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THE EFFECTS OF THREE 10 MINUTE BOUTS COMPARED TO A SINGLE CONTINUOUS BOUT OF MODERATE INTENSITY AEROBIC EXERCISE ON BLOOD GLUCOSE LEVELS IN PARTICIPANTS WITH METABOLIC SYNDROME

A Thesis

Submitted to the School of Graduate Studies and Research

in Partial Fulfillment of the

Requirements for the Degree

Master of Science

Bradley Jack Polen

Indiana University of Pennsylvania

December 2016

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Title: The Effects of Three 10 Minute Bouts Compared to a Single Continuous Bout of Moderate Intensity Aerobic Exercise on Blood Glucose Levels in Participants with Metabolic Syndrome

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Metabolic syndrome is a cluster of elevated cardiometabolic risk factors that may increase the risk of developing non-insulin dependent diabetes (Stone et al., 2013). The American College of Sports Medicine recommends 30 minutes of continuous moderate-vigorous intensity aerobic exercise can significantly reduce risk factors associated with metabolic syndrome. However, no published research investigates blood glucose responses after three 10 minute bouts of moderate-vigorous intensity aerobic exercise in this population. Ten participants (6 women) between the age of 18 and 45 years old, with metabolic syndrome volunteered for this study with elevated fasting blood glucose levels (113.0±45.7 mg/dL). The sample was exposed to both conditions and blood glucose levels were recorded throughout exercise and rest. Results indicated either three 10 minute bouts or one continuous bout of exercise will significantly reduce blood glucose levels (p=0.00) and there were no significant differences between the conditions (p>0.05).

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CHAPTER I

INTRODUCTION

The American College of Cardiology (ACC) and American Heart Association (AHA) Adult Treatment Panel (ATP IV) define metabolic syndrome as the presence of three or more cardiometabolic risk factors which include abdominal obesity, pre-hypertension, pre-hyperglycemia, and dyslipidemia (Stone et al., 2013). Approximately 35% of the United States population has been diagnosed with metabolic syndrome (Aguilar et al., 2015). The presence of metabolic syndrome increases the risk of cardiovascular events by approximately two fold and five fold increases the likelihood of developing non-insulin dependent diabetes (NIDD) (Churilla et al., 2008).

Previous research suggest that obesity (Martin et al., 2016) and a significant amount of time spent sedentary (Honda et al., 2016) (Rockette-Wagner et al., 2015) may accelerate the development of metabolic syndrome. The American College of Sports Medicine (ACSM) recommends treating individuals with metabolic syndrome by incorporating a minimum 30 minutes of moderate intensity physical activity, 5 days a week, for 3 consecutive months. This may reduce cardiometabolic risk factors associated with metabolic syndrome (Chen et al., 2005).

Furthermore, the ACSM suggests that a minimum of 30 minutes of moderate intensity physical activity can be met by either one continuous bout or three 10 minute bouts of aerobic exercise (ACSM GETP 2014). However, limited research is currently available investigating three 10 minute bouts compared to one continuous bout of aerobic exercise in metabolic syndrome participants. More research is needed to determine the

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effects of three 10 minute bouts of aerobic exercise on cardiometabolic risk factors associated with metabolic syndrome.

Problem Statement

Investigate the use of three 10 minute bouts of exercise compared to one continuous bout of aerobic exercise and examine the effect of these differing approaches on blood glucose levels in persons with metabolic syndrome.

Research Questions

1. Will there be a significant difference in blood glucose levels 2 hours post exercise between three 10 minute bouts versus one continuous bout in persons with metabolic syndrome?
2. Will three 10 minute bouts of aerobic exercise affect or lower blood glucose levels when compared to one continuous bout in persons with metabolic syndrome?
3. What are the cumulative effects of three 10 minute bouts of aerobic exercise on blood glucose levels compared to one continuous bout in the persons with metabolic syndrome?

Hypotheses

1. Three 10 minute bouts of aerobic exercise will significantly reduce blood glucose levels when compared to one continuous bout 2 hours post exercise in persons with metabolic syndrome.
2. Three 10 minute bouts of aerobic exercise will significantly reduce blood glucose levels when compared to one continuous bout in persons with metabolic syndrome.

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3. The cumulative effect from three 10 minutes bouts of aerobic exercise will significantly reduce blood glucose levels when compared to 30 minutes of continuous aerobic exercise in persons with metabolic syndrome.

Definition of Terms

1. **Acute Exercise** – One session of moderate-vigorous intensity aerobic exercise.
2. **Chronic Exercise** – Multiple sessions of moderate-vigorous intensity aerobic exercise performed ≥12 weeks.
3. **ACC/AHA ATP IV** – American College of Cardiology / American Heart Association Adult Treatment Panel Fourth Report
4. **ACSM GETP 2014** – American College of Sports Medicine Guidelines for Exercise Testing and Prescription 9th edition.
5. **Aerobic Exercise** – repetitive rhythmic contraction of large muscle groups promoting cardio respiratory fitness such as walking or jogging (Bacchi et al. 2013).
6. **Blood Glucose** – monosaccharide that is the end product of carbohydrate catabolism utilized by the human body to provide energy (Lebovitz, 1999).
7. **One Continuous Bout** – single 30 minute bout of moderate-vigorous intensity aerobic exercise.
8. **Three 10 Minute Bouts** – 10 minute bouts used to accumulate 30 minutes of moderate-vigorous intensity aerobic exercise.

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9. **<u>Exercise</u>** – a subcategory of physical activity that is planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness (Caspersen et al., 1985).
10. **<u>Glucometer</u>** – portable hand-held device intended for self-testing blood glucose levels from capillary whole blood samples (TRUE METRIX™).
11. **<u>Metabolic Syndrome</u>** – presence of three or more cardiometabolic risk factors that include dyslipidemia, pre-hypertension, pre-diabetes, and abdominal obesity that increase the risk of developing NIDD (Stone et al., 2013).
12. **<u>Physical Activity</u>** – any bodily movement produced by skeletal muscles that result in energy expenditure (Caspersen et al., 1985).
13. **<u>Non-Insulin Dependent Diabetes (NIDD)</u>** – medical condition in which the pancreas produces sufficient amount of insulin to prevent ketoacidosis but not enough to meet the total needs of the body (American Diabetes Association., 2011).

Assumptions

1. All participants completed both the three 10 minute bouts and one continuous bout of aerobic exercise to the best of their ability.
2. Blood glucose monitoring devices were calibrated and reading accurate measurements.
3. Participants completed submaximal exercise test to the best of their ability.
4. Participant ingested Glucerna shake 2 hours prior to exercise.

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5. Participants did not consume any source of caffeine such as soda, energy drinks, or coffee while fasting for 8 hours prior to exercise.
6. Participants were honest when answering questions regarding their physical activity levels and metabolic screening questionnaire.

Limitations

1. Recruitment of participants were limited to Indiana County, PA.
2. High-density lipoprotein and triglycerides were not measured during this study.
3. Majority of data collection was conducted on the weekends.
4. Sample size may be too small to see significant differences.
5. Financial compensation was not provided for our participants.
6. Abnormal distribution of blood glucose was detected within the entire cohort

Significance

Low levels of physical activity are related to most components of metabolic syndrome (Paffenbarger et al., 1983) (Siscovick et al., 1985) (Rockette-Wagner et al., 2015). Regular physical activity provides substantial health benefits to individuals' with metabolic syndrome. Previous research suggests a one continuous bout of aerobic exercise may reduce blood glucose levels (Baynard et al., 2005). However, to our knowledge, there are no published studies investigating the effects of three 10 minute bouts of aerobic exercise on cardiometabolic risk factors in individuals with metabolic syndrome. Results from this research may provide practitioners with a more effective and practical way to prescribe exercise for their patients by reducing time spent sedentary which catalyzes metabolic syndrome and NIDD (Rockette-Wagner et al., 2015). Therefore, the purpose of study is to investigate the use of three 10 minute bouts of

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aerobic exercise compared to one continuous bout and their effects on blood glucose levels in persons with metabolic syndrome.

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CHAPTER II

REVIEW OF LITERATURE

NIDD affects 23.7 million people, in the United States, and the incidence of NIDD has been estimated to increase by 20% (29.6 million) before the year 2030. (Whiting et al., 2011). In order to prevent the incidence of NIDD, the risk factors associated to metabolic syndrome must be reduced. Epidemiological studies have demonstrated that participating in physical activity and exercise is an effective strategy for the treatment of metabolic syndrome and as a preventative measure for NIDD (Castaneda 2003) (Diabetes Prevention Program Research Group 2002). The following chapter will provide a brief review of the literature regarding the role and practice of physical activity and exercise as a treatment for metabolic syndrome.

Metabolic Syndrome

Metabolic syndrome also known as syndrome X, insulin resistance syndrome, deadly quartet or plurimetabolic syndrome is classified by the group of cardiometabolic risk factors such as arterial hypertension, insulin resistance, hyperinsulinemia, glucose intolerance, central obesity, and dyslipidemia (Ciolac et al., 2004). A consensus on the definition of metabolic syndrome has been controversial, each supported or argued by different health organizations. However, the ACSM endorses the criteria set by the ACC/AHA ATP IV.

To be diagnosed with metabolic syndrome, the participant must meet three out of five criteria established by the ACC/AHA ATP IV which includes a high waist circumference (WC) (>102 cm in men or > 88cm in women), elevated fasting blood glucose levels (BG) (≥100 mg/dL), low levels of high density lipoprotein (HDL) (<40

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mg/dL in men or <50 mg/dL in women), elevated triglyceride levels (TG) (≥150 mg/dL), and elevated blood pressure (≥130 systolic (SBP) and / or ≥85 diastolic (DBP) mmHg).

Metabolic syndrome is a global pandemic that may increase the incidence NIDD. Surveillance data suggests that close to one billion people worldwide have metabolic syndrome (Eckel et al. 2008). However, global estimates of metabolic syndrome vary considerably, depending on the population studied, diagnostic criteria, and study design used. The National Health Expenditure Projections from the Centers of Medicare and Medicaid Services expect health care cost to increase by 19.9% with an average spending of $621 billion dollars by 2022 (Center of Medicare and Medicaid Services 2012). Health care cost are significantly reduced for adults who participated in regular physical activity or structured exercise (Nicholl et al,. 1994). Participants that incorporate regular physical activity or exercise have the potential to save a significant amount of money by preventing the incidence of NIDD.

