase as a result of increased stride length as well as providing the base for absorption of the GRF (Gottschall & Kram, 2003).

Establishing a caloric prediction equation to more accurately estimate EE is an important goal. In a recent study examining self-reported distances by a cross-section of walkers, it was suggested that self-reported distance may be able to provide a more accurate and reliable method for calculating EE compared to self-reported time (Williams, 2012). Using self-reported time for a walking or running prescription is dependent on knowing the pace that the person decides to walk/run which affects intensity. Williams (2012) reported that estimated EE was 32% greater for women and 37% greater for men when calculated from time compared to distance; suggesting that EE estimations based on time are much more likely to overestimate EE than EE based on distance. If a clinician or researcher can calculate EE without having to use intensity estimations for the calculation, the current research suggests that would seem to be a much more repeatable and reliable method for estimating caloric expenditure.

Regarding pace, there tends to be a speed which must lead to a decision by the person whether it is more mechanically efficient to walk or run. It has been reported that at a speed of approximately 3.7 mph, this decision to walk or run typically must be made (Waters & Mulroy, 1999). In their research on a number of different types of animals, Heglund & Taylor (1988) reported that the speeds that an animal must transition from a trot to a gallop are strongly related to body size. However, it was concluded that the relative increases in stride frequency and speed of locomotion was fairly constant over the span of the large group of animals which varied greatly in body size (Heglund & Taylor, 1988). Therefore, if taking this information into consideration as it may relate to humans, it could be reasonably assumed that as a person's body size or frame increases, their stride frequency and speed of preferred pace should mirror the relative increase in size. So while 3.7 mph may be a typical transition pace for most people, there may be some variation as it relates to body size with smaller body sizes having to make the

decision at a slower speed while larger body sizes may be able to make the decision at a faster speed. A speed at or below 3.7 mph tends to favor walking for metabolic efficiency while speeds at or above 4.9 mph tend to favor running (Gonelli, Gimenez Filho, Carraro, Montebelo, & Cesar, 2011). A transition speed can fall anywhere between 3.7 to 4.4 mph (Gonelli et al., 2011). When walking or running around the transition speed, there have been reports that running does not elicit a significantly higher EE per unit distance than walking (Monteiro & de Araújo, 2009; Verlengia et al., 2012). Creatine kinase levels (which would suggest an increase in intensity) were also not reported to be significantly higher while running at the transition speed compared to walking (Verlengia et al., 2012). Therefore, it is very important to take preferred pace (or speed) of walking or running in any attempts at determining EE at paces which a participant is comfortable and successful performing at.

For the most part, research comparing walking versus running the same distance has reported that running produces the greater EE when completing the same distance as walking. A number of studies have supported this viewpoint (Bhambani & Singh, 1985; Cesar et al., 2013; Fellingham, Roundy, Fisher, & Bryce, 1978; Gonelli et al., 2011; Hall, Figueroa, Fernhall, & Kanaley, 2004; Howley & Glover, 1974; Verlengia et al., 2012; Wilkin, Cheryl, & Haddock, 2012). Some have reported gender differences even within running with males showing greater EE per unit distance than females (Bhambani & Singh, 1985; Hall et al., 2004; Loftin et al., 2010). When only referring to walking, for the most part it has not reported to have a significantly different EE per unit distance between genders (Bhambani & Singh, 1985; Loftin et al., 2010; Morris et al., 2014) while others have reported a significant difference mirroring running (Hall et al., 2004). When the EE per unit distance was compared against amount of fat-free mass (FFM), any significant differences that existed between genders disappeared (Hall et

al., 2004; Loftin et al., 2010; Morris et al., 2014). This could be due to females generally as a whole having a higher portion of body mass that is made up of fat mass (FM), and therefore are carrying relatively more extra weight (Hall et al., 2004).

As it relates to exercise for overweight or obese populations, it is important for exercise prescription purposes to determine to what effect excess body weight influences overall EE. Despite significant differences in body weight and body composition, some recent research has reported a lack of significant difference among normal weight walkers, overweight walkers, and distance runners when purely assessing EE over a defined distance such as kcal/mile (Loftin et al., 2010; Morris et al., 2014). This data is comparable to findings which reported assessing gross EE between normal weight and overweight individuals over an absolute distance or time (Browning et al., 2006; Loftin et al., 2010; Welle, Forbes, Statt, Barnard, & Amatruda, 1992). It has been suggested by some that when only evaluating the gross caloric expenditure to walk or run one mile, caloric expenditure could be similar whether walking or running (Browning et al., 2006; Loftin et al., 2010; Morris et al., 2014; Welle et al., 1992). This is a stark difference to what has been reported previously when considering a within-subject design (Bhambani & Singh, 1985; Cesar et al., 2013; Fellingham et al.; 1978; Gonelli et al., 2011; Hall et al., 2004; Howley & Glover, 1974; Verlengia et al., 2012; Wilkin et al., 2012). Echoing previously reported data, when the EE per defined distance were compared against the participant's FFM, any significant differences in EE disappeared (Browning et al., 2006; Loftin et al., 2010; Morris et al., 2014; Treuth, Figueroa-Colon, Hunter, Weinsier, Butte, & Goran, 1998). If it were true that the EE over a defined measureable distance such as a mile were not substantially different, an individual beginning an exercise program would expend similar kcal either running or walking for a given distance (Morris et al., 2014). Unnecessary increases in pain or discomfort

could lead to decreases in adherence to exercise and failing to complete what has been prescribed to them (Ekkekakis & Lind, 2006). Loading the body with additional weight should increase the overall EE in a manner relative to how much extra weight is considered inactive (Waters & Mulroy, 1999).

Browning et al. (2006) stated that part of the inter-individual difference in EE could be accounted for by differences in fat mass; though the exact location of adipose tissue was not found to be a significant factor. Browning et al. (2006) also reported that the net metabolic cost of walking for obese walkers was about 10% greater per kg of body weight than the normal weight group. Body weight and gender are variables that are very easily measured by a clinician or researcher. With regards to exercise prescription, not only is it important to consider changes that may need to be made to duration, intensity, or type of exercise but also the clinician or researcher must keep track of what effect the lost weight is having on EE. Leibel, Rosenbaum, and Hirsch (1995) reported that forced weight gain of 10% of original body weight from initial body weight led to an increase in total 24-hour EE in both those who had previously been considered obese and those that had not. A forced weight loss of 10% of original body weight from initial body weight led to a decrease in total 24-hour EE for both groups as well (Leibel et al., 1995). This data illustrates the effect that substantial fluctuations in body weight can have on the total EE of a person throughout the day as well as when performing exercise. It was reported by Foster et al. (1995) that the EE during walking was reduced by a much greater amount than the degree to be expected by the loss in weight and was not proportional to degree of weight loss. Öhrstöm, Hedenbro, & Ekelund (2001) employed a surgically imposed weight loss through vertical banded gastroplasty (also known as stomach stapling) and had opposite results as Foster et al. (1995). However, Öhrstöm et al. (2001) based their EE determinations from a comfortable

walking speed and suggested that the increase in EE they reported at the comfortable walking speed could potentially be due to the significant increase in comfortable walking speed and therefore leading to more actual work being performed than before weight loss. This change in preferred pace would play a substantial role in their EE calculations so this will be an important point to consider when re-evaluating EE calculations.

If a researcher or clinician can make exercise prescriptions or recommendations based upon an easily measurable exercise mode such as walking or running distance, then perhaps some of the guesswork related to intensity and duration can be limited. Recent research suggests that simply measuring and reporting distance walked or ran may provide a much more reliable method for evaluating EE (Loftin et al., 2010; Williams, 2012). As previously stated, the equation published by Loftin et al. (2010) and supported by Morris et al. (2014) could potentially provide a useful prediction of EE over a defined distance which in this case is a mile. An important evaluation for further validation of the equation would be to determine if the equation (which includes body weight and gender as factors) can still accurately predict EE per mile following weight loss. The purpose of this study was to compare EE for walking & running for pre- and post-intervention as well as to compare the measured EE values to the predicted EE values derived from the Loftin et al. (2010) equation.

MATERIALS AND METHODS

Participant Recruitment

As part of a larger study, an attempt was made to recruit 18 participants (9 per group) from the University of Mississippi and Oxford, MS communities. The desired participants were sedentary adults between the ages of 18 – 44 (males) and 18 – 54 (females). The participants were assigned to the two treatment groups in a counter-balance design to attempt to limit any unintended substantial differences in gender and aerobic capacity between the groups at baseline. One group was prescribed an aerobic exercise regimen based on an accumulated walking time per week (TIME) and another group was prescribed an aerobic exercise regimen based on an accumulated walking distance (DIST) per week. The Physical Activity Readiness Questionnaire (PAR-Q) (Thomas, Reading, & Shephard, 1992) was used during pre-screening in order to screen for any potential contraindications to exercise. Participants completed a 7-day physical activity questionnaire to determine physical activity status (Sallis, Haskell, & Wood, 1985). Self-reported height and weight was also obtained prior to arrival for calculating BMI for appropriateness of potential participants. Potential participant recruitment was aimed at recruiting an overweight but otherwise healthy adult population. A participant was considered for the study if they were considered overweight but otherwise healthy as determined by answers to the PAR-Q. Participants with a BMI greater than 25.0 kg/m^2 were initially considered for inclusion in the study, but in order to be selected body fat percentage was the final determinant and would override BMI if necessary. Each participant's body composition was evaluated using

dual energy x-ray absorptiometry (DXA) as measured by a Hologic Delphi, QDR series (Bedford, MA) apparatus and height and body mass were measured by standard scales upon arrival. Body fat percentage ranges for consideration in the study were determined using previously published recommendations based on gender and age (ACSM, 2010). Overweight but otherwise healthy males were considered if their body fat percentage was greater than 22% and overweight but otherwise healthy females were considered if their body fat percentage was greater than 32% (ACSM, 2010).

Pre-Intervention Procedures

Following inclusion in the study, baseline testing involved a number of exercise tests and evaluations. Indirect calorimetry was employed to measure EE during treadmill walking using the ParvoMedics TrueOne 2400 measurement system. Before any metabolic testing was conducted, the system was calibrated against standard gases ($O_2 = 16.0\%$, $CO_2 = 4.0\%$). The approved participants were evaluated by walking on a treadmill at their preferred pace. This speed was determined by evaluating their pace from 6 timed 70 feet trials on an indoor track. Participants were timed over the middle 50 feet during each trial and preferred pace was determined as the mean pace traveled over those 6 trials in a manner previously described (Browning & Kram, 2005; Loftin et al., 2010; Morris et al., 2014). Once on the treadmill, participants stood for 5 minutes to assess standing ambulatory rest. Then after a brief warm-up, participants walked a one-mile distance at their preferred pace. This kcal/mile measurement was evaluated against the kcal/mile that was predicted using the equation published by Loftin et al. (2010). Immediately following completion of the one-mile walk, participants stood quietly on the treadmill for an additional period to assess excess post-exercise oxygen consumption (EPOC).

This EPOC period lasted for five minutes which for every participant was more than long enough for the participant to return to resting VO_2 as measured during standing ambulatory rest.

Exercise Intervention

When the intervention was ready to begin, the primary investigator (PI) assigned the participant to one of the two groups: TIME or DIST using a counterbalance design mentioned previously. The PI informed the participant of their baseline testing results and where it related to population norms. The PI then outlined and discussed the exercise each participant needed to perform each day or week. Participants were informed about the difference between daily physical activity (such as walking from one class to another) and the planned exercise program to be followed and reported. All participants were instructed to correspond with the PI through use of a Qualtrics online survey to give a weekly self-report update on the exercise that had been performed that week. The PI requested that participants refrain from other strenuous exercise and resistance training during the span of the intervention and to try to stick to the prescribed exercise as closely as they can. Each participant was also asked to report weekly exercise as honest and truthfully as possible and to not purposely over or underestimate time or distance. Each participant kept a weekly journal logging the amount of walking and running done each bout.

Intervention styles are presented in Tables 2.1 & 2.2 (page 97). These styles were different in their prescription style but were intended to have a similar weekly caloric expenditure, regardless of group placement. Intervention was to be aimed at eliciting a weight loss of at least 5% of starting body mass and lasted for 10 weeks which exceeded the minimum intervention length for a physical activity program employing self-report data as outlined in a

review by Bravata et al. (2007). Only those participants that completed the intervention and were able to return for post-testing data collection were included in the analysis. Since the participants were considered previously sedentary, a low level of exercise was needed to be initially prescribed and steadily increased as the participants adjusted.