Definition and Guidelines of Physical Activity and Exercise

Many individuals use physical activity and exercise, interchangeably. However, physical activity and exercise are not synonyms. Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure (Caspersen et al., 1985). Physical activity is an umbrella term for all activities of daily living. Many of the epidemiological studies measure the effect of physical activity on participants with metabolic syndrome.

Exercise is a subcategory of physical activity consisting of planned, structured, and repetitive bodily movement done to improve and / or maintain one or more components of physical fitness (Caspersen et al., 1985). Many of the scientific studies

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measure the effect of exercise on participants with metabolic syndrome. The ACSM recommends that a minimum of ≥150 minutes per week (min/wk) of moderate intensity; ≥75 min/wk of vigorous intensity; or a combination of the two exercise intensities for three consecutive months may significantly reduce cardiometabolic risk factors associated with metabolic syndrome (ACSM GETP 2014). However, only 1 in 5 United States adults (20%) participate in 30 minutes of moderate intensity physical activity for 5 days a week (U.S. Department of Health and Human Services 2014).

Epidemiological Studies and Metabolic Syndrome

As a result of only 20% of the United States population meeting the ACSM guidelines, the prevalence of metabolic syndrome has increased by 3% since the year 2000 (Falkner et al., 2014). A recent cross-sectional analysis of the 2003-2012 National Health and Nutrition Examination Study (NHANES), which examines the association of leisure time physical activity and metabolic syndrome, as defined by the ACC/AHA ATP IV, suggest that 35% of adults <60 years old and 50% of adults' ≥60 years old, in the United States, were estimated to have metabolic syndrome (Aguilar et al., 2015). Several studies have investigated the influence of proper diet, exercise, and medication on the incidence NIDD (Churilla et al., 2008). The Diabetes Prevention Program (DPP) was one of the first studies to compare and contrast different modalities used to treat metabolic syndrome and prevent NIDD.

The Diabetes Prevention Program Research Group (2002) conducted a 6 year nationwide study investigating lifestyle intervention programs on participants with elevated cardiometabolic risk factors associated with the development of NIDD. Researchers recruited 3,234 nondiabetic participants (68% women) (≥25 years old) who

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were overweight (≥24 kg/m²) and sedentary with elevated glucose levels (95-125 mg/dL). Participants were randomized into either a lifestyle intervention group, metformin, or placebo group. The lifestyle intervention group were to participate in ≥150 minutes a week of moderate physical activity such as brisk walking and received dietary advice. The metformin group received an initial dose of 850 milligrams (mg) twice daily with standard lifestyle recommendations from a physician. The placebo group received an initial dose of 850 mg twice daily of a placebo pill with standard lifestyle recommendations from a physician.

Results, from the Diabetes Prevention Program Research Group (2002), indicated that the lifestyle intervention group when compared to the placebo group, significantly decreased the incidence of NIDD (58%) ($p \leq 0.05$), as did the metformin group (31%) ($p \leq 0.05$) when compared to the placebo. The study provided valuable data suggesting that lifestyle intervention, which incorporated exercise and proper diet, can reduce the incidence of NIDD more effectively than metformin, alone. The Diabetes Prevention Program Research Group (2002) did not examine whether the intervention reduced the time spent sedentary, but more recent data suggest that a significant amount of time spent sedentary may increase the prevalence of metabolic syndrome.

To confirm this hypothesis, Rockette-Wagner et al., (2015) conducted a study examining the participants from the original Diabetes Prevention Program Research Group (2002) study regarding whether the lifestyle intervention changed the amount of time spent being sedentary and the impact of the sedentary time on the incidence of diabetes. Over 3,200 participants (≥25 years old) from the DPP study received an interviewer administered modifiable activity questionnaire (MAQ) which collected

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moderate to vigorous leisure and occupational physical activity. Results demonstrated the lifestyle intervention was successful at increasing leisure time and occupational physical activity when compared to the metformin and placebo participants ($p \leq 0.05$).

Based off the findings from Rockette-Wagner et al., (2015), researchers suggest that individuals who participate in physical activity intervention programs will increase their leisure time and occupational physical activity levels after the program has concluded. However, the DPP's intensive methodology is not easily replicated into the low socioeconomic community setting (Diabetes Prevention Program Research Group 2002) where low levels of physical activity are most prevalent, in the United States (U.S. Department of Health and Human Services 2014).

Seidel et al., (2008) conducted a study to investigate medically underserved urban neighborhoods to determine if cardiometabolic risk factors associated with metabolic syndrome could be reduced with the modified lifestyle intervention in the original DPP. Researchers recruited 50 participants (age 54.0±10.5 years) (84.1% female) from 573 individuals screened for metabolic syndrome. The modified lifestyle intervention included 12 weekly sessions over 12-14 weeks which incorporated group exercise classes and dietary seminars that emphasized food choices, fat, and calorie intake while WC, HDL, SBP, DBP, TG, and BG were measured during baseline, month three, and month six throughout the study.

Results show a significant reduction in waist circumference and blood pressure after six months of the physical activity intervention. However, 61.2% of the participants had elevated BG after the physical activity intervention compared to only 42% at baseline ($p \leq 0.05$). Furthermore, there were no significant reductions or increased risk factors after

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3 months of the intervention. Based on the results, Seidel et al. (2008) suggest that participants with metabolic syndrome in areas of low socioeconomic status can decrease their risk for NIDD at low cost in low socioeconomic communities. Furthermore, Seidel et al. (2008) propose their modified intervention program provides additional external validity so their results may be more applicable to the population when compared to the Diabetes Prevention Program Research Group (2002) intervention program.

In conclusion, the Diabetes Prevention Program Research Group (2002), Rockette-Wagner et al. (2015), and Seidel et al. (2008) suggest that lifestyle interventions that incorporate ≥150 minutes of moderate, daily, physical activity and proper diet over the course of a short and long period of time can significantly reduce cardiometabolic risk factors associated with metabolic syndrome. Furthermore, the prevalence of metabolic syndrome may be correlated with the amount of time spent sedentary. Structured aerobic exercise that includes manipulating the frequency, intensity, time, and type of exercise performed may provide additional health benefits to metabolic syndrome participants.

Metabolic and Endocrinological Effects of Exercise

Epidemiological studies have demonstrated that increasing physical activity levels and decreasing time spent sedentary are essential in reducing cardiometabolic risk factors associated with metabolic syndrome. The benefits from structured aerobic exercise have been well documented. Many studies have presented significant reductions in BP (Carpio-Rivera et al., 2016), BG (Phillppe et al., 2016), TG (Bellou et al., 2013) and increased HDL (Gordon et al., 1994) after an acute bout of aerobic exercise noted in healthy populations.

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On the other hand, chronic adaptations such as increased exercise capacity (Taylor et al., 2016), maximal oxygen consumption (Deuk-Ja et al., 2016), stroke volume (Steding-Ehrenborg et al., 2013) and further increases in HDL (Durstine et al., 2001) have been presented. Additionally, chronic exercise was associated with reduced heart rate (Deuk-Ja et al., 2016), body weight (Swift et al., 2014) and further reductions in BG (Moghetti et al., 2016), BP (Deuk-Ja et al., 2016), and TG (Durstine et al., 2001) were detected in healthy populations.

Strong evidence exist suggesting structured aerobic exercise can significantly reduce risk factors associated with metabolic syndrome in the healthy populations. However, the positive effect of exercise participants with metabolic syndrome remains unclear (Mora-Rodriguez et al. 2014). Many research studies have been conducted to determine the effects of structured aerobic exercise on participants with metabolic syndrome to increase the body of knowledge to determine a consensus.

Long-Term Aerobic Exercise Studies

Aerobic exercise is a repetitive rhythmic contraction of large muscle groups promoting cardiorespiratory fitness (CRF) such as walking or jogging (Bacchi et al. 2013). The benefits of performing moderate-vigorous intensity aerobic exercise has been well documented. However, the exercise intensity that yields the maximal beneficial adaptations are unclear in persons with metabolic syndrome. According to the ACSM, vigorous aerobic exercise will provide additional benefits to healthy individuals when compared to moderate aerobic exercise. Tjonna et al., (2008) hypothesized there would be similar health benefits to individuals with metabolic syndrome that incorporated vigorous intensity into their exercise prescription.

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Tjonna et al., (2008) investigated the influence of different exercise intensities and their effect on cardiometabolic risk factors associated with the metabolic syndrome in 32 adults, mean age of 52.3 years old. Participants were randomized to either a control group or two separate exercise groups with equal volumes of either moderate continuous exercise at 70% heart rate reserve or aerobic interval training at 70% heart rate reserve progressing to 90% heart rate reserve 3 times a week for 16 week.

Results present significant reductions in WC (105.1±5.3 pre; 99.1±5.0 post; p=0.01) and SBP (131±6.0 pre; 121.0±5.0 post; p=0.05) in the moderate intensity group. However, these changes were similar in the interval group (WC; 105.5±4.1 pre; 100.5±3.6 post; p=0.05) (SBP; 144.0±5.0 mmHg pre; 135.0±5.0 mmHg post; p=0.05) while there was also a reduction in BG (6.9±0.6 mmol/L pre; 6.6±0.6 mmol/L post; p=0.05) and an increase in HDL (0.69±0.07 mmol/L pre; 0.84±0.10 mmol/L post; p=0.05). No significant reductions were observed in DBP or TG from either group (p>0.05). Results present that either moderate or interval aerobic training will significantly reduce cardiometabolic risk factors associated with the metabolic syndrome.

Interval training that incorporated different intensities throughout the showed beneficial changes in cardiometabolic risk factors such as decreasing blood glucose and increasing high density lipoprotein levels (Tjonna et al., 2008). Furthermore, along with exercising at a higher intensity, the ACSM recommends exercising for a longer duration will provide further reductions in cardiometabolic risk factors in healthy populations. Johnson et al (2007) suggest that the effects of varying duration and intensities of aerobic exercise will provide the same beneficial changes in metabolic syndrome participants.

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Johnson et al. (2007) investigated the use of various exercise training regimens on their effect of cardiometabolic risk factors associated to metabolic syndrome on 171 participants (80 women, 91 men) 40-65 years old who were overweight (≥25 kg/m²) and class one obese (≤35 kg/m²) who did not meet the ACSM physical activity guidelines that had metabolic syndrome, according to the ACC/AHA ATP IV criteria. Participants were randomly assigned to a 6 month control or one of three 8 month exercise training groups of low amount / moderate intensity (LAMI) equivalent to walking ~19 km/week, low amount / vigorous intensity (LAVI) equivalent to jogging ~ 19 km/week, or high amount / vigorous intensity (HAVI) equivalent to jogging ~32 km/week.

Results show a significant reduction in TG (Baseline 161.6±96.4 mg/dL; Mean Difference -36.2±75.8 mg/dL; p=0.001) in the LAMI group. There were no significant changes in any cardiometabolic risk factors with the LAVI group (p>0.05) and there were beneficial changes in all cardiometabolic risk factors ((WC; Baseline 95.3±9.8 cm; Mean Difference -2.6±3.3 cm; p=0.001), (SBP; Baseline 130.2±14.1 mmHg; Mean Difference -4.2±13.6 mmHg; p=0.001), (DBP; Baseline 85.7±7.5 mmHg; Mean Difference -4.0±8.5 mmHg; p=0.001) (TG; Baseline 151.0±84.6 mg/dL; Mean Difference -19.2±35.4 mg/dL; p=0.001)) except BG (p>0.05) from the HAVI group. Results show that the LAMI exercise prescription improved TG levels and no other risk factors. While HAVI improved all metabolic syndrome risk factors except BG. This research suggest an exercise dose response may play an effect of cardiometabolic risk factors associated with metabolic syndrome.

Based on the results from Johnson et al. (2007) and Tjonna et al. (2008) it’s still unclear if aerobic exercise progressively increasing and decreasing in intensities, would

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provide additional benefits based on the dose response of exercise and inverse relationship in metabolic syndrome participants. Sari-Sarraf et al. (2015) proposed that incorporating different stages of intensities with a high amount of exercise performed would show further reductions in cardiometabolic profiles in metabolic syndrome participants.

Sari-Sarraf et al. (2015) examined 22 males, 54±8 years old, with metabolic syndrome to evaluate the effect of combined continuous interval aerobic training, 3 times a week for 16 weeks. Participants were randomly placed into either the combined continuous interval aerobic training group or a control group. The participants in the training group exercised at 50% of their max heart rate for 5 minutes then progressed to 20 minutes of continuous exercise at 70% max heart rate. Followed by twelve (4x3) minute intervals at 90% max heart rate with a three minute active recovery at 70% max heart rate between intervals. Once the intervals were competed, a five minute cool down at 50% max heart rate was performed. Participants from both groups were asked to continue with their normal diet and physical activity patterns outside the study protocol.

Results indicate a significant reduction in DBP (Baseline 91.5±7.2 mmHg; week 8 85.5±7.5 mmHg; p=0.05), TG (Baseline 190.5±41.3 mg/dL; week 8 162.4±41.9 mg/dL; p=0.05), BG (Baseline 117.7±18.5 mg/dL; week 8 108.8±15.5 mg/dL; p=0.05), and WC (Baseline 112.6±9.4 cm; week 8 111.0±9.5 cm; p=0.05) during week 8 and further reductions in the same risk factors (DBP (Baseline 91.5±7.2 mmHg; week 16 79.5±8.7 mmHg; p=0.001)) (TG (Baseline 190.5±41.3 mg/dL; week 16 147.1±37.8 mg/dL; p=0.001)) (BG (Baseline 117.7±18.5 mg/dL; week 16 106.0±10.7 mg/dL; p=0.001)) (WC (Baseline 112.6±9.4 cm; week 16 109.2±8.8 cm; p=0.001)) after week 16 of the study.

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There were no significant changes in HDL or SBP from the exercise group and no significant changes in any risk factor from the control group ($p>0.05$). Results suggest that 16 weeks of combined continuous interval aerobic training regimens in men with the metabolic syndrome could significantly reduce cardiometabolic risk factors in metabolic syndrome participants, however, HDL and SBP were not lowered from their exercise protocol.

Although, Johnson et al. (2007) was able to see a significant reduction in all cardiometabolic risk factors while Tjonna et al. (2008) saw a reduction in all cardiometabolic risk factors except triglycerides. However, Sari-Sarraf et al., (2015) saw a significant reduction in all cardiometabolic risk factors except HDL. Results from Tjonna et al (2008), Johnson et al. (2007), and Sari-Sarraf et al. (2015) suggest the benefits of exercise are associated with the changes in metabolic syndrome. However, the ACC/AHA ATP IV and ACSM previously illustrated that sedentary lifestyle and obesity may increase the prevalence of metabolic syndrome. The changes associated from exercise, based on previous studies, did not explain whether the risk factors associated with metabolic syndrome are correlated with changes in aerobic fitness or body composition.

Stewart et al. (2005) investigated whether risk factors associated with the metabolic syndrome are meditated by changes in fitness or body composition in 104 participants (51 men 53 women) between 55-75 years old. Participants were randomly assigned to either an exercise or control group. The exercise group performed 60-90% of their heart rate reserve on either a treadmill, stationary bike, or stair stepper 3 days a week for 26 weeks. The control group did not receive any aspect of the intervention.

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Results demonstrate a significant increase in HDL (Baseline 56.8±5.4 mg/dL; Mean Difference +3.0±1.9 mg/dL; p=0.001) from the exercise group. In addition, no statistically significant differences were noted from the other risk factors in either exercise or the control group. Stewart et al. (2005) proposed that long-term aerobic exercise may not improve cardiometabolic risk factors in persons with the metabolic syndrome, however, Stewart stated that 17.7% of exercisers and 7.6% controls no longer had metabolic syndrome after the study.

Stewart et al., (2005) demonstrated that exercise may not be essential for treating participants with metabolic syndrome. However, the studies conducted by Tjonna et al. (2007), Johnson et al. (2008), and Sara-Sarraf et al. (2015) endorse exercise has an effect. In conclusion, research suggest continuous aerobic exercise training that last ≥8 weeks, in duration, and the intensity performed may significant reduce risk factors associated with metabolic syndrome. Future research is needed to determine the role of exercise on metabolic syndrome risk factors.

Short-Term Aerobic Exercise Studies

Additional benefits and further reduction of cardiometabolic risk factors are experienced for participants who exercise longer, more frequently, or at higher intensities in healthy populations. However, limited published research is available investigating the effects of short-term aerobic exercise on cardiometabolic risk factors associated with metabolic syndrome. Hoseini et al. (2014) investigated the effect of 8 weeks of aerobic exercise on metabolic syndrome related risk factors on 38 male participants, 22.7 (±3.3) years old. Participants were randomly assigned to either a control group or an exercise group. The exercise group performed 50 minutes of aerobic exercise at 60-80% heart rate

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reserve, 3 days a week, for 8 weeks. The control group were asked to continue their activities of daily living and did not receive any intervention.

Results present a significant reduction in HDL (Pre 49.7±8.7 mg/dL; Post 59.4±4.5 mg/dL; p=0.05), SBP (Pre 115.5±10.2 mmHg; Post 110.4±9.1 mmHg; p=0.05), DBP (Pre 74.8±6.1 mmHg; Post 68.7±4.9 mmHg; p=0.05), WC (Pre 82.3±5.2 cm; Post 76.3±6.4 cm; p=0.05), and TG (Pre 99.1±26.5 mg/dL; Post 52.4±8.5 mg/dL; p=0.05) while there were no significant changes in BG (p>0.05) and no significant changes in the control group. Results from Hoseini et al., (2014) propose that a minimal of two months of aerobic exercise is needed to see changes in cardiometabolic risk factors in participants with metabolic syndrome. However, according to the ACC/AHA ATP IV criteria their participants did not have metabolic syndrome based off of their baseline values while Hoseini et al. (2014) claimed the participants in this study had metabolic syndrome.

The literature examining the effects short term aerobic exercise on cardiometabolic risk factors associated with metabolic syndrome is limited. Most researchers' primary focus was weight reduction and it is unlikely to see a significant amount of body weight reduction after a short term of exercise. Although, previous research presented in this literature review recorded their short term outcomes this was not their main objective. No additional studies investigating these effects were found during this literature review.

Three 10 Minute Bouts of Aerobic Exercise

Long-term and short-term aerobic exercise may reduce cardiometabolic risk factors associated with metabolic syndrome. If continuous aerobic exercise is discontinued, over an extended period of time, the improvements gained in the

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cardiometabolic risk factors can deteriorate within a few days (Lin et al. 2015) (Churilla et al. 2008). However, adaptations after 8 weeks of aerobic exercise can be rapidly regained by one continuous bout of aerobic exercise in healthy populations (Burstein et al. 1985) (Heath et al. 1983). The literature investigating these physiological effects on participants with metabolic syndrome and NIDD are limited.

To our knowledge, there are no studies published investigating the effects of three 10 minute bouts of aerobic exercise on cardiometabolic risk factors associated with metabolic syndrome. However, there is one study published that compares three 10 minute bouts versus one continuous bout of aerobic exercise in the NIDD population. Participants with metabolic syndrome have a five-fold likelihood to develop NIDD (Churilla et al., 2008). The results from this study may help provide researchers a possible outcome.

Baynard et al., (2005) recruited 9 women (53.0±6 years old) with NIDD and 6 women (49.0±4.0 years old) in the healthy control group. Participants completed 3 randomly ordered oral glucose tolerance test (OGTT). The first OGTT was performed prior to the one continuous bout of aerobic exercise while the second OGTT was performed prior to the three 10 minute bouts of aerobic exercise. A third OGTT was used on the third day of the study with no exercise performed that day. Glucose and insulin were measured every 30 minutes for 4 hours during the OGTT.