Following completion of the 10-week intervention, participants returned individually to the lab to have post-testing completed. Post-test procedures mirrored pre-test procedures nearly exactly to evaluate effect of intervention with the notable exception that the participant returned a day later following the first post-testing session to complete a 5 minute run at their preferred run pace. Their preferred run pace was determined based on their self-selected pace to complete a jog at a leisurely pace around a 200 meter indoor track. All caloric data was then corrected to a one-mile distance to estimate their EE when running one-mile.

Table 2.1 – Exercise prescription for TIME group

Week	Days/Week	Time/Day	Type	Minimum Kcal/Week
1	3 – 4	30 min	Walk	500
2	3 – 4	30 min	Walk	700
3	4 – 5	30 min	Walk	800
4	5	35 min	Walk	900
5	5	40 min	Walk	1000
6	4 – 5	40 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1100
7	4 – 5	45 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1200
8	4 – 5	50 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1300
9	4 – 5	55 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1500
10	4 – 5	60 min	Walk/Run: Alternate 5-min walk bouts with 5-min run bouts.	1750

Table 2.2 – Exercise prescription for DIST group

Week	Miles/Week	Minimum Kcal/Week
1	5	500
2	7	700
3	8	800
4	9	900
5	10	1000
6	11	1100
7	12	1200
8	13	1300
9	15	1500
10	17.5	1750

STATISTICS

A within-subjects repeated- measures ANOVA (RM-ANOVA) was used to compare the measured kcal/mile for the one-mile walk (pre-test), predicted kcal/mile for the one-mile walk (pre-test), measured kcal/mile for the one-mile walk (post-test), measured kcal/mile for the one-mile run (post-test), and the predicted kcal/mile (post-test). All kcal/mile predictions were estimated using the equation published by Loftin et al. (2010). A within-subjects RM-ANOVA was used to compare the EPOC values for the pre-test one-mile walk, post-test one-mile walk, and the post-test one-mile run. All analyses were conducted using SPSS software (Version 20, SPSS, Inc., Chicago, IL). Statistical significance was defined as a p-level less than 0.05 and eta squared was calculated to determine effect sizes.

RESULTS

Participant Characteristics

The study aimed to recruit at least 24 participants and was able to initially enroll 21 participants (10 in DIST group, 11 in TIME group) in the study. Of those 21, seven participants did not complete the intervention and post-testing portions of the study and were thus not included in any analysis. Of those seven drop-outs, three participants dropped out due to sickness or injury unrelated to the study not allowing them to continue with the program (one from DIST group, two from TIME group), three participants dropped out due to previous commitments which prevented them from fully investing their time to the program and chose to end their inclusion with the study (two from DIST group, one from TIME group), and another participant moved out-of-state prior to finishing the program and was unable to return for any post-testing (from DIST group). This left the total number of participants who completed the study at 14 (8 from TIME group, 6 from DIST group) and these were the participants that were eligible for data analysis. Of those eight participants in the TIME group, six were female and two were male. Of those six participants in the DIST group, three were female and three were male. As mentioned previously, the total sample size will be considered rather than by group placement. Therefore, the total sample size who was considered for evaluation was 14 participants (9 females, 5 males).

Table 2.3 (page 100) shows physical characteristics of the total study sample at baseline and following exercise intervention. As noted in Table 2.3 (page 100), body composition

parameters including body mass, body fat and fat free mass did not change following the 10
week exercise intervention.

Table 2.3 - *Physical characteristics of participants (baseline & post-intervention)*

Variable		Mean	SD	Min	Max
Age (years)	Pre	23.5	4.9	19	34
	Post	23.8	5.6	20	34
Height (m)	Pre	1.70	0.11	1.52	1.90
	Post	1.70	0.11	1.52	1.90
Body Mass (kg)	Pre	92.8	20.3	61.2	126.9
	Post	93.1	20.7	59.8	122.9
Body fat %	Pre	35.9	5.9	25.8	45.6
	Post	35.8	5.1	26.1	45.2
Fat mass (kg)	Pre	33.1	9.1	21.8	51.0
	Post	33.3	9.1	20.9	49.0
Fat-free	Pre	59.7	14.1	36.3	82.0
mass (kg)	Post	59.8	14.3	38.9	81.8

* Indicates significant change ($p < 0.05$) from
baseline .

Table 2.4 (page 101) shows preferred walk paces (baseline & post-intervention),
preferred run pace, predicted EE using the Loftin et al. (2010) equation (baseline & post-
intervention), measured EE for both walk and run sessions. RM-ANOVA showed that measured
walk EE at both baseline and post-exercise one-mile walk at preferred pace was not significantly
different from predicted EE using the Loftin et al. (2010) equation (Pre-test measured vs. Pre-test
predicted: $p = 0.913$; Post-test measured vs. Post-test predicted: $p \approx 1.0$). However, RM-ANOVA
did indicate that measured run EE was significantly different from predicted EE $F_{4,8} = 23.627$ ($p
< 0.0005$, $\eta^2 = 0.682$) at post-intervention as well as from measured walk EE at the same time-

point $F_{4,8} = 22.821$ ($p = 0.002$, $\eta^2 = 0.919$). Figure 2.1 (page 102) displays the EE/mile data for each condition.

Table 2.4 - *Exercise pace & caloric expenditure per mile (baseline & post-intervention)*

Variable		Mean	SD	Min	Max
Preferred Walk Pace	Pre	3.18	0.36	2.70	3.70
(mph)	Post	3.08	0.32	2.60	3.60
Preferred Run Pace	Post	5.13	0.52	4.40	6.00
(mph)					
Predicted EE	Pre	112.5 [a]	18.0	84.0	137.7
(kcal/mile)	Post	113.8 [a]	17.9	83.1	140.5
Measured Walk EE	Pre	117.8 [a]	21.9	78.0	161.0
(kcal/mile)	Post	111.9 [a]	24.8	73.0	148.0
Measured Run EE	Post	136.5 [b]	26.9	93.6	192.4
(kcal/mile)					

* Different letters indicate p < 0.05.
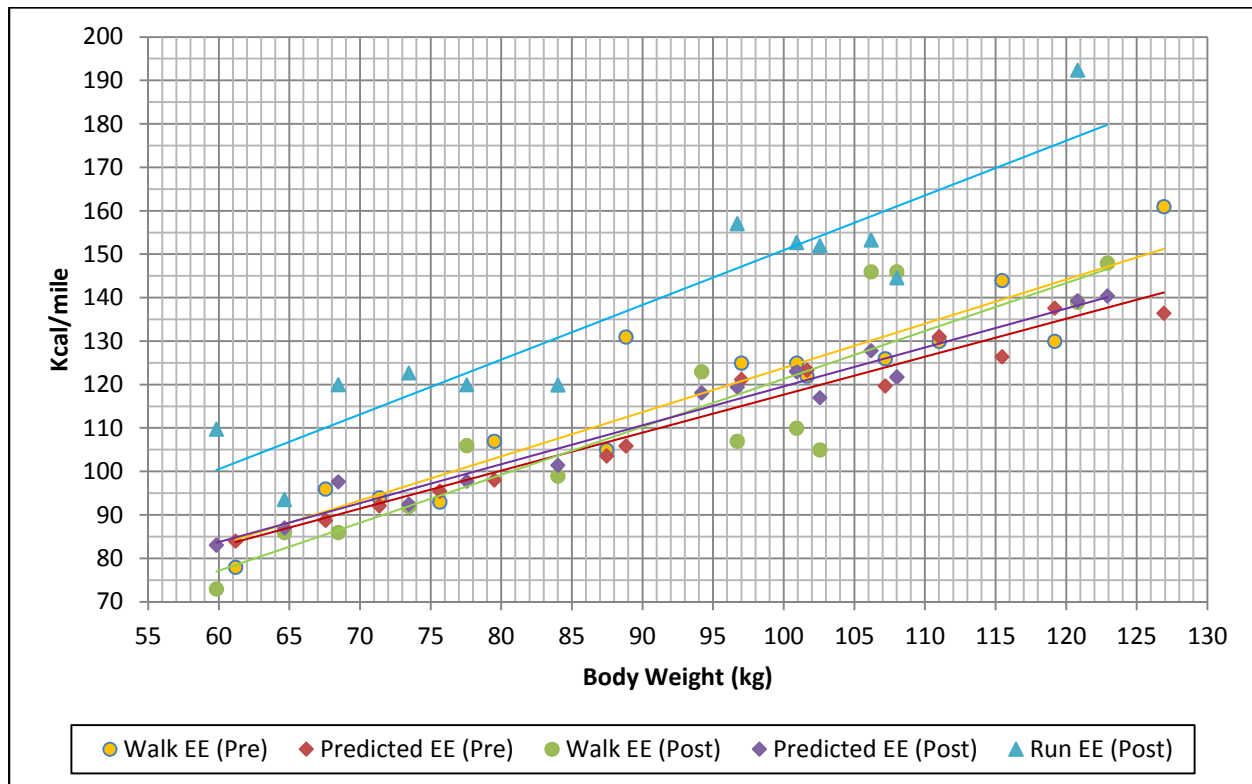
Figure 2.1 - EE/mile per kg of Body Mass

Table 2.5 (page 103) shows EPOC data following each of the preferred one-mile walks (baseline & post-intervention) and the preferred run. RM-ANOVA showed that there was not a significant difference in EPOC for the Preferred Walk at both time-points ($p = 0.599$). However, RM-ANOVA did indicate that Run EPOC was significantly greater than both Walk EPOC values $F_{2,10} = 45.881$ ($p < 0.0005$, $\eta^2 = 0.807$). The mean Walk EPOC (Pre) was 1.09 L, the mean Walk EPOC (Post) was 0.93 L, and the mean Run EPOC (Post) was 2.81 L.

Table 2.5 - *EPOC values following one-mile walk or run (baseline & post-intervention)*

Variable		Mean	SD	Min	Max
EPOC (L)	Walk (Pre)	1.09 [a]	0.42	0.34	1.74
	Walk (Post)	0.93 [a]	0.42	0.17	1.73
	Run (Post)	2.81 [b]	1.00	1.71	4.92

Different letters indicate significant difference
($p < 0.05$) for within-subject comparison.

DISCUSSION

The current study attempted to evaluate whether a significant weight loss as the result of an exercise program would lead to a significant difference in EE per mile walked or run. In addition, the study attempted to evaluate the predictability of the Loftin et al. (2010) equation to accurately estimate EE prior to and following exercise intervention for weight loss. Overall, the participants who completed the study did not lose weight as a group. A number of participants lost weight but there were also participants who gained weight to offset the other participants' loss, showing the overall mean body mass to actually increase by 0.3 kg. This change in mass was not considered a significant change from baseline so the evaluations can essentially be considered to be measured at a similar body mass at each time-point overall. While an attempt was made to recruit at least 24 participants, only 21 were able to be recruited and brought into the laboratory with one of those not even starting one of the exercise programs at all. Of those 20 who began, 5 ended up dropping out at some point during the 10-week intervention and not returning for post-intervention data collection. This represents a 25% dropout rate which is fairly comparable to drop-out rates reported by other researchers in similar short-term exercise programs which have employed self-reports of brisk walking for previously sedentary results. In an 18-week study, Woolf-May et al. (1999) had a drop-out rate of 29.1%. In their 16-week study, Coleman et al. (1999) experienced a drop-out rate of 11%. A 12-week study by Murphy, Nevill, Neville, Biddle, and Hardman (2002) reported a drop-out rate of 42.9%. Another 12-week study reported a drop-out rate of 29% (Murtagh, Boreham, Nevill, Hare, & Murphy 2005). Regarding

the intended sample size, with the intended 24 participants total, the trial should have had at least 80% power to detect a decrease in body mass of 5% of original body mass as a result of the exercise intervention at the 0.05 significance level. This a priori analysis was conducted using G*Power 3.1.7 (Dusseldorf, Germany) using RM-ANOVA within-between interaction.