Results indicated that the three 10 minute bouts (Mean Difference -14.3±3.2 mmol/L) did not significantly reduce blood glucose or insulin when compared to the continuous bout (Mean Difference -14.1±3.0 mmol/L) ($p>0.05$). The NIDD group did have a higher glucose response but an acute bout of either the continuous or three 10

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minute bouts did not alter glucose control the following day in either the NIDD or healthy control.

Literature Review Conclusion

In conclusion, based on epidemiological studies, the prevalence of metabolic syndrome is increasing at a significant rate. Participating in regular physical activity can significantly reduce the incidence of metabolic syndrome and sedentary behavior. The appropriate exercise intensity, duration, and frequency for participants with metabolic syndrome remains unclear. Research from Sari-Sarraf et al., (2015), Tjonna et al., (2008), and Johnson et al., (2007) suggest that exercise at different intensities, while Hoseini et al., (2014) suggest exercise at a constant intensity, are essential in the reduction of cardiometabolic risk factors associated with metabolic syndrome.

However, Stewart et al., (2005) suggests that exercise will help reduce cardiometabolic risk factors but it may not be essential. Baynard et al., (2005) concluded that three 10 minute bouts had no significant difference in NIDD women when compared to one continuous bout. With no known research published on three 10 minute bouts of aerobic exercise on cardiometabolic risk factors associated with metabolic syndrome more research is needed to determine a consensus.

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CHAPTER III

METHODS

Participants and Recruitment

Adult men and women between the ages of 18-45 years old living in Indiana County, PA were recruited for the study. In order to be eligible for participation in the study, participants were required to be sedentary in terms of not meeting the American College of Sports Medicine / Centers of Disease Control guidelines for physical activity. These include not exercising for either ≥150 minutes a week of moderate intensity; ≥75 minutes a week of vigorous intensity; or a combination of the two exercise intensities for 3 consecutive months.

In addition, participants must have been diagnosed with metabolic syndrome by their physician / healthcare provider or had to meet 3 out of 5 criteria established by the American College of Cardiology and American Heart Association Adult Treatment Panal (ACC/AHA ATP IV) for metabolic syndrome. These include a high WC (>102 cm in men or >88 cm in women), elevated fasting BG (≥100 mg/dL), low levels of HDL (<40 mg/dL in men or <50 mg/dL in women), elevated TG (≥150 mg/dL), and elevated BP (≥130 systolic (SBP) and / or ≥85 diastolic (DBP) mmHg) based on an interviewer administered metabolic screening questionnaire. A copy of the metabolic screening questionnaire is located in *"Appendix A."*

Inclusion / Exclusion Criteria

Inclusion criteria for the study required, participants to be free of diagnosis and / or signs and symptoms of cardiovascular, pulmonary, or metabolic diseases including peripheral / coronary artery disease, chronic obstructive pulmonary disease, asthma,

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chronic bronchitis, insulin dependent diabetes (IDD) and / or NIDD. Additionally, participants must not to have been hospitalized within the past 6 months for any cardiovascular, metabolic, or pulmonary event. Females who were pregnant and any individuals with any previous / current musculoskeletal injury inhibiting the ability to walk or requiring the use of an assistive device to walk for 30 minutes, continuously, were excluded. Furthermore, any individual using any hypoglycemic lowering medication, with an allergy to milk / soy, or lactose intolerant were also excluded.

In addition, a detailed medication log list was utilized to obtain information on medication that could potentially influence heart rate or blood pressure values at rest or during exercise. The medication log also ensured that participants were not taking any hypoglycemic lowering medication. A copy of the medication log is located in *"Appendix B."*

Recruitment

Participants in this study were volunteers and were recruited from Indiana County through the use of paper and email fliers, telephone screenings, and in-person advertising. Paper and email fliers were developed to provide information regarding the study design, required criteria, and potential benefits from this research. Paper fliers were distributed to several buildings on the Indiana University of Pennsylvania campus, YMCA of Indiana County, local community events, and many local businesses throughout Indiana County. The email flier was distributed to all faculty and staff members employed at Indiana University of Pennsylvania. Before being enrolled in the study, potential participants contacted the principal investigator, via email or phone to volunteer for this study. A copy of the paper and email recruitment flier is located in *"Appendix C."*

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Interested individuals contacted the principal investigator to discuss the study and expectations in further detail. A copy of the script is provided in *"Appendix D."* If the potential participant understood expectations and expressed interest in volunteering the principal investigator would obtain verbal consent to ask questions regarding the interested participants medical history and physical activity levels to determine eligibility.

Once interested individuals were deemed eligible for inclusion in the study, they were asked to read, thoroughly understand and sign the informed consent form. A copy of the consent form is located in *"Appendix E."* The informed consent provided participants with a description of the study parameters such as purpose, participant requirements, risk and benefits of participation, and withdrawal information. The informed consent reminded the participant that participation was voluntary and no compensation would be provided. Once the participant signed the consent form the participant began the submaximal exercise test in the Human Performance Laboratory in Zink Hall Room 111C on the campus of Indiana University of Pennsylvania.

Instrumentation

In this study, multiple measurement tools were used to evaluate variables including heart rate, blood pressure, blood glucose, weight, and ratings of perceived exertion (RPE). The following tools used in these assessments are located in the Human Performance Lab in Zink Hall.

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Waist Circumference

Waist circumference was obtained using an anthropometric measuring tape immediately above the iliac crest. (ACSM GETP., 2014). The measurement was recorded to the nearest centimeter measurement.

Blood Glucose

A TRUE METRIX PRO Glucotmeter® (Trividia Health, INC. Fort Launderdale, FL) was used to assess the concentration of glucose expressed by milligrams of glucose per deciliter (mg/dL) of capillary blood. This glucometer demonstrates a 1% error rate within ±15 mg/dL (Evaluation of Accuracy and User Performance of the TRUE METRIX™ 2014).

Blood Pressure

An aneroid sphygmomanometer was utilized to assess blood pressure. The sphygmomanometer was placed superior to the cubital fossa, inflated to 200 mmHg (millimeters of mercury) and slowly deflated.

Rating of Perceived Exertion (RPE)

Borg's Rating of Perceived Exertion (RPE) scale, a method of determining how an individual "perceives" their level of fatigue based on intensity, was used to determine perceived exertion during exercise testing. This scale was designed to correlate to heart rate ranging from 60 bpm to 200 bpm.

Heart Rate

Polar Heart Rate Monitors were used to measure heart rate during exercise and rest. Heart rate monitors were placed on the xiphoid process of the sternum and locked in place on the participants back.

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Body Weight

Body weight was measured using a Detecto 439 Eye Level Beam Physician Scale® (Global Industrial INC. Port Washington, NY). Measures were recorded to the nearest pound.

Safety Precautions

Exercise is safe and has many health benefits. The ACSM states that moderate intensity exercise related cardiovascular events are rare and estimated in 1 out of 15,000 individuals' experience (Riebe et al., 2015). The bout of exercise the participants performed during this study are similar activities of daily living (such as walking) the participants could do safely, comfortably and independently, on their own.

Although the risk for cardiovascular events are low, the principal investigator ensured our participants were in a safe environment. To ensure safety for the research participants, all equipment used throughout the study was calibrated, functioning properly, and participants only exercised at a moderate intensity. Participants exercised at a moderate intensity of 40->60% heart rate reserve (HRR) and / or and RPE >14. Participants did not exceed a HRR of ≥80% or an RPE ≥15. Furthermore, the principal investigator and research assistants were cardiopulmonary resuscitation (CPR) and automated external defibrillator (AED) certified.

The thesis committee chair was notified of the time and day of each session of data collection. In the event that advanced medical personnel was needed, the Zink Hall emergency action plan, was adopted and followed in order to ensure the most effective method for emergency medical services (EMS) to reach the participant as quickly as possible. A copy of the Zink Hall emergency action plan is listed in *"Appendix F."*

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Assessment and Measurement Procedures

In order to ensure quality control, all equipment and tools used for data collection were calibrated and functioning properly prior to any study procedure. Throughout the study, participants, first, came to the Human Performance Lab in Zink Hall and rest for 5 minutes. After resting for 5 minutes, participants resting heart rate (RestHR) and blood pressure were measured. Once resting values were obtained, maximum heart rate (MaxHR) were calculated using the Gellish Equation (Gellish et al., 2007) and HRR were calculated with the Karvonen Formula (Karvonen et al., 1957). Intensity calculations for the Karvonen Formula were 40%, 60%, and 80%. These percentages were converted to their decimal form to be inserted into the following equations.

$$\text{MaxHR} = 207 - [(0.7)(\text{age})]$$

$$40\%\ \text{HRR} = [(\text{MaxHR} - \text{RestHR})(0.4)] + \text{RestHR}$$

$$60\%\ \text{HRR} = [(\text{MaxHR} - \text{RestHR})(0.6)] + \text{RestHR}$$

$$80\%\ \text{HRR} = [(\text{MaxHR} - \text{RestHR})(0.8)] + \text{RestHR}$$

Once heart rate measurements were calculated, the participant completed a submaximal graded exercise test, as described in *"Appendix G."* The test was terminated once the participant request to stop, ≥80% HRR, or ≥15 RPE is achieved.

Submaximal Graded Exercise Test

All participants performed a submaximal graded exercise test used to measure physical fitness levels by recording their physiological responses during moderate intensity exercise that was commonly used in the Human Performance Laboratory on Indiana University of Pennsylvania campus. The design of the submaximal test is similar to the Modified Balke Graded Exercise Test (ACSM GETP 2014). The data collected

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from the submaximal test was used to individualize each participants exercise prescription for this study. Exercise test were conducted on a Track Master Treadmill (Trackmaster® Treadmills. Newton, KS.) with a constant speed of 3.0 miles per hour which simulated a "brisk walk" throughout the test. Per the submaximal graded exercise test similar to the Modified Balke protocol, treadmill grade increased every 3 minutes by 2.5% which simulated walking at a moderate pace uphill.

Heart rate (HR) and BP were measured prior and during exercise while RPE was only measured during exercise. Termination criteria for the submaximal graded exercise test were met if the participant requested to stop, heart rate reserve reached ≥80%, or RPE ≥15 was achieved, then the test was terminated. Once the participant completed the test or termination criteria were met, the participant walked at a speed of 2.0 miles per hour with no grade which simulated walking on a flat surface for 4 minutes. BP, HR, and RPE were measured every 2 minutes to ensure the participants' physiological responses were normal during the recovery phase of the test.

Three 10 Minute Bout of Aerobic Exercise Protocol

At least 24 hours after the submaximal test, but no longer than 48 hours, the participants returned to the Human Performance Lab in Zink Hall to complete the first exercise session (three 10 minute bouts). Per study protocol, participants were required to fast for a minimum of 8 hours prior to participating in the exercise protocol. In addition to the 8 hour fast, participants did not consume any source of caffeine which included coffee, soda, and / or energy drinks. Due to the need to fast prior to the exercise protocol, participants were provided an 8 fluid ounce Glucerna™ shake and were asked to

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consume this shake 2 hours prior to exercise to avoid hypoglycemia. A full nutritional outline of the Glucerna™ shake is located in *"Appendix H."*

Participants arrived in the morning between 8-10am to the laboratory and rested for 5 minutes. Participants were then asked to sit in a quiet room located within the laboratory. Resting BP, HR, and BG were assessed immediately following the 5 minute rest period. Next, participants exercised for three 10 minute bouts between 40-<60% HRR and / or 11-14 RPE. Each bout was separated by 30 minutes of rest while BP, BG, HR, and RPE were assessed immediately after each 10 minute bout of exercise.

Once all three bouts of exercise were completed, participants rested for 2 hours during which time HR, BP, and BG were obtained at minute 10, minute 20, minute 30 during the rest periods, and 2 hours post exercise. Treadmill parameters were adjusted if participants exceeded ≥80% HRR or ≥15 RPE to ensure participants would be exercising at a moderate intensity. A copy of the data collection sheet for the multiple bouts of aerobic exercise is listed in *"Appendix I."*

One Continuous Bout of Aerobic Exercise Protocol

At least 24 hours after the three 10 minute bouts of aerobic exercise session but no longer than 48 hours, participants returned to the Human Performance Laboratory in Zink Hall to complete the final exercise session (one continuous bout). Prior to exercise, participants fasted for a minimum of 8 hours and 2 hours prior, drank 8 fluid ounces of Glucerna™ shake to avoid hypoglycemia. During the fast, participant were instructed not consume any form of caffeine such as coffee, soda, and / or energy drinks. Similar to the three 10 minute bout exercise protocol, participants returned to the laboratory in the morning between 8-10am and rested for 5 minutes prior to exercise. Resting BP, HR, and

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BG were assessed immediately following the 5 minute rest period. Participant exercised for one continuous 30 minute bout at 40-<60% HRR and / or 11-14 RPE.

Throughout the one continuous bout, BP, BG, HR, and RPE were assessed during exercise at minute 10, 20, and 30. Once the continuous bout of exercise was completed the participants rested for 2 hours while HR, BP, and BG were obtained at minute 10, minute 20, minute 30, during the rest periods, and 2 hours post exercise. If participants exceeded ≥80% HRR or ≥15 RPE, during exercise, treadmill grade was adjusted accordingly to ensure participant were still exercising at a moderate intensity. A copy of the data collection sheet for the single continuous bout of aerobic exercise is listed in *"Appendix J."* After the single bout of exercise and once 2 hour post measurements were obtained, participant received a 355mL Gatorade® and 68 gram Clif Bar®. A copy of the nutritional values of Gatorade® and the Clif Bar® are located in *"Appendices K and L,"* respectfully.

Confidentiality

Throughout the duration of the study participant data was kept confidential between the participant and principal investigator. All data was stored in a locked filing cabinet in a location only accessible to the principal investigator and research assistants. Upon request of the participant, their confidential information would be shared with that individual.

Research Design & Statistical Analysis

The research design of this project is quasi-experimental in nature. This is an acceptable design, but with some loss of external validity due to lack of random sampling. Statistical analyses were performed using the IBM Statistical Package for the

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Social Scientist (SPSS) version 23.0 (IBM Corp, Armonk, NY). Descriptive statistics were used to describe demographic characteristics such as age, body composition, blood pressure, and heart rate for the entire cohort and stratified by gender. For all analyses, significance was set at alpha level of $p \leq 0.05$. All continuous data was assessed for normality.

Normality distributed data is reported as mean (standard deviation), non-normal variables as median (interquartile range). Depending on the characteristics of the variable and the hypothesis being tested, t-test, analysis of variance (ANOVA) were used. More specifically, paired sample t-test were used to assess differences between blood glucose levels before and after exposure to conditions. Furthermore, Analyses of Variance (ANOVA) examined changes in blood glucose levels between each exercise protocol and within the 30 minutes of exercise. Finally, in order to assess the cumulative effect of exercise a pairwise comparison was utilized to detect any significant differences between the baseline mean blood glucose value and the remaining blood glucose values recorded at different time periods throughout exercise.

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CHAPTER IV

RESULTS

Baseline Results

The following chapter will provide results of statistical analyses performed on data from the study for the entire cohort and stratified by subgroup, either by gender or exercise protocol for normality. Further analyses were conducted to detect statistically significant differences and test hypotheses.

Demographics

A total of 15 individuals were screened for this study, 10 individuals were enrolled and completed the entire protocol. From the 5 individuals that did not complete the protocol, 1 (20%) participant became pregnant, 3 (60%) participants were not present for their exercise session, and 1 (20%) participant requested to withdraw. From the 10 participants that completed the protocol, 3 (30%) of the participants were recruited from Indiana University of Pennsylvania, 5 (50%) of the participants were recruited from the YMCA of Indiana County, and 2 (20%) participants were recruited within the IUP community. In addition, all participants self-reported 3 out of 5 risk factors associated with metabolic syndrome. None of the participants self-reported their physician diagnosed them with metabolic syndrome. Furthermore, none of the participants were prescribed any medication that would influence their resting or exercising blood glucose values.

All participants were residents of Indiana County. During the recruitment phase, no specific gender or race was targeted. Despite this six women and one African American male were enrolled in the study. Overall, the mean age of the cohort was 30.1

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(±8.1) years old with a mean weight of 201.0 (±24.9) pounds and mean waist circumference of 109.0 (±7.9) centimeters. Baseline descriptive data of the entire cohort and between genders presented in Table 1.

Table 1

Descriptive Characteristics for the Cohort (n=10) and Stratified by Gender

	Total Cohort (*n*=10)	±SD	**p*	Males (*n*=4)	±SD	Females (*n*=6)	±SD	***p*
Self-Reported Risk Factors	*n*			*n*		*n*		
BG	8	---	---	3	---	5	---	---
SBP	7	---	---	3	---	4	---	---
DBP	7	---	---	3	---	4	---	---
WC	9	---	---	4	---	5	---	---
HDL	6	---	---	2	---	4	---	---
TG	1	---	---	0	---	1	---	---
Ethnicity								
African American	1	---	---	1	---	0	---	---
Caucasian	9	---	---	3	---	6	---	---
Variables								
Age (years)	30.1	8.3	0.20	25.0	5.4	33.5	8.5	0.12
Weight (lbs)	201.0	25.6	0.20	203.8	13.9	199.2	32.5	0.77
WC (cm)	109.0	8.1	0.20	111.3	2.5	107.4	10.4	0.52
BG (mg/dL)	113.0	45.7	0.02	115.5	18.4	111.3	59.6	0.90
SBP (mmHg)	129.0	7.4	0.07	130.0	9.7	128.3	6.4	0.72
DBP (mmHg)	82.6	8.1	0.04	79.0	9.3	85.0	6.9	0.27
HR (bpm)	81.6	13.7	0.20	75.5	15.2	85.7	12.4	0.28

**p* for Kolmogorov Smirnov test within the entire cohort for normality. ***p* for t-test for comparisons between genders.

A Kolmogorov-Smirnov test for normality was used to detect any underlying significant variations within the entire cohort. This test showed statistically significant effects within the cohort (alpha set at $p \leq 0.05$). The only variables that trended significant was blood glucose ($p=0.02$) and diastolic blood pressure ($p=0.04$). Based upon independent sample t-tests, no statistically significant differences were noted between

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genders ($p>0.05$). The cohort was further stratified by conditions (three 10 minute bouts vs. one continuous bout) as presented in Table 2.

Table 2

Descriptive Characteristics of Cohort (n=10) Stratified by Condition

	Three 10 Minute Bouts	±SD	One Continuous Bout	±SD	*p*
BG (mg/dL)	113.0	45.7	108.8	42.0	0.83
SBP (mmHg)	129.0	7.4	123.2	12.3	0.22
DBP (mmHg)	82.6	8.1	80.6	7.6	0.61
HR (bpm)	81.6	13.7	79.9	11.6	0.77

**p* for t-test for comparisons between conditions

Based upon independent sample t-test, no statistically significant differences were noted between the three 10 minute bouts or one continuous bout baseline characteristics ($p>0.05$). Due to the lack of significant differences between the genders and condition, both sub-cohorts were collapsed and treated as one cohort for all examinations. However, there exist an abnormal distribution in blood glucose values within the entire cohort.

Blood Glucose Responses Before and After Exercise

In order to test hypothesis #1, stating that three 10 minute bouts of aerobic exercise will significantly reduce blood glucose levels when compared to one continuous bout 2 hours post exercise in persons with metabolic syndrome. Blood glucose values after the 5 minute initial rest period prior to exercise and 2 hours post exercise protocol (three 10 minute bouts vs one continuous bout) are presented in table 3. In addition, paired sample correlations assessed the relationship between exercise and blood glucose reduction. Finally, a paired sample t-test was utilized to assess any significant difference on blood glucose levels before and after each exercise protocol concluded.