Considering the within-subject evaluation, the EE per mile walked pre-intervention was not significantly different from the EE per mile walked post-intervention. Based on the previously mentioned lack of change in body mass or other body composition measures, the results were expected. The EE per mile ran was significantly greater than both EE per mile walked pre- and post-intervention. This within-subject difference in EE per unit distance when walking or running supports the previously reported research (Bhambani & Singh, 1985; Cesar et al., 2013; Fellingham et al., 1978; Gonelli et al., 2011; Gottschall & Kram, 2003; Hall et al., 2004; Howley & Glover, 1974; Verlengia et al., 2012; Wilkin et al., 2012). This would also seemingly go against the suggestions that were made by others (Browning et al., 2006; Loftin et al., 2010; Morris et al., 2014; Welle et al., 1992). However, it must be considered that in the case of Loftin et al. (2010) and Morris et al. (2014), their results and suggestions were the product of a between-subjects design employing both normal weight and overweight adults. The difference between the walking EE and running EE was not nearly as high as has been previously suggested. Gottschall and Kram (2003) indicated that running EE should be about 50% higher than walking EE. Previously, Chang and Kram (1999) suggested that running EE should be about 33% higher than walking EE. In the current study, running EE was underestimated by 17.5%. The lower values noted may be due to the fact that the Loftin et al. (2010) study included predicting EE across a marathon run group, a normal weight and an overweight walking group. All of the participants walked or ran at their preferred pace. Supporting the differences that were

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experienced with the within-subject design, the EPOC was significantly greater for the one-mile run than for both one-mile walks.

The aim of the proposition by Loftin et al. (2010) and Morris et al. (2014) was not to challenge the widely held belief that running should elicit greater gains physiologically than walking, but instead by providing a scenario in which overweight or obese individuals who are attempting to alter their sedentary lifestyle can see improvements from an alternative exercise regimen that includes more manageable or tolerable moderate-intensity exercise (Gordon-Larsen et al., 2009). Considering evaluation of the Loftin et al. (2010) equation, no significant differences were seen for the predicted EE/mile for both the pre-intervention one-mile walk and the post-intervention one-mile walk. This would imply that the Loftin et al. (2010) equation is fairly accurate in its predictive ability for walking one-mile. However, the predicted EE/mile was significantly different than the EE/mile measured for the one-mile run. Again, this is not altogether surprising given the widely held belief that running is more costly metabolically than walking, but goes against the suggestions made by Loftin et al. (2010) and Morris et al. (2014). Considering that the equation was developed with a within-subjects design with a wide array of body masses with some of the participant's EE being evaluated through walking and others running, it shouldn't be surprising that a between-subjects design would find the equation to be unsuccessful in predicting EE when running one-mile. Also, the Loftin et al. (2010) equation was developed with a participant population which included normal weight runners but not with overweight runners, and as Figure 2.1 (page 102) illustrates, as body mass increases so does EE regardless of overweight or normal weight status. This is a similar to the suggestions made by Loftin et al. (2010) and Morris et al. (2014).

The significant difference in walking EE and running EE per unit distance in addition to the inability of the Loftin et al. (2010) equation to accurately predict running EE would seem to suggest that the equation may need to be reconsidered in its suggestion for use for prediction of walking or running one-mile distance. The current study supports the Loftin et al. (2010) equation in its ability to accurately predict walking EE, but perhaps a re-evaluation is necessary as it pertains to running EE. The original equation was evaluated with a between-subjects design employing normal weight walkers, normal weight runners, and overweight walkers. Morris et al. (2014) in its attempt to cross-validate the equation, followed the same protocol. Consequently, developing an equation exclusively for running will most probably reduce the predictive error noted in the current within group design. Future research should perhaps attempt to develop an equation that employs a between-subjects design in which each participant across a wide range of body masses from both normal weight and overweight populations is allowed both to walk and run one-mile.

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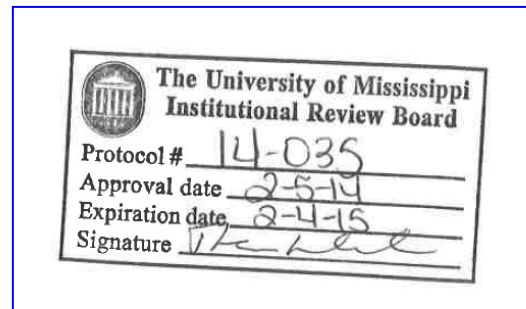
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LIST OF APPENDICES

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APPENDIX A: INFORMED CONSENT

INFORMED CONSENT

Consent to Participate in an Experimental Study

Title: Phase II: Comparing distance-based vs. time-based exercise prescriptions of walking and running for improvement of cardiovascular disease risk factors

Primary Investigator
Cody E. Morris, M.S., PhD Candidate
Department of Health, Exercise Science, and

Recreation Management
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The University of Mississippi
(662) 915-5158

Sponsor
Mark Loftin, Ph.D.
Department of Health, Exercise Science, and
Recreation Management
215 Turner Center

The University of Mississippi
(662) 915-7900

Description
You have already completed Phase I of the study protocol and are now being asked to proceed with Phase II. Your participation is voluntary. You are being asked to participate in a research study for the purpose comparing two walking and running prescription methods as part of a weight loss intervention to assess their similarities or differences. During the tests, we will be asking you to perform several different walking tests while we measure the amount of oxygen you use. We will explain the tests to you and you can ask any questions you have about the study. The second phase will include a 12-week exercise program intervention aimed at eliciting a modest weight loss. You will need to report for baseline testing on 4 separate visits prior to the intervention beginning and 3 visits following the intervention. So as a voluntary participant, you will be required to come to the Kevser Ermin Applied Physiology Lab at the Turner Center on the University of Mississippi campus for seven separate one-two hour sessions. The first visit (Day 1) will involve a DXA scan and ensure body composition appropriateness for the study. Overweight but otherwise healthy males will be considered if their body fat percentage is greater than 22% and overweight but otherwise healthy females will be considered if their body fat percentage is greater than 32%. Day 1 should require approximately 45 minutes to one hour to complete. The second visit will consist of a blood lipid evaluation, measurement of resting metabolic rate, and a balance evaluation. Day 2 should require approximately 60 – 90 minutes to complete. Day 3 will consist of an evaluation of preferred walking pace, a one-mile walk at this preferred pace, and a submaximal aerobic capacity test. Day 3 should require about one hour to complete. Day 4 will consist of explanation of the

exercise program to be performed. Exercise will be prescribed as walking or running per day or per week. You will be required to keep a log of your daily and weekly exercise and report it to the Primary Investigator (Cody Morris) each week. You will be asked to report once during Week 6 for a one-bout monitored exercise period (Day 5) to ensure and encourage accuracy in reporting of exercise data. You will walk one mile and be monitored using indirect calorimetry. Questions will be answered and suggestions given if it is determined that you may be unintentionally misreporting exercise amount. After the 12-week intervention has been completed, you will be required to return for 3 post-testing days. The previously mentioned tests in Day 1 and Day 2 will be combined for the first visit after intervention (or Day 6). The previously mentioned tests in Day 3 will be performed as Day 7 and then you will return one more final visit (Day 8) to perform a 5-minute run at your preferred jogging pace. Once you complete all of these visits, then you are finished with the study.

Day 1 (Pre-test) Experimental Procedures (approximately 60 minutes)
We will ask to measure your height and weight, resting heart rate and blood pressure. The first visit will consist of a body composition measurement day, where you will have your body composition evaluated using a DXA scan. A very low but possible risk for you (and for an unborn fetus) is from the radiation exposure from the DXA scan. The effective dose of radiation for the whole body scan is similar to the daily background radiation experienced in most parts of the world and only about 1/30th of the maximal permissible X-ray dose per year. The DXA should take about 30 minutes to complete. We will then ask to measure your resting heart rate and blood pressure. Overweight but otherwise healthy males will be considered if their body fat percentage is greater than 22% and overweight but otherwise healthy females will be considered if their body fat percentage is greater than 32%. Day 1 should require approximately 45 minutes to one hour to complete.

Day 2 (Pre-test) Experimental Procedures (approximately 60 – 90 minutes)
Once the pre-screening (Day 1) has been completed and you meet the inclusion standards, you will be asked to return for resting baseline measurements (Day 2). Before reporting to the laboratory for the second measurement day, you will need to be fasting from any food or alcohol for at least eight hours as well as abstaining from moderate-intensity exercise for at least two hours and vigorous-intensity exercise for at least 14 hours prior for Day 2 data collection. You will be requested to also have abstained from caffeine for at least four hours and nicotine for two hours. Day 2 will involve resting blood levels of HDL cholesterol, LDL cholesterol, triglycerides (TG), total cholesterol (TC), and blood glucose. This will involve a finger prick drawing a small amount of blood for the purposes of analyzing your blood lipids and blood glucose. We will choose a spot on the side of one of the center fingers on your hand, clean the selected finger site with an alcohol swab and prick the selected site with a small lancet. Then a capillary tube will be held up to the site while we gently squeeze the finger to obtain a drop of blood and this small amount of blood will be collected within 10 seconds. Once the blood is finished collecting, we will provide you with gauze to apply pressure to the puncture until the bleeding stops at which point you will be provided with a bandage. We will then ask to measure your height and weight, resting heart rate and blood pressure. Following completion of these measurements you will then have your resting metabolic rate (RMR) evaluated. You will be asked to rest quietly while lying on your back on a padded training table for 20 minutes prior to any data collection beginning. The room in which measurements will be made will be kept in a comfortable temperature range. The measurement of RMR will take approximately 40 minutes to complete (including the previously mentioned 20 minute rest period). Once the 20 minute

rest period has ended, a laboratory technician will fit you with a hood and canopy system with a tube attached to a machine that measures how much oxygen you use. You will lie still underneath the canopy and breathe normally. You will remain lying on your back and breathing normally underneath the canopy for at least 10 minutes. If the data is considered acceptable you will then be able to remove the hood and canopy system and end the RMR evaluation. If not, we will ask you to remain lying on your back underneath the canopy system for up to another 10 minutes. Once completing the RMR measurements, you will be asked to move to the Applied Biomechanics Laboratory in the room next door for evaluation of balance. You will be instructed to stand as still as possible on the testing device for two different tests which shouldn't last more than 15-20 minutes together. Once you are finished with the balance test, you will have completed Day 2 and we will schedule your Day 3 visit and you will be permitted to leave. Day 2 should require about 60 to 90 minutes to complete.

Day 3 (Pre-test) Experimental Procedures (approximately 60 minutes)
Day 3 will involve a number of exercise tests and evaluations. You will be asked to return to the Kevser Ermin Applied Physiology Laboratory and be asked to walk on a treadmill at your preferred pace. This speed will be determined by evaluating your pace from 6 timed 70 feet trials on an indoor track and be averaged to determine your preferred walking speed. This will be the speed that you will walk on the treadmill. You will then be asked to complete a moderate intensity exercise on a treadmill. A laboratory technician will fit you with a mouthpiece with a tube attached to a machine that measures how much oxygen you use. You will insert the mouthpiece into your mouth and breathe normally. A laboratory technician will set the speed on the treadmill for you and inform you about the protocol. We will provide you a brief warm-up, and then you will walk for one mile on the treadmill at the previously described preferred pace. Immediately following the one-mile walk, you will stand on the treadmill for an additional time period to assess your ability to recover from the exercise you just performed. The amount of time necessary for this period will vary but will be long enough to allow your heart rate to return to within 10 beats of resting heart rate. After your heart rate returns to this previously mentioned resting level, you will perform another moderate-intensity treadmill exercise to predict the maximum amount of oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 2 mph and 2% grade. The entire testing duration in the Kevser Ermin Applied Physiology Lab for Day 3 will last approximately one hour.

Day 4 (Pre-test) Experimental Procedures (approximately 30 minutes)
You will then return for Day 4 when the exercise program is ready to begin and you are available to meet with the primary investigator (PI). Prior to arrival, the PI will have randomly assigned you to one of the two groups: time (TIME) or distance (DIST). The PI will inform you of the results of your baseline testing and where it relates to population norms. The PI will then outline and discuss the exercise you need to perform each day or week. You will be instructed to correspond with the PI via email or telephone to give a weekly self-report update on the exercise that has been performed that week. The PI will request that you refrain from other strenuous exercise during the span of the intervention and to try to stick to the prescribed exercise as closely as you can. You will also be asked to report weekly exercise as honest and truthfully as possible and to not purposely over or underestimate time or distance. You will keep a weekly journal logging the amount of walking and running done each bout. At the end of each week, you will

contact the PI through phone or email to turn in your weekly training log. You will be shown how to download and use the Nike Plus Running App which will use the GPS possessed by your smart phone to measure distance of each walk/run or the time that you walked or ran. If you are in the DIST group, uou will be informed that you only need to keep up with your distances that are prescribed that week; the accumulation of the mileage is the main concern. If you are in the TIME group, you will report all of your walking and running exercise as time which will be measured by a wristwatch or by a timer possessed by your smart phone.

At the beginning of your exercise program, a low level of exercise will be initially prescribed and steadily increased as you adjust. We will ask you to report to the Kevser Ermin Applied Physiology Laboratory during Week 6 for a one-bout monitored exercise period (Day 5) to ensure and encourage accuracy in reporting of exercise data. You will walk one mile and be monitored like the treadmill exercise you performed before. Questions will be answered and suggestions given if it is determined that the participant is unintentionally misreporting exercise amount. You will also fill out a 3-day food recall every four weeks and submit it to the PI for evaluation. You will be informed of the benefits of a healthy diet and dietary recall information will be kept for evaluation. Dietary recall will be conducted at baseline, 4 weeks, 8 weeks and 12 weeks. You will be asked to report intake for consumption on a typical three day period. If you happen to report any atypical consumption, you will be asked to complete an additional 3-day record in order to allow assessment of a more "usual consumption" pattern. You will meet with one of the researchers for a verification interview.

Day 6, 7, & 8 (Post-test) Experimental Procedures
Following completion of the 12-week intervention, you will then be asked to return to the lab to have post-testing completed. Post-test procedures will mirror pre-test procedures nearly exactly to evaluate the effect of the exercise program. Exceptions will include the following: Day 1 and Day 2 will be combined for post-test evaluation (Day 6), Day 7 will involve all exercise procedures as before (Day 3) with the exception that you will return a day later (Day 8) to complete a 5 minute run at your preferred run pace. Your preferred run pace will be determined based on your self-selected pace to complete a jog at a leisurely pace around a 200 meter indoor track (average of three trials). All caloric data will then be corrected to a one-mile distance to estimate your energy expenditure when running one-mile. Day 6 will take approximately two hours to complete, Day 7 will take approximately one hour to complete, and Day 8 will take approximately 30 minutes to complete.

Inclusion Criteria

- If you are a male, you must be between the ages of 18 and 44 and be considered overweight but otherwise healthy and in good health.
- If you are a female, you must be between the ages of 18 and 54 and be considered overweight but otherwise healthy and in good health.
- You must not be currently participating in regular physical activity.
- You must be capable of understanding and providing written informed consent after a full explanation of the study.
- You must be able to walk on a treadmill for one mile.

Exclusion Criteria

- You are not considered fit for participation as determined by the PAR-Q and 7-day PAQ.
- Blood pressure will be measured twice at rest and if two systolic blood pressure values are found to be above 140 or two diastolic blood pressures are found to be above 90, you will not be permitted to participate in the study.
- Heart rate will be measured twice at rest and if both measurements are found to be above 100 bpm, you will not be permitted to participate in the study.
- Women recruited for the study will not be pregnant, as determined by a provided pregnancy test.

Evaluation of Readiness for Exercise

- You will complete a physical activity readiness questionnaire (PAR-Q) and body measures.
- The PAR-Q consists of seven questions that determine if you have any heart disease, chest pain, dizziness, bone or joint problems, or are taking any prescription drugs for a heart condition or your blood pressure that may limit your physical activity.
- If you answer yes to any of the questions on the PAR-Q, you will be ineligible to participate in the study.
- We will be measuring your height and weight, both without shoes.
- Your blood pressure will be analyzed twice using a sphygmomanometer by a trained lab technician. If your blood pressure is 140/90 or greater, you will be excluded from the study.
- You will be asked to complete a physical activity questionnaire that determines how much exercise you have performed over the last 7 days.

Preferred Walking Speed

- You will walk 70 feet at your normal walking pace and do this 6 times.

Preferred Running Speed

- You will run 200 meters at a leisurely jogging pace and do this 3 times.

Oxygen Use While on a Treadmill

- You will stand quietly on the treadmill.
- A laboratory technician will fit you with a mouthpiece with a tube attached to a machine that measures how much oxygen you use.
- You will insert the mouthpiece into your mouth and breathe normally.
- You will walk at your preferred speed for one mile. A laboratory technician will set the speed on the treadmill for you and inform you about the protocol.
- After completion of the one-mile walk, you will continue to stand on the treadmill for an additional period breathing normally as we evaluate your ability to recover from the exercise that you just performed.
- After completing the exercise recovery period you will perform a moderate-intensity treadmill exercise to predict the maximum amount of oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 2 mph and 2% grade.

- After completion of the exercise program, you will complete a 5 minute run at your preferred jogging pace as determined from 3 trials at a leisurely jogging pace on a 200 meter indoor track.

Risks and Benefits

A very low but possible risk for you (and for an unborn fetus) is from radiation exposure from the DXA scan. The effective dose of radiation for the whole body scan is similar to the daily background radiation experienced in most parts of the world and only about $1/30^{th}$ of the maximal permissible X-ray dose per year. Feedback from the DXA scan may provide a greater understanding of your body composition including percent of body fat. If you wish, we will fax the DXA results to your physician.

A laboratory technician will administer a small blood draw at pre-test and post-test using a finger prick to evaluate blood lipids. The amount of blood to be drawn will be very small and will not pose any significant risk to you. However, you will be provided gauze and a bandage to cover the end of their finger to stop the small amount of bleeding. If you wish, we will fax the results of the blood lipid panel and blood glucose analysis to your physician.

At all times during balance testing, the subject will wear a safety harness designed to eliminate the risk of falling during the balance testing protocol.

You may not receive any direct benefit from taking part in this research study. You may experience a potential loss in body weight due to loss in body fat due to the prescribed exercise but this benefit is not guaranteed. Should the testing procedures performed yield results that are abnormal, (e.g. abnormal balance, abnormal walking, abnormal blood lipids) you will be advised. If you decide to speak to your physician, it will be your responsibility set up an appointment with him/her. The results will be available at no cost, should you or your physician request them.

Cost and Payments
There is no cost or payment for participation in this study.

Confidentiality
The study procedures will be monitored continuously so as to ensure your privacy and the confidentiality of your information. The primary investigator (Cody Morris) will be responsible for the data and safety monitoring. Confidentiality will be maintained by password protection and encoding all computer data file names, by not including participant names in the data files, and by using encoded identifiers for all computer data subdirectories. Furthermore, all other research records will be kept separate, stored in secure, locked cabinets with access restricted to the investigators. Only the primary investigator (Cody Morris) of the research team will have direct access to the confidential data records.

Right to Withdraw
You do not have to take part in this study. If you start the study and decide that you do not want to finish, all you have to do is to tell Cody Morris in person, by letter, by email, or by telephone at the Department of Health, Exercise Science, and Recreation Management, 215 Turner Center, The University of Mississippi, University MS 38677, or 662-915-5158, or 770-842-0218. Whether or not you choose to

participate or to withdraw will not affect your standing with the Department of Health, Exercise Science, and Recreation Management, or with the University.

The researchers may terminate your participation in the study without regard to your consent and for any reason, such as protecting your safety and protecting the integrity of the research data.

Student Participants in Investigators' Classes

Special human research subject protections apply where there is any possibility of coercion – such as for students in classes of investigators. Investigators can recruit from their classes but only by providing information on availability of studies. They can encourage you to participate, but they cannot exert any coercive pressure for you to do so. Therefore, if you experience any coercion from your instructor, you should contact the IRB via phone (662-915-7482) or email (irb@olemiss.edu) and report the specific form of coercion. You will remain anonymous in an investigation.

Compensation for Illness or Injury

"I understand that I am not waiving any legal rights or releasing the institution or their agents from liability from negligence.   I understand that in the event of physical injury resulting from the research procedures, The University of Mississippi does not have funds budgeted for compensation for 1) lost wages, 2) medical treatment, or 3) reimbursement for such injuries. The University will help, however, obtain medical attention which I may require while involved in the study by securing transportation to the nearest medical facility."

IRB Approval
This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the IRB at (662) 915-7482.

Statement of Consent

I have read the above information. I have been given a copy of this form. I have had an opportunity to ask questions, and I have received answers. I consent to participate in the study.

_____

Signature of Participant   Date

_____

Signature of Investigator   Date

Statement of consent to be contacted for future studies

The staff of the Applied Biomechanics and Ergonomics Laboratory, Body Composition Laboratory, or Kevser Ermin Applied Physiology Laboratory may be interested in contacting you to participate in future studies. Signing below allows us to contact you with information on future studies.

_____

Signature of Participant   Date

_____

Signature of Investigator   Date

NOTE TO PARTICIPANTS: DO <u>NOT</u> SIGN THIS FORM

IF THE IRB APPROVAL STAMP ON THE FIRST PAGE HAS EXPIRED.

APPENDIX B: RECRUITMENT FLYER

Ready to get 2014 started off right and stick to that New Year's resolution?

The University of Mississippi

is recruiting overweight but otherwise healthy adults aged 18-44 years
Comparing distance-based vs. time-based exercise prescriptions of walking and running for improvement of cardiovascular disease risk factors

Start Date January 2014

HESRM is conducting a research study looking at two different types of walking for exercise prescriptions to see if they help people to lose weight and decrease the occurrence of risk factors of cardiovascular disease.

We will be providing you a FREE DXA scan that measures your body composition. Also, we will provide you a FREE blood lipid panel, FREE blood glucose measurement, FREE resting metabolic rate measurement, and FREE balance assessment in addition to being part of a planned and guided exercise program.

Please note: This research will not pay for participation. All participants must NOT be pregnant or have any form of diagnosed heart disease. In order to be considered for the study you must have a BMI that is at least 25.0 kg/m^2. Also, you must have access to a smart phone and a data plan which allows GPS use. In addition to being part of a 12 week exercise program, the study will consist of eight laboratory sessions which could last about one to two hours each. Participants will be subject to a DXA scan which will expose them to a small dosage of radiation.

If you are interested, or need further information, please reply to Cody Morris by email (cemorri1@go.olemiss.edu) or phone 662-915-5158 (office), 770-842-0218 (cell). Mr. Morris is a PhD candidate in HESRM.

This study has been reviewed by The University of Mississippi's Institutional Review Board.

The University of Mississippi

Department of Exercise Science
University, MS
244 Turner Center
662.915.5570

APPENDIX C: RECRUITMENT EMAIL

Students, faculty, and staff,

Ready to get 2014 started off right and stick to that New Year's resolution?

The University of Mississippi Department of Health, Exercise Science, and Recreation Management is recruiting subjects for a study entitled, "Comparing distance-based vs. time-based exercise prescriptions of walking and running for improvement of cardiovascular disease risk factors". We will be looking at two different types of walking for exercise prescriptions to see if they help people to lose weight and decrease the occurrence of risk factors of cardiovascular disease.

We will be providing you a FREE DXA scan that measures your body composition. Also, we will provide you a FREE blood lipid panel, FREE blood glucose measurement, FREE resting metabolic rate measurement, and FREE balance assessment in addition to being part of a planned and guided exercise program.

Please note: This research will not pay for participation. All participants must NOT be pregnant or have any form of diagnosed heart disease. In order to be considered for the study you must have a BMI that is at least 25.0 kg/m^2. Also, you must have access to a smart phone and a data plan which allows GPS use. In addition to being part of a 12 week exercise program, the study will consist of eight laboratory sessions which could last about one to two hours each. Participants will be subject to a DXA scan which will expose them to a small dosage of radiation.

If you are interested, or need further information, please reply to Cody Morris by email (cemorri1@go.olemiss.edu) or phone 662-915-5158 (office), 770-842-0218 (cell).

Mr. Morris is a PhD candidate in HESRM.

This study has been reviewed by The University of Mississippi's Institutional Review Board.

APPENDIX D: RECRUITMENT SCRIPT – RESPONSE TO INTEREST PHONE CALL

Potential Participant Interest Phone Call (script) – Gauging interest

Thank you (_____) for inquiring about our study. HESRM is recruiting 36 overweight adults aged 18-44 for a study looking at the differences in an exercise prescription based on walking for time and walking for distance. We hope that as a result of the exercise that you will be performing that you may have the opportunity to see an improvement in body composition. The exercise program that we are looking for participants for will last for 12 weeks. In addition, you will be asked to report for 4 baseline measurement days lasting about an hour to an hour and a half each prior to the 12 weeks, one during the intervention period, and 3 post-intervention measurement days lasting about the same amount of time as before after the 12 weeks. We will be looking at these two different types of walking for exercise prescriptions to see if they help people to lose weight and decrease the occurrence of risk factors of cardiovascular disease.