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Table 3

Descriptive Characteristics of Blood Glucose Values Before and After Exercise Protocols

Condition	Baseline	±SD	Rest2Hrs	±SD	R	*p	Mean Difference	±SD	**p
Three 10 Minute Bouts	113.0	45.7	85.3	24.9	0.82	0.00	-27.0	29.0	0.01
One Continuous Bout	108.8	42.0	96.3	34.1	0.96	0.00	-12.5	13.7	0.02

* Rest2Hrs=2 Hours Rest**p* for paired sample correlations between Baseline and 2 Hours Rest Blood Glucose Values. ***p* for paired sample t-test between Baseline and 2 Hours Rest Blood Glucose Values.

Paired sample correlations indicated a significant positive relationship between blood glucose reductions in both three 10 minute bouts (R=0.82; p<0.00) and one continuous bout (R=0.96; p<0.00) of aerobic exercise. Additionally, both three 10 minute bouts (p=0.01) and one continuous bout (p=0.02) significantly reduced blood glucose levels 2 hours post exercise when compared to baseline values.

Mixed Between-Within Analysis of Variance

In order to test hypothesis #2, stating three 10 minute bouts of aerobic exercise will significantly reduce blood glucose levels when compared to one continuous bout in persons with metabolic syndrome a mixed between-within analysis of variance (ANOVA) was conducted to analyze between the exercise conditions within the 30 total minutes of aerobic exercise. Results from the mixed between exercise conditions within 30 total minutes of aerobic exercise analysis of variance are presented in table 4.

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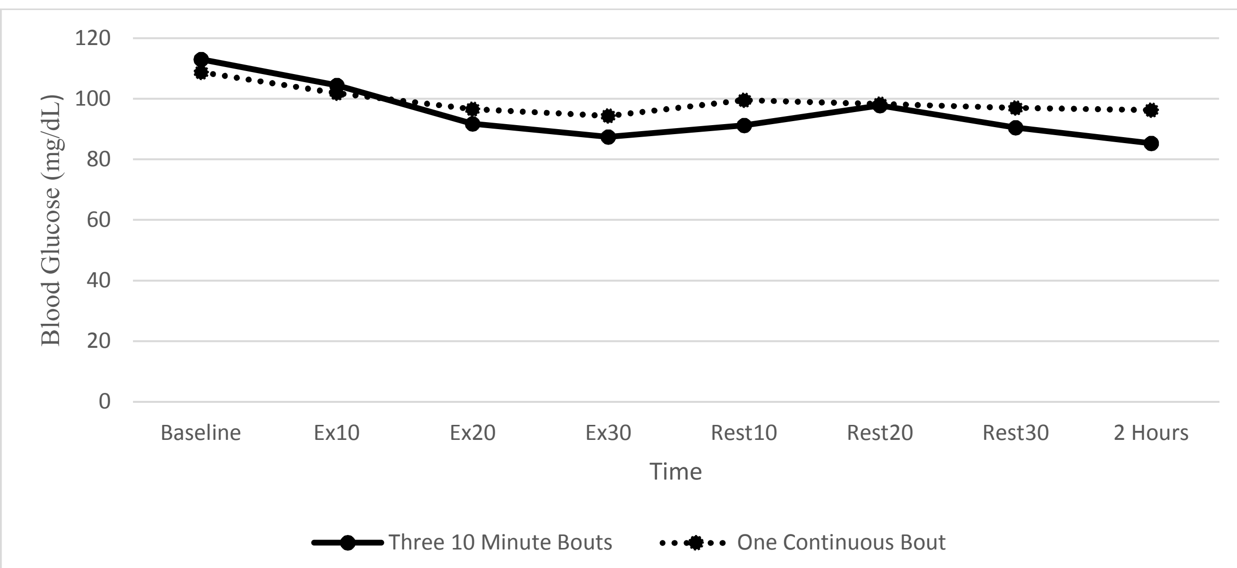
Table 4

Mixed Between Exercise Conditions Within 30 Total Minutes of Aerobic Exercise

Source	F	*p*
30 Total Minutes of Aerobic Exercise	4.77	<0.00
Exercise Conditions	1.29	0.29
30 Total Minutes of Aerobic Exercise versus Exercise Conditions	1.94	0.08

Results from the ANOVA indicated a significant impact on the effect of 30 minutes of aerobic exercise on the reductions of blood glucose levels (F=4.77; p<0.00). According to the ANOVA, the effect of 30 minutes of aerobic exercise was the only interaction that was statistically significant. The 30 minutes of aerobic exercise was either accumulated through three 10 minute bouts or one continuous bout of aerobic exercise. The effect of the 30 minutes of exercise from the two conditions are presented in Figure 1.

Figure 1. Mean blood glucose values throughout aerobic exercise protocols.



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Cumulative Effect of Aerobic Exercise

In testing hypothesis #3, stating the cumulative effect from three 10 minutes bouts of aerobic exercise will significantly reduce blood glucose levels when compared to 30 minutes of continuous aerobic exercise in persons with metabolic syndrome. Pairwise comparisons were utilized to detect the cumulative effect of both exercise protocols as shown in table 5.

Table 5

Pairwise Comparisons of Blood Glucose Values Throughout Both Exercise Protocols

Time	Mean Blood Glucose (mg/dL)	Mean Differences Compared to Baseline	*p*
Baseline	110.9	0.0	1.00
Ex10Mins	103.2	7.7	1.00
Ex20Mins	94.2	16.7	0.21
Ex30Mins	90.9	20.0	0.01
Rest10Mins	95.4	15.5	0.10
Rest20Mins	98.1	12.9	0.53
Rest30Mins	93.8	17.1	0.12
Rest2Hrs	90.8	20.1	0.28

Results from the pairwise comparisons indicated a significant difference between pre-exercise blood glucose and 30 minutes of exercise blood glucose levels (p=0.01). No statistically significant interactions between 30 minutes of aerobic exercise and exercise conditions ($F \leq 1.94$; $p \geq 0.08$). Finally, no statistically significant effects of the exercise conditions were detected (F=1.29; p=0.28).

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CHAPTER V

DISCUSSION AND CONCLUSION

The purpose of this study was to compare the acute effects between three 10 minute bouts or one continuous bout of moderate intensity aerobic exercise on blood glucose levels in persons with metabolic syndrome. Results from the current study indicate that both protocols significantly reduced blood glucose levels in this population. However, no statistically significant differing blood glucose values were detected when the three 10 minute bouts were compared to the one continuous bout of moderate intensity aerobic exercise.

Hypotheses

In testing hypothesis #1 that three 10 minute bouts of aerobic exercise will significantly reduce blood glucose levels when compared to one continuous bout 2 hours post exercise in persons with metabolic syndrome, the null hypothesis was accepted. Results from the paired sample t-test indicated both three 10 minute bouts and one continuous bout of aerobic exercise will significantly reduce blood glucose levels 2 hours post exercise. Additionally, paired sample correlations presented significant positive correlations between blood glucose reductions and 30 minutes of aerobic exercise in both exercise protocols. Results suggest that both three 10 minutes and one continuous bout of aerobic exercise will significantly reduce blood glucose levels 2 hours post exercise when compared to baseline.

In testing hypothesis #2 that three 10 minute bouts of aerobic exercise will significantly reduce blood glucose levels when compared to one continuous bout in persons with metabolic syndrome, the null hypothesis was accepted. Results from the

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mixed between-within analysis of variance indicated that the effect of 30 minutes of aerobic exercise significantly reduced blood glucose levels. However, there were no statistically significant differences whether the 30 minutes of aerobic exercise was performed in three 10 minute bouts or one continuous bout. Results suggest that performing either one continuous bout or thee 10 minute bouts of moderate intensity aerobic exercise will significantly reduce blood glucose levels.

In testing for hypothesis #3, that the cumulative effect from three 10 minutes bouts of aerobic exercise will significantly reduce blood glucose levels when compared to 30 minutes of continuous aerobic exercise in persons with metabolic syndrome, the null hypothesis was accepted. Results from the pairwise comparisons indicated a significant difference exist between baseline blood glucose and 30 minutes of exercise blood glucose levels. Results suggest that a minimum of 30 minutes of moderate intensity aerobic exercise will significant reduce blood glucose levels.

Limitations and Assumptions

There were many limitations that may have influenced the results. The power may have been too small to see significant differences between the three 10 minute bouts of exercise and one continuous bout of exercise. Researchers estimated a maximum of 20 participants were needed to detect statistically significant differences between the three 10 minute bouts of exercise and one continuous bout of exercise. Unfortunately, only 10 participants were able to complete the study. One possible explanation for this limitation was the time commitment. Each session of exercise lasted 4 hours in length and not many individuals were willing to spend a significant amount of time in the laboratory.

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Consequently, this low power may also be a possible explanation for the abnormal distribution of blood glucose levels. While analyzing the data, an outlier was noted. Their resting blood glucose values increased the baseline blood glucose mean of the entire cohort, significantly. However, researchers cannot determine whether this phenomenon is normal due to the low power. Another possible explanation for the low power may be due to the lack of financial compensation. Originally, researchers wanted to compensate their participants for extensive time commitment. However, no funds were generated to combat this limitation.

Additionally, a lack of financial compensation may have been a possible explanation for the higher participation rate in females when compared to males. Previous research suggest males are more likely to participant in research when financially compensated while females participate for the experience (Patrick et al., 1998). However, both males and female participants in this study self-reported their interest was due to the potential benefits the result may present and that money was not a major factor. To increase the number of participants, financial compensation may be an effective strategy.

Another limitation was that all of our participants self-reported their cardiometabolic risk factors and physical activity levels. Ideally, researchers would have preferred investigating a population with a metabolic syndrome diagnoses from their health care professional. Also, recording all risk factors associated with metabolic syndrome may have been appropriate. However, the technology used to examine HDL and TG was not present in the laboratory during data collection while BP and WC were assessed to describe baseline characteristics of the cohort.

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Additionally, when participants were self-reporting their physical activity, researchers used an original questionnaire that was commonly used in the laboratory to subjectively assess physical activity levels. This physical activity questionnaire was not a valid or certified method used by other institutions such as the global physical activity questionnaire used by the World Health Organization. This may have potentially excluded a few participants that self-reported physical activity levels that met or exceeded the ACSM guidelines.