As a voluntary participant, you will be required to come to the Kevser Ermin Applied Physiology Lab at the Turner Center on the University of Mississippi campus for four separate one hour sessions. In order to be considered for the study you must have a BMI that is at least 25.0 kg/m^2. Also, you must have access to a smart phone and a data plan which allows GPS use. We will require you to fill out 2 forms (PAR-Q and 7-day PAQ) in order to determine whether you are healthy enough and physically active enough to participate. We will then ask to measure your height and weight. You will be required to complete a pregnancy test before a DXA scan. We do this because the DXA scan gives off a minimal amount of radiation that may harm your fetus. We will give you written and oral instructions on how to complete the pregnancy test. The DXA scan will require you to lie flat on the scanner while the wand travels back and forth over your body. The DXA scan measures your body fat percentage. Once completed, we will measure your resting blood pressure and heart rate. After this, we will schedule your second meeting and allow you to leave. This initial meeting should last about 60 minutes.

When you return for your second meeting, we will request that you be fasting from all food and alcohol for 8 hours, caffeine for 4 hours, and nicotine for 2 hours. We will also request that you not perform any moderate-intensity exercise within 2 hours or vigorous-intensity exercise within 14 hours of coming into the lab. On your second visit we will be performing a resting blood lipid panel as well as evaluating resting metabolic rate. The blood lipid panel will involve a finger prick that will draw a small amount of blood to evaluate the cholesterol levels in your blood as well as your blood sugar. Following completion of this test, we will ask you to lie still on a padded training table for 20 minutes. After this 20 minutes is up, a laboratory technician will fit you with a mouthpiece with a tube attached to a machine that measures how much oxygen you use. You will insert the mouthpiece into your mouth and breathe normally. You will be lying still breathing through the mouthpiece for about 10 minutes. A laboratory technician will inform you more about the protocol upon your arrival and answer any questions that you have. Following this, you will then have your balance evaluated using our Neurocom device. You will be instructed to stand as still as possible on the NeuroCom for two different tests which shouldn't last more than 15-20 minutes together. After completion of this test, we will schedule your third session and allow you to leave. Your second visit should last between 60 and 90 minutes long.

When you report for your third visit, we will be performing a number of exercise tests. First, you will have your preferred walking pace evaluated. This speed will be determined by evaluating your pace from 6 timed 70 feet trials on an indoor track and be averaged to determine your preferred walking speed. You will then be asked to complete a moderate intensity exercise on a treadmill at this just described preferred pace. A laboratory technician will fit you with a mouthpiece with a tube attached to a machine that measures how much oxygen you use. You will insert the mouthpiece into your mouth and breathe normally. A laboratory technician will set the speed on the treadmill for you and inform you about the protocol. We will provide you a brief warm-up, and then you will walk for one mile on the treadmill at the previously described preferred pace. Immediately following the one-mile walk, you will stand on the treadmill for an additional time period to assess your ability to recover from the exercise you just performed.

The amount of time necessary for this period will vary but will be long enough to allow your heart rate to return to within 10 beats of resting heart rate. After sufficient time has passed for your heart rate to return back to within 10 beats of your resting heart rate, you will perform a moderate-intensity treadmill exercise to predict the maximum amount of oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 2 mph and 2% grade. When you complete the test, we will schedule your third meeting and you will be permitted to leave. Your third visit should last about 60 minutes.

You will then return for Day 4 when the exercise program is ready to begin and you are available to meet with the primary investigator (PI). Prior to arrival, the PI will have randomly assigned you to one of the two groups: time (TIME) or distance (DIST). The PI will inform you of the results of your baseline testing and where it relates to population norms. The PI will then outline and discuss the exercise you need to perform each day or week. You will be instructed to correspond with the PI via email or telephone to give a weekly self-report update on the exercise that has been performed that week. The PI will request that you refrain from other strenuous exercise during the span of the intervention and to try to stick to the prescribed exercise as closely as you can. You will also be asked to report weekly exercise as honest and truthfully as possible and to not purposely over or underestimate time or distance. You will keep a weekly journal logging the amount of walking and running done each bout. At the end of each week, you will contact the PI through phone or email to turn in your weekly training log. You will be shown how to download and use the Nike Plus Running App which will use the GPS possessed by your smart phone to measure distance of each walk/run or the time that you walked or ran.

At the beginning of your exercise program, a low level of exercise will be initially prescribed and steadily increased as you adjust. You will also fill out a 3-day food recall every four weeks and submit it to the PI for evaluation. You will be informed of the benefits of a healthy diet and dietary recall information will be kept for evaluation. Dietary recall will be conducted at baseline, 4 weeks, 8 weeks and 12 weeks using the Nutrient Data System, a nutrient analysis software program designed for research. You will be asked to report intake for consumption on a typical three day period. You will be asked to report to the laboratory during Week 6 for a one-bout monitored exercise period (Day 5) to ensure and encourage accuracy in reporting of exercise data. You will walk one mile and be monitored using indirect calorimetry. This visit will last approximately 30 to 45 minutes. Questions will be answered and suggestions given if it is determined that you are unintentionally misreporting exercise amount.

Following completion of the 12-week intervention, you will then be asked to return to the lab to have post-testing completed. Post-test procedures will mirror pre-test procedures nearly exactly to evaluate the effect of the exercise program. Exceptions will include the following: Day 1 and Day 2 will be combined for post-test evaluation (Day 6), Day 7 will involve all exercise procedures as before (Day 3) with the exception that you will return a day later (Day 8) to complete a 5 minute run at your preferred pace. Your preferred pace will be determined based on your self-selected pace to complete a jog at a leisurely pace around a 200 meter indoor track (average of three trials). All caloric data will then be corrected to a one-mile distance to estimate your energy expenditure when running one-mile. Day 6 will take approximately two hours to complete, Day 7 will take approximately one hour to complete, and Day 8 will take approximately 30 minutes to complete. Then you are finished with the study. We will provide you with water at the end of the day.

Would you like to participate in our study? _____ yes   _____ no

(no). Thank you very much for calling.

(yes). I need to ask you some questions to see if you qualify for the study. Answering them is, of course, voluntary. You can tell me you don't want to do this or you can stop at any time, and there will be no penalty of any kind – these are your rights. All of your answers will be kept confidential. These questions have to do with your health and some are very personal. Are you willing to hear them?

Great.

Are you between the ages of 18-44?

Are you a man or a woman?

Do you feel any pain in your chest when you perform exercise?

Are you taking any prescription medications?

Do you have a medical condition that would prevent you from walking on the treadmill?

Do you have any joint conditions would prevent you from walking on the treadmill?

From the last time you weighed yourself, how much did you weigh? _____(weight) _____(date)

How tall are you? _____(height)

(Don't ask, just do the math) Based on the last two questions, what is their BMI? _____(BMI)

Ask questions from the PAR-Q here!

PAR-Q

YES   NO

☐   ☐   1. Has your doctor ever said that you have a heart condition **and** that you

should only do physical activity recommended by a doctor?

☐   ☐   2. Do you feel pain in your chest when you do physical activity?

☐   ☐   3. In the past month, have you had chest pain when you were not doing

Physical activity?

☐   ☐   4. Do you lose your balance because of dizziness or do you ever lose

consciousness?

☐   ☐   5. Do you have a bone or joint problem (for example, back, knee or hip) that

         could be made worse by a change in your physical activity?

☐   ☐ 6. Is your doctor currently prescribing drugs (for example, water pills) for

              your blood pressure or heart condition?

☐   ☐ 7. Do you know of **<u>any other reason</u>** why you should not do physical

              activity?

Based on the questions above and the questions from the PAR-Q, could the person participate in the study? ____ yes ____ no

If yes, assign day for the subject to come to the lab.

Date_____   Email _____

APPENDIX E: RECRUITMENT SCRIPT – RESPONSE TO INTEREST EMAIL

Potential Participant Interest Email (script) – Gauging interest

Thank you (_____) for inquiring about our study. HESRM is recruiting 36 overweight adults aged 18-44 for a study looking at the differences in an exercise prescription based on walking for time and walking for distance. We hope that as a result of the exercise that you will be performing that you may have the opportunity to see an improvement in body composition. The exercise program that we are looking for participants for will last for 12 weeks. In addition, you will be asked to report for 4 baseline measurement days lasting about an hour to an hour and a half each prior to the 12 weeks, one during the intervention, and 3 post-intervention measurement days lasting about the same amount of time as before after the 12 weeks. We will be looking at these two different types of walking for exercise prescriptions to see if they help people to lose weight and decrease the occurrence of risk factors of cardiovascular disease.

As a voluntary participant, you will be required to come to the Kevser Ermin Applied Physiology Lab at the Turner Center on the University of Mississippi campus for four separate one hour sessions. In order to be considered for the study you must have a BMI that is at least 25.0 kg/m^2. Also, you must have access to a smart phone and a data plan which allows GPS use. We will require you to fill out 2 forms (PAR-Q and 7-day PAQ) in order to determine whether you are healthy enough and physically active enough to participate. We will then ask to measure your height and weight. You will be required to complete a pregnancy test before a DXA scan. We do this because the DXA scan gives off a minimal amount of radiation that may harm your fetus. We will give you written and oral instructions on how to complete the pregnancy test. The DXA scan will require you to lie flat on the scanner while the wand travels back and forth over your body. The DXA scan measures your body fat percentage. Once completed, we will measure your resting blood pressure and heart rate. After this, we will schedule your second meeting and allow you to leave. This initial meeting should last about 60 minutes.

When you return for your second meeting, we will request that you be fasting from all food and alcohol for 8 hours, caffeine for 4 hours, and nicotine for 2 hours. We will also request that you not perform any moderate-intensity exercise within 2 hours or vigorous-intensity exercise within 14 hours of coming into the lab. On your second visit we will be performing a resting blood lipid panel as well as evaluating resting metabolic rate. The blood lipid panel will involve a finger prick that will draw a small amount of blood to evaluate the cholesterol levels in your blood as well as your blood sugar. Following completion of this test, we will ask you to lie still on a padded training table for 20 minutes. After this 20 minutes is up, a laboratory technician will fit you with a mouthpiece with a tube attached to a machine that measures how much oxygen you use. You will insert the mouthpiece into your mouth and breathe normally. You will be lying still breathing through the mouthpiece for about 10 minutes. A laboratory technician will inform you more about the protocol upon your arrival and answer any questions that you have. Following this, you will then have your balance evaluated using our Neurocom device. You will be instructed to stand as still as possible on the NeuroCom for two different tests which shouldn't last more than 15-20 minutes together. After completion of this test, we will schedule your third session and allow you to leave. Your second visit should last between 60 and 90 minutes long.

When you report for your third visit, we will be performing a number of exercise tests. First, you will have your preferred walking pace evaluated. This speed will be determined by evaluating your pace from 6 timed 70 feet trials on an indoor track and be averaged to determine your preferred walking speed. You will then be asked to complete a moderate intensity exercise on a treadmill at this just described preferred pace. A laboratory technician will fit you with a mouthpiece with a tube attached to a machine that measures how much oxygen you use. You will insert the mouthpiece into your mouth and breathe normally. A laboratory technician will set the speed on the treadmill for you and inform you about the protocol. We will provide you a brief warm-up, and then you will walk for one mile on the treadmill at the previously described preferred pace. Immediately following the one-mile walk, you will stand on the treadmill for an additional time period to assess your ability to recover from the exercise you just performed.

The amount of time necessary for this period will vary but will be long enough to allow your heart rate to return to within 10 beats of resting heart rate. After sufficient time has passed for your heart rate to return back to within 10 beats of your resting heart rate, you will perform a moderate-intensity treadmill exercise to predict the maximum amount of oxygen your body can consume during exercise. This additional test will be ended when you reach 60% of your predicted Heart Rate Reserve, which is the difference between your age-predicted heart rate max and resting heart rate. The protocol involves stages which increase by 1 mph and 1% grade every minute. The first stage begins with the treadmill at 2 mph and 2% grade. When you complete the test, we will schedule your third meeting and you will be permitted to leave. Your third visit should last about 60 minutes.

You will then return for Day 4 when the exercise program is ready to begin and you are available to meet with the primary investigator (PI). Prior to arrival, the PI will have randomly assigned you to one of the two groups: time (TIME) or distance (DIST). The PI will inform you of the results of your baseline testing and where it relates to population norms. The PI will then outline and discuss the exercise you need to perform each day or week. You will be instructed to correspond with the PI via email or telephone to give a weekly self-report update on the exercise that has been performed that week. The PI will request that you refrain from other strenuous exercise and resistance training during the span of the intervention and to try to stick to the prescribed exercise as closely as you can. You will also be asked to report weekly exercise as honest and truthfully as possible and to not purposely over or underestimate time or distance. You will keep a weekly journal logging the amount of walking and running done each bout. At the end of each week, you will contact the PI through phone or email to turn in your weekly training log. You will be shown how to download and use the Nike Plus Running App which will use the GPS possessed by your smart phone to measure distance of each walk/run or the time that you walked or ran. At the beginning of your exercise program, a low level of exercise will be initially prescribed and steadily increased as you adjust. You will also fill out a 3-day food recall every four weeks and submit it to the PI for evaluation. You will be informed of the benefits of a healthy diet and dietary recall information will be kept for evaluation. Dietary recall will be conducted at baseline, 4 weeks, 8 weeks and 12 weeks using the Nutrient Data System, a nutrient analysis software program designed for research. You will be asked to report intake for consumption on a typical three day period. You will be asked to report to the laboratory during Week 6 for a one-bout monitored exercise period (Day 5) to ensure and encourage accuracy in reporting of exercise data. You will walk one mile and be monitored using indirect calorimetry. This visit will last approximately 30 to 45 minutes. Questions will be answered and suggestions given if it is determined that you are unintentionally misreporting exercise amount.

Following completion of the 12-week intervention, you will then be asked to return to the lab to have post-testing completed. Post-test procedures will mirror pre-test procedures nearly exactly to evaluate the effect of the exercise program. Exceptions will include the following: Day 1 and Day 2 will be combined for post-test evaluation (Day 6), Day 7 will involve all exercise procedures as before (Day 3) with the exception that you will return a day later (Day 8) to complete a 5 minute run at your preferred pace. Your preferred pace will be determined based on your self-selected pace to complete a jog at a leisurely pace around a 200 meter indoor track (average of three trials). All caloric data will then be corrected to a one-mile distance to estimate your energy expenditure when running one-mile. Day 6 will take approximately two hours to complete, Day 7 will take approximately one hour to complete, and Day 8 will take approximately 30 minutes to complete. Then you are finished with the study. We will provide you with water at the end of the day.

Would you like to participate in our study? _____ yes   _____ no

Qualification for study questions

Dear (_____),

Thank you for your interest in our study! I need to ask you some questions to see if you qualify for the study. Answering them is, of course, voluntary. You can tell me if you don't want to do this by responding back to my email saying so, and there will be no penalty of any kind – these are your rights. All of your answers will be kept confidential. These questions have to do with your health and some are very personal. If you are willing, please reply back to this email with the answers to these questions. If you are not, simply reply back that you are not interested in participating.

1. Are you between the ages of 18-44?

2. Are you a man or a woman?

3. Do you feel any pain in your chest when you perform exercise?

4. Are you taking any prescription medications?

5. Do you have a medical condition that would prevent you from walking on the treadmill?

6. Do you have any joint conditions would prevent you from walking on the treadmill?

7. From the last time you weighted yourself, how much did you weigh? _____(weight) _____(date)

8. How tall are you? _____(height)

(Don't ask, just do the math) Based on the last two questions, what is their BMI? _____(BMI)

PAR-Q

YES   NO

☐   ☐   **1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?**

☐   ☐   **2. Do you feel pain in your chest when you do physical activity?**

☐   ☐   **3. In the past month, have you had chest pain when you were not doing physical activity?**

☐   ☐   **4. Do you lose your balance because of dizziness or do you ever lose consciousness?**

☐   ☐   **5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**

☐   ☐   **6. Is your doctor currently prescribing drugs (for example, water pills) for your blood**

pressure or heart condition?

☐ ☐ **7. Do you know of <u>any other reason</u> why you should not do physical activity?**

ASSESSMENT

Based on the questions above and the questions from the PAR-Q, could the person participate in the study? _____ yes _____ no

If yes, assign day for the participant to come to the lab for their familiarization day.

Date_____ Email _____

APPENDIX F: PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

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

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

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

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to <u>all</u> PAR-Q questions, you can be reasonably sure that you can:
- start becoming much more physically active — begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal — this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:
- if you are not feeling well because of a temporary illness such as a cold or a fever — wait until you feel better; or
- if you are or may be pregnant — talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

<u>Informed Use of the PAR-Q</u>: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____ DATE_____

SIGNATURE OF PARENT _____ WITNESS _____
or GUARDIAN (for participants under the age of majority)

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

CSEP
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APPENDIX G: 7-DAY PHYSICAL ACTIVITY RECALL

7-Day Physical Activity Recall

SSN

PAR#: 1 2 3 4 5 6 7   Participant_____

Interviewer_____ Today is_____ Today's Date_____

1. Were you employed in the last seven days?   0. **No** (Skip to Q#4)   1. **Yes**
2. How many days of the last seven did you work?   _____ days
3. How many total hours did you work in the last seven days?   _ . hours last week
4. What two days do you consider your weekend days?   _____ _____

(mark days below with a squiggle)

WORKSHEET
DAYS

	SLEEP	1 __	2 __	3 __	4 __	5 __	6 __	7 __
M O R N I N G	Moderate							
	Hard							
	Very Hard							
A F T E R N O O N	Moderate							
	Hard							
	Very Hard							
E V E N I N G	Moderate							
	Hard							
	Very Hard							
Total Min Per Day	Strength:	____	____	____	____	____	____	____
	Flexibility:							

4a. Compared to your physical activity over the past 3 months, was last week's physical activity more, less, or about the same? 1. More 2. Less 3. About the same	6. Do you think this was a valid PAR Interview? 1. Yes 0. No If NO, go to the back and explain.
5. Were there any problems with the PAR interview? 0. No 1. Yes If YES, go to the back and explain.	7. Were there any special circumstances concerning this PAR ? 0. No 1. Yes, If YES, what were they?(circle) 1. Injury all week 2. Illness all week 3. Illness part week 4. Injury part week 5. Pregnancy 6. Other:

APPENDIX H: PREGNANCY TESTING PROCEDURES FOR DXA SCAN

Pregnancy Testing Procedures:

Subjects will come to Turner 248A, the DXA lab. The researcher will give a urine pregnancy testing kit to the subject and give oral directions, as well as written directions. The researcher will escort the subject to the restroom and obtain urine sample from subject once completed. The researcher will then take the sample to turner 248A to analyze the sample.

FOR POSTIVE TEST ONLY!

Script for Positive Pregnancy Test:

"The pregnancy test appears to be positive. We cannot complete a body composition scan on you because of the positive reading. We recommend that you see your physician."

APPENDIX I: 3-DAY DIETARY RECALL

Diet Record

Day_____of _____days

Participant ID_____   Type of oil you use at home?

Date of Intake:_____   Type of margarine you use at home?

DOB: _____ Gender: M   F   What type of milk do you typically drink? (Skim,1%, 2%, Whole)

When was the last time you had anything to eat or drink?_____ Type of Bread?

Time AM PM	Food or Beverage *Please list each food eaten on a* *separate line.*	Portion Eaten?	Where was food consumed? Home Fast Food Work Other	How prepared? Cooking method Seasonings Additions Anything unique?	ICE
Time AM PM					Y N
Time AM PM					Y N
Time AM PM					Y N
Time AM					Y N

PM				
Time **AM** **PM**				Y N
Time **AM** **PM**				Y N

Does this day's intake reflect your usual pattern?   Yes or No   If no, why not?

Did you take any vitamins or minerals today?   Yes or No   If yes please provide the following:

1. Name:_____ Brand_____ Strength (i.e. 500 mg or mcg or IU) _____

How may of these do you take per day?_____

2. Name:_____ Brand_____ Strength (i.e. 500 mg or mcg or IU) _____

How may of these do you take per day?_____

APPENDIX J: WEEKLY EXERCISE SELF-REPORT LOG (TIME GROUP)

Weekly Exercise Log (TIME GROUP)

1. How many minutes did you walk on the following days during the previous week?

   Monday: _____
   Tuesday: _____
   Wednesday: _____
   Thursday: _____
   Friday: _____
   Saturday: _____
   Sunday: _____
   TOTAL _____

2. How many minutes did you run on the following days during the previous week?

   Monday: _____
   Tuesday: _____
   Wednesday: _____
   Thursday: _____
   Friday: _____
   Saturday: _____
   Sunday: _____
   TOTAL _____

3. When you performed your prescribed walk or run this week, did you prefer to perform it alone or with an exercise partner?
   ___ Alone
   ___ With one exercise partner
   ___ With multiple exercise partners

4. Did you perform anything that could be considered exercise other than the prescribed exercise during the previous week?
   ___ Yes
   ___ No

5. If you answered "Yes" to Question #4, please detail the exercise you performed in the box below.

APPENDIX K: WEEKLY EXERCISE SELF-REPORT LOG (DISTANCE GROUP)

Weekly Exercise Log (DISTANCE GROUP)

1. How many miles did you walk or run on the following days during the previous week?

Monday: _____
Tuesday: _____
Wednesday: _____
Thursday: _____
Friday: _____
Saturday: _____
Sunday: _____
TOTAL   _____

2. When you performed your prescribed walk or run this week, did you prefer to perform it alone or with an exercise partner?
   ___ Alone
   ___ With one exercise partner
   ___ With multiple exercise partners

3. Did you perform anything that could be considered exercise other than the prescribed exercise during the previous week?
   ___ Yes
   ___ No

4. If you answered "Yes" to Question #4, please detail the exercise you performed in the box below.

APPENDIX L: STEPS FOR LABORATORY PROTOCOL & PROCEDURES

Steps for Protocol (Morris Dissertation)

Participant: _____

Participant #: _____

Day 1 (Pre-intervention)

First lab arrival (DATE): _____

☐ Informed Consent

☐ PAR-Q

☐ 7-day PAQ

Inclusion Criteria

Age: _____

Height: _____

Weight: _____

Gender: _____

☐ If female,

    ☐ Pregnant? Rule out.

    ☐ Hysterectomy? Proceed.

    ☐ Perform pregnancy test. Provide directions.

        ☐ Positive? Rule out.

        ☐ Negative? Proceed.

BMI calculation (kg/m^2): _____

Resting HR: _____

☐ Over 100 bpm? Rule out.

☐ Less than 100 bpm? Proceed.

Heart Rate Max calculation (220 – age): _____

Resting BP (1)_____   (2)_____

☐ Over 200/110 twice? Rule out.

☐ Within normal limits? Proceed.

Enter Body Composition Lab for DXA.

☐ Subject removes all metal objects from body.

☐ Perform DXA.

DXA Scan Body Fat %: _____

      ☐ Male at or above 22% BF? If yes, proceed.

      ☐ Female at or above 32% BF? If yes, proceed.

      FFM: _____
      FM: _____

☐ Is participant considered "overweight but otherwise healthy"? _____

☐ Schedule participant for Day 2.
      Inform participant of the following:
            -You need to be fasting from any food or alcohol for at least 8 hours
            -Abstaining from moderate-intensity exercise for at least 2 hours and vigorous-intensity
            exercise for at least 14 hours prior for Day 2.
            -Abstain from caffeine for at least 4 hours and nicotine for 2 hours.
      Date: _____
      Scheduled time: _____

TOTAL TIME FOR TESTING_____

<div align="center">NOTES</div>

_____

_____

<div align="center">

Day 2 (Pre-intervention)

</div>

Date: _____
Scheduled time: _____
Arrival time: _____
Weight: _____

Day 2 Inclusion/Exclusion Criteria

☐ Has participant fasted from food for 8 hours?

☐ Has participant fasted from alcohol for 8 hours?

☐ Has participant abstained from MOD-int. exercise for at least 2 hours?

☐ Has participant abstained from VIG-int. exercise for at least 14 hours?

☐ Has participant fasted from caffeine for 4 hours?

☐ Has participant fasted from nicotine for 2 hours?

If so, proceed. If not, reschedule.
Reschedule date/time (if necessary): _____

Enter Blood Chemistry Lab for lipid panel using Cholestech LDX

☐ 1. The patient should sit quietly for five minutes before the blood sample is collected.

☐ 2. A capillary plunger will be put into the end of a Cholestech Capillary Tube with the colored mark and then set aside.

☐ 3. Choose a spot on the side of one of the center fingers of either hand. To help increase blood flow, the fingers and hands should be warm to the touch. To warm the hand, you can:

    a. Wash the patient's hand with warm water, **OR**
    b. Apply a warm (not hot) compress to the hand for several minutes, **OR**
    c. Gently massage the finger from the base to the tip several times to bring the blood to the fingertip.

☐ 4. Clean the site with an alcohol swab. It will be very important **to thoroughly dry the area with a gauze** pad before pricking the finger.

☐ 5. Firmly prick the selected site with a lancet.