Finally, most of data collection was conducted on the weekends. This limitation was initially a solution to accommodate our participants work schedules. However, 4 individuals that were excluded from the study self-reported exercise session on the weekends were not acceptable for them. Also, our participants self-reported that performing the exercise protocols on the weekends were not ideal with their schedules as well. As a result, this limitation may have influenced the low power.

Additionally, many assumptions were concluded to ensure our participants were safe throughout exercise and the results were valid. Researchers assumed participants were compliant with the protocols and procedures, such as completing the submaximal graded exercise test and both exercise protocols to the best of their abilities. To combat this assumption, researchers used objective methods to assess our participants HR and RPE throughout the study. Also, researchers assumed the participants were fasting and did not consume any source of caffeine such as coffee, energy drinks, or soda. This assumption was installed to remove any variable that may influence resting BG, HR, and BP. However, no strategy was utilized to combat this assumption.

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Furthermore, the participants were asked to drink a Glucerna™ shake 2 hours prior to exercise to prevent hypoglycemia during their session. Additionally, researchers assumed the equipment used throughout data collection was calibrated and providing accurate / consistent measurements. To overcome this assumption, researchers would calibrate and inspect all equipment before exercise to ensure all readings are most accurate according to the manufacturers' recommendations. Finally, it was assumed that all of our participants were honest when answering questions regarding their physical activity levels and metabolic screening questionnaire. Unfortunately, no strategies were developed to overcome this assumption.

Implications for Future Research

In the analyses conducted, researchers investigated BG values and not all aspects of metabolic syndrome such as BG, TG, and HDL. Therefore, future researchers' next step would conduct these analyses to determine the acute effects between single either three 10 minute bouts of exercise or one continuous bout of exercise on BG, TG, and HDL. Additionally, researchers used a convenient sample throughout the study. Future studies should consider investigating a sample more ethnically diverse. Also, 100% of our participants self-reported 3 out of the 5 risk factor criteria. Therefore, future researchers should examine a sample that has been diagnosed with metabolic syndrome. Finally, the mean age of the cohort in this study was 30.1 years old. Epidemiological studies suggest that 50% of United States citizens' ≥60 years old have metabolic syndrome. Future studies should consider investigating participants with metabolic syndrome ≥60 years old.

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Conclusion

A significant amount of time spent sedentary may accelerate the development of metabolic syndrome (Rockette-Wagner et al., 2015). The American College of Sports Medicine, Centers of Disease Control, and Diabetes Prevention Program recommends all participants with metabolic syndrome to accumulate 30 minutes of moderate to vigorous intensity exercise on most days of the week. The findings from this study suggests that participants with metabolic syndrome between the ages of 18-45 can significantly reduce their blood glucose levels after either one continuous bout or three 10 minute bouts of exercise. Therefore, individuals with metabolic syndrome may perform either modality when accumulating their physical activity and reducing blood glucose levels as a result.

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Appendix A

Metabolic Syndrome Screening Questionnaire

I am going to start by asking you a few questions about yourself.

1. Do you engage in physical activity?
   ☐ Yes ***(ineligible if ≥ 150 mins/wk for 3 consecutive months)***
   How many consecutive months have you been engaged in physical activity?

   ____

   How many days of the week____________________
   How many minutes each day____________________
   ☐ No
   ☐ Don't know ***(ineligible)***
   ☐ Refused ***(ineligible)***

2. How old are you?
   Age _______ ***(<18 or >45 years of age, ineligible)***

3. Has your physician or health care provider diagnosed you with metabolic syndrome?
   ☐ Yes
   ☐ No
   ☐ Don't know ***(ineligible)***
   ☐ Refused ***(ineligible)***

4. Are you able to walk for 30 minutes without the assistance of another person?
   ☐ Yes
   ☐ No ***(ineligible)***
   ☐ Don't know ***(ineligible)***
   ☐ Refused ***(ineligible)***

5. Are you currently taking any medications?
   ☐ Yes ***(ineligible if taking any blood sugar lowering medications)***
   What medications are you taking? ________________________________
   ☐ No
   ☐ Don't know ***(ineligible)***
   ☐ Refused ***(ineligible)***

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6. Do you have to use a walker, crutches, or special equipment such as a straight cane to help you get around?
   - ☐ Yes ***(ineligible)***
     What do you use? ______________________________
   - ☐ No
   - ☐ Don't know ***(ineligible)***
   - ☐ Refused ***(ineligible)***

7. Are you currently under a physicians order not to exercise?
   - ☐ Yes ***(ineligible)***
   - ☐ No
   - ☐ Don't know ***(ineligible)***
   - ☐ Refused ***(ineligible)***

8. Do you ever experience chest pain, shortness of breath, or feelings of light-headedness upon exertion?
   - ☐ Yes ***(ineligible)***
   - ☐ No
   - ☐ Don't know ***(ineligible)***
   - ☐ Refused ***(ineligible)***

9. Has your physician or health care provider told you that you have high triglyceride levels or high amount of fat in your blood?
   - ☐ Yes
     What was your triglyceride level (≥150 mg/dL)? _________________
   - ☐ No
   - ☐ Don't know
   - ☐ Refused ***(ineligible)***

10. Has your physician or health care provider told you that you have high blood pressure?
    - ☐ Yes
      What was your blood pressure (≥130 systolic and / or ≥ 85 diastolic mmHg)? ______________________
    - ☐ No
    - ☐ Don't know
    - ☐ Refused ***(ineligible)***

11. Has your physician or health care provider told you that you have high blood sugar?
    - ☐ Yes
      What was your blood sugar (≥100 mg/dL)? _______________________
    - ☐ No
    - ☐ Don't know
    - ☐ Refused ***(ineligible)***

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12. Has your physician or health care provider told you that you have low HDL or "good" cholesterol levels?
   ☐ Yes
      What was your HDL cholesterol (<40 mg/dL in men / <50 mg/dL in women)? ________________________
   ☐ No
   ☐ Don't know
   ☐ Refused ***(ineligible)***

13. Has your physician or health care provider told you that you have a high waist circumference?
   ☐ Yes
      What was your waist circumference (>102 cm in men / >88 cm in women)? ________________________
   ☐ No ***(ineligible if <3 risk factor)***
   ☐ Don't know ***(ineligible if <3 risk factor)***
   ☐ Refused ***(ineligible)***

14. Have you been hospitalized within the past 6 months?
   ☐ Yes ***(ineligible if hospitalized for any cardiac, pulmonary, or metabolic disease)***
      What were you hospitalized for? ______________________________
   ☐ No
   ☐ Don't know ***(ineligible)***
   ☐ Refused ***(ineligible)***

15. Are you allergic to milk, soy, wheat, tree nuts, or peanuts?
   ☐ Yes ***(ineligible if allergic to milk or soy)***
      Allergies: ________________________
   ☐ No
   ☐ Don't know ***(ineligible)***
   ☐ Refused ***(ineligible)***

16. Are you lactose intolerant?
   ☐ Yes ***(ineligible)***
   ☐ No
   ☐ Don't know ***(ineligible)***
   ☐ Refused ***(ineligible)***

17. Are you allergic to any fruits?
   ☐ Yes
      What fruits are you allergic to? __________________________
   ☐ No
   ☐ Don't know ***(ineligible)***
   ☐ Refused ***(ineligible)***

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For women only.

18. Are you currently pregnant?

- ☐ Yes ***(ineligible)***
- ☐ No
- ☐ Don't know ***(ineligible)***
- ☐ Refused ***(ineligible)***

**** If participant is eligible, participant can be scheduled for an appointment.***
***** If the participant is not eligible, thank them for their time and explain that all information collected in the phone interview will be destroyed.***

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Appendix B

Medication Log

Participant: ______________________
ID:_____________________________

Drug Name	Brand Name	Dosage per day	Reason for medication

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Appendix C

Paper & Email Recruitment Flier

RESEARCH PARTICIPANTS NEEDED!

Has your physician or healthcare professional told you that you have metabolic syndrome or may be at risk for developing cardiovascular disease and / or type II diabetes?

The Department of Kinesiology, Health, and Sport Science at Indiana University of Pennsylvania is conducting a study on how acute exercise may reduce risk factors in participants with metabolic syndrome or at risk for developing cardiovascular disease and type II diabetes. The results from this study may provide medical practitioners with a more applicable way to prevent the development of cardiovascular disease and type II diabetes.

As a participant in this study, you will be asked to participate in:

1. Submaximal exercise test to assess fitness level.
2. 24 to 48 hours after test walk on a treadmill 3 times lasting 10 minutes with 30 minutes separated between each bout.
3. 24 to 48 hours after first exercise protocol is completed return to walk on a treadmill 1 time lasting 30 minutes.

Your participation in this study will be greatly appreciated! However, no compensation will be received.

To volunteer for this study, please contact Bradley J. Polen at **330-771-2583** and leave a message with your name and telephone number or email at QVRV@iup.edu for more information.

THIS PROJECT HAS BEEN APPROVED BY THE INDIANA UNIVERSITY OF PENNSYLVANIA INSITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS (Phone: 724.357.7730)

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Appendix D

Metabolic Screening Consent Script

Thank you for calling to find out more about our research study. My name is Bradley J. Polen and I am a researcher at the Indiana University of Pennsylvania, Department of Kinesiology, Health, and Sport Science. The purpose of this research study is to examine the use of three 10 minute bouts of exercise as a treatment for patients with metabolic syndrome.

As a part of our formal study, we will be asking you to complete a submaximal graded exercise test which is a test used to measure your fitness level and how your body responses to moderate intensity exercise. 1-2 days later you will be asked to come back to perform three 10 minute bouts of exercise. Before you start the multiple bouts of exercise, you will be asked to not eat any food or consume any form of caffeine such as soda, coffee, or energy drinks for 8 hours prior to exercise. Also, 2 hours before exercise you will be asked to drink a shake to ensure you do not have low blood sugar during the exercise protocol. Each bout will be separated by 30 minutes of rest until all 3 bouts are complete.