☐ 6. Gently squeeze the finger to obtain a large drop of blood. Wipe away this first drop of blood, as it may contain tissue fluid.

☐ 7. Squeeze the finger gently again while holding it downward until a second large drop of blood forms. **Do not milk the finger.** The puncture should provide a free-flowing drop of blood.

☐ 8. Next, hold the capillary tube horizontally or at a slightly descending angle by the end with the plunger. Touch it to the drop of blood without touching the skin. The tube will fill by capillary action up to the black mark. **Do not collect air bubbles.** If it is necessary to collect another drop of blood, wipe the finger with gauze then massage again from base to tip until a large drop of blood forms.

☐ 9. Fill the capillary tube within 10 seconds.

☐ 10. Wipe off any excess blood from the finger and have the participant apply pressure to the puncture until the bleeding stops.

DATA:
Total cholesterol: _____   LDL cholesterol: _____

HDL cholesterol: _____   Triglycerides: _____

Blood glucose: _____

Following completion of lipid panel, participant returns to Applied Physiology Lab:

☐ Have participant lie still on padded table quietly for 20 minutes.

☐ Following 20 minute rest period, place canopy and hood in place.

☐ First 5 min are to allow stabilization of participant, do not use data in analysis.

☐ Measure RMR using remaining 5 minutes.

    ☐ Is coefficient of variation less than 10%? If yes, proceed. If no, continue to collect until it is.

DATA:
Avg. VO_2 (over 5 min): _____   Avg. VCO_2 (over 5 min): _____

EE/min [using Weir (1949) equation]: _____
REE (kcal/min) = $3.9(VO_2) + 1.1(VCO_2)$

REE (kcal/day): _____
REE = kcal/min x 1440

Participant proceeds to Biomechanics Lab for Balance FAMILIARIZATION.

☐ Turn on Neurocom and allow system to initialize and zero force plate.

☐ Stand participant on force plate and line up medial malleolus on horizontal line, outer border of heel at appropriate height line.
    (S) Short 30 – 55" (76 – 140 cm)
    (M) Medium 56 – 65" (141 – 165 cm)
    (T) Tall 66 – 80" (166 – 203 cm)

☐ Complete one trial of each condition of Sensory Organization Test (SOT).

☐ Complete one trial of condition (backward/forward) of Motor Control Test (MCT).

☐ Schedule participant for Day 3.
    Inform participant of the following:
        -Abstaining from moderate-intensity exercise for at least 2 hours and vigorous-intensity exercise for at least 14 hours prior for Day 2.
        -Abstain from caffeine for at least 4 hours and nicotine for 2 hours.
    Date: _____
    Scheduled time: _____

TOTAL TIME FOR TESTING_____

<center>NOTES</center>

_____

_____

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<center>**Day 3 (Pre-intervention)**</center>

Date: _____
Scheduled time: _____
Arrival time: _____
Weight: _____

Day 3 Inclusion/Exclusion Criteria

☐ Has participant abstained from MOD-int. exercise for at least 2 hours?

☐ Has participant abstained from VIG-int. exercise for at least 14 hours?

☐ Has participant fasted from caffeine for 4 hours?

☐ Has participant fasted from nicotine for 2 hours?
  If so, proceed. If not, reschedule.
  Reschedule date/time (if necessary): _____

Resting HR: _____

☐ Over 100 bpm? Rule out.

☐ Less than 100 bpm? Proceed.

Resting BP (1)_____   (2)_____

☐ Over 200/110 twice? Rule out.

☐ Within normal limits? Proceed.

60% HRR: _____
        $60\% \ HRR = [(HR_{max} - HR_{rest}) \times 0.60] + HR_{resting}$

Participant proceeds to Biomechanics Lab for Balance Assessment.

☐ Turn on Neurocom and allow system to initialize and zero force plate.

☐ Stand participant on force plate and line up medial malleolus on horizontal line, outer

<center>155</center>

border of heel at appropriate height line.
(S) Short 30 – 55" (76 – 140 cm)
(M) Medium 56 – 65" (141 – 165 cm)
(T) Tall 66 – 80" (166 – 203 cm)

☐ Enter participant data –   Birthdate: _____ Height: _____

☐ Place "QUIET" sign on door and close door.

☐ Complete Sensory Organization Test (SOT).

☐ Complete Motor Control Test (MCT).

Preferred Pace determination
Walk speed evaluation (70 ft trials, timed over middle 50 ft):
        - Times: 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____
        - Preferred Walking Speed: _____

Following completion of PP determination, participant returns to Applied Physiology Lab:

☐ Participant stands for Standing Ambulatory Rest data (5 min)

☐ Brief warm-up (3 min at ½ preferred pace): _____

☐ Participant walk at preferred pace (1 mile)
- Based on PP, this will last for: _____
- Total EE: _____

☐ Participant stands for EPOC data (5 min) –
➤ Return to within 4.5 mL/kg/min **OR** 1.5 METs
- Time to recover: _____
- Total O_2 consumption (L): _____
- EPOC (L/min): _____

Predicted EE using Loftin et al. (2010) equation: _____
        Kcal = [mass(kg) x 0.789] – [gender (men=1, women=2) x 7.634] + 51.109

☐ Brief rest period for HR to return to w/in 10 bpm of standing $HR_{resting}$: _____

☐ Submaximal VO_2 test: Begin at 2 mph/2% → increase 1 mph/1% each min.
- Finish test when HR reaches _____ bpm
- Heart Rate Max calculation (220 – age): _____
- Time exercised: _____
- VO_2 achieved: _____
- % of HRR achieved: _____
- Final HR reached: _____

- Extrapolated VO2max: _____

☐ Schedule participant for Day 4.
      Date: _____
      Scheduled time: _____

TOTAL TIME FOR TESTING_____

<div align="center">NOTES</div>

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<u>Day 4 (Pre-intervention)</u>

Date: _____
Scheduled time: _____
Arrival time: _____
Weight: _____

Participant proceeds to Applied Physiology Lab for exercise prescription discussion.

☐ Inform participant of their baseline scores related to population norms.

☐ Discuss specific guidelines of exercise prescription.
      Group: _____

☐ Discuss how to report exercise.
- Show how to access Qualtrics.
- Show how to download and use Nike$^+$ Running app.

☐ Discuss when and how to report 3-day food recall (week 4, week 8, week 12).

☐ Schedule participant for Day 5 (during week 6).
      Date: _____
      Scheduled time: _____

<div align="center">NOTES</div>

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Day 5 (during week 6 of intervention)

Date: _____
Scheduled time: _____
Arrival time: _____
Weight: _____

Day 5 Inclusion/Exclusion Criteria

☐ Has participant abstained from MOD-int. exercise for at least 2 hours?

☐ Has participant abstained from VIG-int. exercise for at least 14 hours?

☐ Has participant fasted from caffeine for 4 hours?

☐ Has participant fasted from nicotine for 2 hours?
   If so, proceed. If not, reschedule.
   Reschedule date/time (if necessary): _____

Preferred Pace determination
Walk speed evaluation (70 ft trials, timed over middle 50 ft):
   - Times: 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____
   - Preferred Walking Speed: _____

Following completion of PP determination, participant returns to Applied Physiology Lab:

☐ Participant stands for Standing Ambulatory Rest data (5 min)

☐ Brief warm-up (2 min at ½ preferred pace): _____

☐ Participant walk at preferred pace (5 min)
   - Based on PP, 1-mile would last for: _____
   - Correction factor from 5 min to mile time: _____
   - Total EE: _____

☐ Schedule participant for Day 6 (post-intervention).
   Inform participant of the following:
      -You need to be fasting from any food or alcohol for at least 8 hours
      -Abstaining from moderate-intensity exercise for at least 2 hours and vigorous-intensity
      exercise for at least 14 hours prior for Day 2.
      -Abstain from caffeine for at least 4 hours and nicotine for 2 hours.
   Date: _____
   Scheduled time: _____

NOTES
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Day 6 (Post-intervention)

Date: _____

Scheduled time: _____

Arrival time: _____

Weight: _____

Day 6 Inclusion/Exclusion Criteria

☐ Has participant fasted from food for 8 hours?

☐ Has participant fasted from alcohol for 8 hours?

☐ Has participant abstained from MOD-int. exercise for at least 2 hours?

☐ Has participant abstained from VIG-int. exercise for at least 14 hours?

☐ Has participant fasted from caffeine for 4 hours?

☐ Has participant fasted from nicotine for 2 hours?
    If so, proceed. If not, reschedule.
    Reschedule date/time (if necessary): _____

Age: _____

Height: _____
Weight: _____

Gender: _____

☐ If female,

        ☐ Pregnant? Rule out.

        ☐ Hysterectomy? Proceed.

        ☐ Perform pregnancy test. Provide directions.

                ☐ Positive? Rule out.

                ☐ Negative? Proceed.

Enter Body Composition Lab for DXA.

☐ Subject removes all metal objects from body.

☐ Perform DXA.

DXA Scan Body Fat %: _____
        FFM: _____
        FM: _____

Enter Blood Chemistry Lab for lipid panel using Cholestech LDX

DATA:

Total cholesterol: _____   LDL cholesterol: _____

HDL cholesterol: _____   Triglycerides: _____

Blood glucose: _____

Following completion of lipid panel, participant returns to Applied Physiology Lab:

☐ Have participant lie still on padded table quietly for 20 minutes.

☐ Following 20 minute rest period, place canopy and hood in place.

☐ First 5 min are to allow stabilization of participant (do not use data in analysis).

☐ Measure RMR using remaining 5 minutes.

    ☐ Is coefficient of variation less than 10%? If yes, proceed. If no, continue to collect until it is.

DATA:

Avg. VO_2 (over 5 min): _____   Avg. VCO_2 (over 5 min): _____

EE/min [using Weir (1949) equation]: _____
REE (kcal/min) = $3.9(VO_2) + 1.1(VCO_2)$

REE (kcal/day): _____
REE = kcal/min x 1440

Participant proceeds to Biomechanics Lab for Balance Assessment.

☐ Turn on Neurocom and allow system to initialize and zero force plate.

☐ Stand participant on force plate and line up medial malleolus on horizontal line, outer border of heel at appropriate height line.
    (S) Short 30 – 55" (76 – 140 cm)
    (M) Medium 56 – 65" (141 – 165 cm)
    (T) Tall 66 – 80" (166 – 203 cm)

☐ Enter participant data –   Birthdate: _____ Height: _____

☐ Place "QUIET" sign on door and close door.

☐ Complete Sensory Organization Test (SOT).

☐ Complete Motor Control Test (MCT).

☐ Schedule participant for Day 7.
    Inform participant of the following:
        -Abstaining from moderate-intensity exercise for at least 2 hours and vigorous-intensity
        exercise for at least 14 hours prior for Day 7.
        -Abstain from caffeine for at least 4 hours and nicotine for 2 hours.
    Date: _____
    Scheduled time: _____

TOTAL TIME FOR TESTING_____

NOTES
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Day 7 (Post-intervention)

Date: _____
Scheduled time: _____
Arrival time: _____
Weight: _____

Day 7 Inclusion/Exclusion Criteria

☐ Has participant abstained from MOD-int. exercise for at least 2 hours?

☐ Has participant abstained from VIG-int. exercise for at least 14 hours?

☐ Has participant fasted from caffeine for 4 hours?

☐ Has participant fasted from nicotine for 2 hours?
    If so, proceed. If not, reschedule.
    Reschedule date/time (if necessary): _____

Resting HR: _____

☐ Over 100 bpm? Rule out.

☐ Less than 100 bpm? Proceed.

Resting BP (1)_____ (2)_____

☐ Over 200/110 twice? Rule out.

☐ Within normal limits? Proceed.

60% HRR: _____

60% HRR = [(HR$_{max}$ – HR$_{rest}$) x 0.60] + HR$_{resting}$

Preferred Pace determination

Walk speed evaluation (70 ft trials, timed over middle 50 ft):

- Times: 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____
- Preferred Walking Speed: _____

Following completion of PP determination, participant proceeds to Applied Physiology Lab:

☐ Participant stands for Standing Ambulatory Rest data (5 min)

☐ Brief warm-up (3 min at ½ preferred pace): _____

☐ Participant walk at preferred pace (1 mile)
- Based on PP, this will last for: _____
- Total EE: _____

☐ Participant stands for EPOC data
- Time to complete: _____
- Total O$_2$ consumption (L): _____
- EPOC (L/min): _____

Predicted EE using Loftin et al. (2010) equation: _____

Kcal = [mass(kg) x 0.789] – [gender (men=1, women=2) x 7.634] + 51.109

☐ Brief rest period for HR to return to w/in 10 bpm of HR$_{resting}$

☐ Submaximal VO$_2$ test: Begin at 2 mph/2% → increase 1 mph/1% each min.
- Finish test when HR reaches _____ bpm
- Heart Rate Max calculation (220 – age): _____
- Time exercised: _____
- VO$_2$ achieved: _____
- % of HRR achieved: _____
- Final HR reached: _____
- Extrapolated VO2max: _____

☐ Schedule participant for Day 8.

Inform participant of the following:

-Abstaining from moderate-intensity exercise for at least 2 hours and vigorous-intensity exercise for at least 14 hours prior for Day 8.

-Abstain from caffeine for at least 4 hours and nicotine for 2 hours.

Date: _____

Scheduled time: _____

TOTAL TIME FOR TESTING_____

NOTES

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_____

Day 8 (Post-intervention)

Date: _____

Scheduled time: _____

Arrival time: _____

Weight: _____

Day 8 Inclusion/Exclusion Criteria

☐ Has participant abstained from MOD-int. exercise for at least 2 hours?

☐ Has participant abstained from VIG-int. exercise for at least 14 hours?

☐ Has participant fasted from caffeine for 4 hours?

☐ Has participant fasted from nicotine for 2 hours?

If so, proceed. If not, reschedule.

Reschedule date/time (if necessary): _____

Resting HR: _____

☐ Over 100 bpm? Rule out.

☐ Less than 100 bpm? Proceed.

Resting BP (1)_____   (2)_____

☐ Over 200/110 twice? Rule out.

☐ Within normal limits? Proceed.

Preferred RUN Pace determination

Run speed evaluation (Time to complete a "leisurely jog" around a 200 meter track):

- Times: 1. _____   2. _____

- Preferred Running Speed: _____

Following completion of PP determination, participant proceeds to Applied Physiology Lab:

☐ Participant stands for Standing Ambulatory Rest data (5 min)

☐ Brief warm-up (3 min at ½ preferred pace): _____

☐ Participant run at preferred pace (5 min)
- Based on PP, this would last for: _____
- Average VO_2 over 5-min run: _____
- Total EE: _____

☐ Participant stands for EPOC data (5 min) –
➢ Return to within 4.5 mL/kg/min **OR** 1.5 METs
- Time to recover: _____
- Total O_2 consumption (L): _____
- EPOC (L/min): _____

Predicted EE using Loftin et al. (2010) equation: _____
Kcal = [mass(kg) x 0.789] – [gender (men=1, women=2) x 7.634] + 51.109

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EDUCATION_____

Doctor of Philosophy   **The University of Mississippi**, University, MS
                                     Dept. of Health, Exercise Science, & Recreation Mgt
                                     Major Area: Health & Kinesiology
                                     Primary Emphasis: Exercise Physiology
                                     Secondary Emphasis: Biomechanics
                                     August 2014

                     Dissertation: Comparing Distance-based vs. Time-based Exercise
                                     Prescription of Walking and Running for Improvement of
                                     Cardiovascular Disease Risk Factors

Master of Science   **The University of Mississippi**, University, MS
                                     Dept. of Health, Exercise Science, & Recreation Mgt
                                     Major Area: Exercise Science
                                     Emphasis: Exercise Physiology
                                     December 2011

                          Thesis: Cross-validation of a Recently Published Equation Predicting
                                     Energy Expenditure to Run or Walk a Mile in Normal Weight
                                     and Overweight Adults

Bachelor of Science   **Lipscomb University**, Nashville, TN
                                          Dept. of Kinesiology
                                          Major Area: Exercise Science
                                          Minor Area: Biology
                                          December 2008

RELEVANT WORK EXPERIENCE

August 2009 – Present   **Graduate Research Assistant**
        Kevser Ermin Applied Physiology Laboratory
        Department of Health, Exercise Science, & Recreation Management
        The University of Mississippi

- Research Design & Implementation
- Data Collection & Analysis

August 2009 – Present   **Graduate Teaching Assistant**
        Department of Health, Exercise Science, & Recreation Management
        The University of Mississippi

- Instructor of record for the following courses:
    - ES 456, Exercise Testing & Prescription
    - ES 457, Exercise Testing & Prescription Lab
    - ES 402, Exercise Leadership
    - ES 396, Allied Health Terminology
    - ES 348, Physiology of Exercise
    - ES 349, Physiology of Exercise Lab
    - HP 203, First Aid & CPR
    - HP 191, Personal & Community Health
    - EL 151, Weight Lifting
    - EL 124, Racquetball

June 2010 – July 2011   **Cardiology Graduate Assistant**
        Cardiac Rehabilitation Graduate Assistant
        Baptist Memorial Hospital, North Mississippi

- Worked in Phase I & II Cardiac Rehab facility
- Group and Individual Exercise Prescription
- Health/Fitness Evaluation & Assessment
- Community Health Fairs and Screenings

May 2008 – July 2009   **Onsite Screening Specialist**
          Lifesigns, Inc.
          Nashville, TN

- Health Screenings & Evaluations
- Community Health Fairs

August 2008 – June 2009   **Intramural Coordinator**
          Student Recreation Center
          Lipscomb University, Nashville, TN

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TEACHING EXPERIENCE

August 2009 – Present

- UM ~ ES 456 – Exercise Testing & Prescription (Summer 2013)
- UM ~ ES 457 – Exercise Testing & Prescription Laboratory (Summer 2012, Fall 2012, Spring 2013, Summer 2013)
- UM ~ ES 402 – Exercise Leadership (Winter Intersession 2014)
- UM ~ ES 396 – Allied Health Terminology (Spring 2014)
- UM ~ ES 348 – Physiology of Exercise (Fall 2013, Spring 2014)
- UM ~ ES 349 – Physiology of Exercise Laboratory (Spring 2012, Fall 2013)
- UM ~ HP 203 – First Aid & CPR (Spring 2013)
- UM ~ HP 191 – Personal & Community Health (Summer 2012, Summer 2014)
- UM ~ EL 151 – Weight Lifting (Fall 2009, Spring 2010, Fall 2011)
- UM ~ EL 124 – Racquetball (Fall 2009, Spring 2010, Fall 2011)

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RESEARCH EXPERIENCE

January 2010 – Present

The University of Mississippi Kevser Ermin Applied Physiology Laboratory

- *Cross-validation of a Recently Published Equation Predicting Energy Expenditure to Run or Walk a Mile in Normal Weight and Overweight Adults,* **PI**
- *Impact of Alternative Footwear on Human Energy Expenditure,* **PI**
- *Comparing Distance-based vs. Time-based Exercise Prescription of Walking and Running for Improvement of Cardiovascular Disease Risk Factors,* **PI**

September 2013 – Present

The University of Mississippi Applied Biomechanics Laboratory

- *Impact of Alternative Footwear on Human Balance*
- *Evaluating Human Balance Following an Exercise-induced Weight Loss Intervention, PI*

August 2013 – Present

The University of Mississippi – Dept. of Health, Exercise Science, & Recreation Mgt.

- Student advisor to undergraduate Honor's Thesis students from Sally McDonnell Barksdale Honor's College
- Student advisor to undergraduate majors.

PEER-REVIEWED JOURNAL ARTICLES

1. **Morris, C.E.**, Owens, S., Waddell, D., Bass, M., Bentley, J. & Loftin, M. <u>Cross-validation of a Recently Published Equation Predicting Energy Expenditure to Run or Walk a Mile in Normal Weight and Overweight Adults.</u> Measurement in Physical Education and Exercise Science. 18(1): 1-12, 2014.
2. **Morris, C.E.**, Chander, H., Wilson, S., Loftin, M., & Garner, J.C. <u>Impact of Alternative Footwear on Human Energy Expenditure</u>. (Manuscript in Preparation).
3. Chander, H., **Morris, C.E.**, Wilson, S., Loftin, M., & Garner, J.C. <u>Impact of Alternative Footwear on Human Balance</u>. (Manuscript in Preparation).
4. **Morris, C.E.**, Loftin, M., Owens, S.G., Valliant, M., & Garner, J.C. <u>Comparing a Distance vs. Time-based Walking and Running Intervention for Improvement of Cardiovascular Disease Risk Factors</u>. (Manuscript in Preparation).
5. **Morris, C.E.**, Loftin, M., Owens, S.G., Valliant, M., & Garner, J.C. <u>Evaluation of the Accuracy of a Previously Published Equation to Predict Energy Expenditure Per Unit Distance Following Weight Loss</u>. (Manuscript in Preparation).
6. **Morris, C.E.**, Garner, J.C., Chander, H., Owens, S.G., Valliant, M., & Loftin, M. <u>Evaluating Human Balance Following an Exercise-induced Weight Loss Intervention</u>. (Manuscript in Preparation).

ABSTRACTS

1. **Morris, C.**, Loftin, M., Owens, S. Waddell, D., Bass, M., & Bentley, J. <u>Cross-validation of a Recently Published Equation Predicting Energy Expenditure to Run or Walk a Mile in Normal Weight and Overweight Adults.</u> ACSM Annual Meeting, Indianapolis, IN, May 28– June 1, 2013. Medicine and Science in Sports and Exercise, 45(5):S, 2013.
2. **Morris, C.**, Loftin, M. Owens, S. Waddell, D. & Bass, M. <u>The Effect of Excess Body Mass on Excess Post-Exercise Oxygen Consumption at Preferred Walking Pace.</u> SEACSM Regional Meeting, Greenville, SC, February 14 – 16, 2013.

3. **Morris, C.**, Loftin, M., Owens, S. Waddell, D., Bass, M., & Bentley, J. <u>Cross-validation of a Recently Published Equation Predicting Energy Expenditure to Run or Walk a Mile in Normal Weight and Overweight Adults.</u> SEACSM Regional Meeting, Jacksonville, FL, February 9 – 11, 2013.

RESEARCH FUNDING

1. **Morris, C.E.**, Chander, H., Wilson, S., Loftin, M., & Garner, J.C.
   Impact of Alternative Footwear on Human Energy Expenditure and Balance
   Internal Grant at UM: Graduate Student Council
   Role: Primary Investigator
   Funding Request: $1,000
   Status: Approved, 2013

2. Recipient of UM Summer Thesis and Dissertation Scholarship – Summer 2011
3. Recipient of UM Graduate School's Summer Research Assistantship Scholarship – Summer 2014

RELEVANT GRADUATE COURSEWORK

<u>The University of Mississippi</u>

- ES 632 – Advanced Structural Kinesiology
- ES 618 – Advanced Muscle Physiology
- ES 616 – Exercise Physiology II
- ES 615 – Physiological Aspects of Aging
- ES 614 – Cardiovascular Physiology
- ES 613 – Health Aspects of Physical Activity
- ES 611 – Exercise Physiology I
- ES 612 – Instrumentation and Analysis in Biomechanics
- ES 609 – Motor Behavior
- ES 608 – Methods and Procedures of Graded Exercise Testing
- ES 548 – Biomechanics of Injury
- ES 620 – Selected Topics in Exercise Science (Writing for Publication)
- ES 625 – Research Design and Evaluation
- ES 651 – Advanced Individual Study
- ES 697 – Thesis
- ESPR 797 – Dissertation
- BISC 529 – Endocrinology
- HP 646 – Introduction to Epidemiology

- NHM 619 – Sports Nutrition
- NHM 612 – Nutrition & Exercise in Health & Disease Management
- PHAD 681 – Applied Multivariate Analysis
- PHAD 680 – General Linear Models
- EDRS 701 – Educational Statistics II
- EDRS 501 – Educational Statistics I

MEMBERSHIPS

- Southeast chapter of American College of Sports Medicine (SEACSM), 2011 – Present
- American College of Sports Medicine (ACSM), 2012 – Present

CERTIFICATIONS

- Lay Responder: CPR/AED/First Aid Certification, 2010 – 2012

HONORS/AWARDS

- UM, HESRM J. Robert Blackburn Graduate Student of the Year Award – 2013
- Atlantic Sun Athletic Conference, Academic All-Conference – Varsity Baseball 2005, 2006
- Lipscomb Merit Award Scholarship – 2005, 2006, 2007, 2008
- Lipscomb's Who's Who – 2008

PROFESSIONAL SERVICE

- UM, College of Applied Sciences, appointed to serve on search committee to fill position of Associate Dean, Summer 2013
- UM, HERSM Area 4 Special Olympics Student Volunteer Coordinator, 2011 – 2012

REFERENCES

Mark Loftin, Ph.D., FACSM
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Former Department Chair
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