Before, and after each bout of exercise, your blood pressure, blood sugar, and heart rate will be measured. Blood pressure will be measured with a blood pressure cuff commonly used by a doctor. Heart rate will be measured with a heart rate monitor worn around your chest and blood sugar will be measured with blood sample from a finger prick on the tips of your finger. Researchers will also ask you to measure the intensity of your exercise from 6 to 20. Once the three bouts are complete, you will rest for 2 hours and a final blood sugar measurement will be taken. 1-2 days, after the multiple bouts of

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exercise are complete, you will be asked to return to perform a single 30 minute bout of continuous exercise.

Prior to exercise you will be asked to not eat any food or consume any form of caffeine such as soda, coffee, or energy drinks for 8 hours. You will not be taking a shake 2 hours prior to exercise. Your blood pressure, blood sugar, and heart rate will be measured before, during, and after the single bout of exercise. Researchers will also ask you to measure the intensity of your exercise from 6 to 20. Once the single bout of exercise is complete, you will rest for 2 hours and a final blood sugar measurement will be taken. After the final 2 hours are completed, you will receive a Gatorade and a Clif Bar. If you are allergic to wheat, tree nuts, or peanuts a serving of fruit will be given to you instead of the Clif Bar. Do you think you might be interested in participating in the study?

{If No}: Thank you very much for calling.

{If Yes}: Before enrolling you in this study, I must determine if you are eligible. So, what I would like to do now is ask you a few questions about your current medical history and physical activity levels. You also need to understand that all information that I receive from you by phone, including your name and any other identifying information, will be confidential and will be kept under lock and key. The only purpose of these questions is to determine whether you are eligible to participate in our study. Keep in mind, your participation is voluntary; therefore, you do not have to complete these questions if you choose not to. Do I have you permission to ask you these questions?

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Appendix E

Informed Consent Form for Participants

Mr. Bradley J. Polen is studying how walking 3 times per day versus walking 1 time per day may affect blood sugar levels in people with metabolic syndrome. The information provided will help you make a decision whether or not to participate. You are eligible to participate, because you have no signs or symptoms of any disease and you are not physically active according to the American College of Sports Medicine and Center of Disease Control.

This study may report that walking 3 times throughout the day will be able to lower blood sugar levels better when compared to walking once per day. As a part of our formal study, we will be asking you to complete a submaximal graded exercise test which is a test used to determine your physical fitness and how your body responses to walking at a moderate pace. During this test you will walk on a treadmill with a speed of 3.0 miles per hour with an incline that will increase every 3 minutes to that will feel like you are walking uphill and the hill getting steeper every 3 minutes until you feel the need to stop or you've reached a certain heart rate value. The total time for the test to be completed will be 30 minutes. After the test is completed you will receive a shake that will be used for the next session.

1-2 days after the submaximal graded exercise test is completed you will be asked to come back to walk on a treadmill at a speed of 3.0 miles per hour with an incline that will feel like you are walking uphill for 10 minutes 3 times. There will be 30 minutes of rest in between each round of walking. Before you start, you will be asked to not eat any food or drink any soda, coffee, or energy drinks for 8 hours before you come in for the

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first session. Also, 2 hours before you come to the lab you will be asked to drink a shake so you do not have low blood sugar during session.

Before, during, and after each round of walking your blood pressure, blood sugar, and heart rate will be recorded every 10 minutes. The helpers will ask you "how hard are you working" every 10 minutes. Once the 3 rounds of walking are complete, you will rest for 2 hours and your blood sugar, heart rate, and blood pressure will be taken every 10 minutes for the first 30 minutes of rest and after the 2 hour rest period. The total commitment time for the first session of exercise is 4 hours.

1-2 days, after the walking three 10 minute rounds in one day are complete, you will be asked to return to walk for 30 minute, non-stop. Before you come to the lab you will be asked to not eat any food or drink any soda, coffee, or energy drinks for 8 hours. Also, 2 hours before you come to the lab you will be asked to drink a shake so you do not have low blood sugar during session. Before, during, and after the 30 minutes of walking your blood pressure, blood sugar, and heart rate will be recorded every 10 minutes. Helpers will ask you "how hard you are working" every 10 minutes as well.

Once the 30 minutes of non-stop walking is complete, you will rest for 2 hours and a final blood sugar, heart rate, and blood pressure measurement will be taken every 10 minutes for the first 30 minutes of rest and after the 2 hour rest. After the 2 hours rest period is completed, you will receive a sports drink and a cereal bar. If you are allergic to wheat, tree nuts, or peanuts you will receive a serving of fruit that you are not allergic to instead of the cereal bar. The total time for the second session of walking is will take 3 hours.

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Throughout the study blood pressure, heart rate, ratings of perceived exertion, and blood sugar will be measured. Blood pressure will be measured using a blood pressure cuff commonly used by your doctor. Heart rate will be measured with a heart rate monitor that will be strapped to your chest and a watch that you will wear on your wrist. Ratings of perceived exertion will be measured based on a 6-20 scale. Researchers will ask you “how hard is the exercise?” and you will answer between 6 and 20. The number 6 is considered “very, very easy” while the number 20 is considered “very, very hard.” Blood sugar will be measured with the use of a glucometer and a small finger prick on your fingers.

There are risks in participating in this study. These risks are associated with all exercise which may include but not limited to low blood sugar, high heart rate, high blood pressure, and pain throughout the body. To help provide you in a safe environment, researchers will be measuring blood sugar levels, heart rate, and blood pressure to ensure all vital signs are within normal limits during exercise. In the event of a medical emergency, all research personnel are trained in providing CPR and AED. There is a plan installed in the event advanced medical care is needed.

Your participation in this study is completely voluntary and no compensation will be given. If you do not want to participate in this study you may withdraw at any time by notifying Mr. Bradley J. Polen. Upon your request to withdraw all of your data collected will be destroyed. Your confidentiality will be protected throughout the study. All data collected regarding you will be kept in a locked filing cabinet that either Dr. Kristi L. Storti, or I will have access too. The information obtained in the study may be published in scientific journals or presented at scientific meetings, but your identity will be kept

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confidential. If you are willing to participate in this study, please sign the statement below.

Mr. Bradley J. Polen
Principal Investigator
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330-771-2583
B.J.Polen@iup.edu

Dr. Kristi L. Storti
Co-Investigator
Department of Kinesiology
Indiana University of PA
236 Zink Hall
Indiana, PA 15705
724-357-2392
Kristi.storti@iup.edu

CERTIFICATION of INFORMED CONSENT

I certify that I have explained the nature and purpose of this research study to the above-named individual(s), and I have discussed the potential benefits and possible risks of study participation. Any questions the individual(s) have about this study have been answered, and we will always be available to address future questions as they arise. THIS PROJECT HAS BEEN APPROVED BY THE INDIANA UNIVERSITY OF PENNSYLVANIA INSITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS (Phone: 724.357.7730)

Printed Name of Person Obtaining Consent	Role in Research Study
Signature of Person Obtaining Consent	Date
Printed Name of Participant	Role in Research Study
Signature of Participant	Date

The informed consent form will be printed on IUP letterhead.

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Appendix F

Zink Hall Emergency Action Plan

Serious Injury

- A serious injury is one in which the victim will obviously need advanced medical care and / or possible hospitalization and where little or no time is available to consult a medical professional before taking action

Examples Includes:

- Severe Chest Pain or Pressure
- Severe Bleeding
- Suspected Spine or Head Injury
- Loss of Consciousness
- Difficulty Breathing
- Stoppage of Breathing
- Obvious Fracture or Joint Dislocation
- Suspected Abdominal Injury
- Seizure
- Injury to any of the Body's Senses

Procedure:

- **Supervising Individual (instructor, student worker, coach) CHECKS the scene and victim and attends immediately to the victim using those techniques taught via Standard First Aid and CPR Training.**
- **Supervising Individuals instructs a responsible individual (if available) to CALL EMS. If an additional individual is not present the Supervising Individual must cease attending to the victim and alert EMS.**
    - If using a cell phone dial 911 or if using a university phone dial 9-911. Relay the following information to the 911 operator:
        1. Your name and title
        2. The phone number and location of where you are calling from
        3. Nature of injury to the victim
        4. Specific location of the victim
        5. Ask to have Citizen's Ambulance dispatched
        6. Ask to have IUP Campus Police dispatched
        7. Ask if any individual should meet the ambulance if they are unsure of your exact location
- **Return to victim and provide CARE**
    - **If possible remove all individuals from the facility who are not directly responsible for assisting in the provision of care**
    - **Always be sure to complete an incident report and immediately document your care and those actions which were performed**
    - **Report each and every incident to your supervisor or the HPED office**

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Injuries of Less Severity

- Open Wounds, General Illness, Contusions, Mild Muscle Injuries….
  - Treat with those techniques taught in Standard First Aid and CPR Training
  - Refer for the further care
  - Complete incident report and document actions

Phone Access

- HPED and Faculty Offices
- Zink Fitness Center
- Pool Deck
- Emergency Call Box outside of Southwest Corner of Building

Facility Access

- Handicapped Building Entrance on South Side of Building
- Rear Doors of Zink at Loading Deck

Emergency Equipment Access

- Fitness Center (Wound Care / Airway)
- Pool Deck (Wound Care / Airway)
- Zink Cage (Wound Care / Airway)
- HPED Faculty and Lounge (Wound Care / Airway)
- Faculty Offices (Wound Care)

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Appendix G

Submaximal Graded Exercise Test

Participant: ________________________ ID: ________________________________

Resting Heart Rate: _________________ Resting Blood Pressure: _______________

40% Heart Rate Reserve: _____________ Estimated Max Heart Rate: _____________

60% Heart Rate Reserve: _____________ 80% Heart Rate Reserve: _______________

Minutes	MPH	Percent Grade	Heart Rate	Blood Pressure	RPE
0-3	3.0	0			
3-6	3.0	2.5			
6-9	3.0	5.0			
9-12	3.0	7.5			
12-15	3.0	10.0			
15-18	3.0	12.5			
18-21	3.0	15.0			
Recovery					
0-2	2.0	0			
2-4	2.0	0			

MaxHR = 207 – [(age)(0.7)]

% HRR = [(MaxHR - RestHR)(%)] + RestHR

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Appendix H

Glucerna Shake Nutritional Facts

Serving Size 1 bottle (8 fl oz)			
Amount Per Serving			
Kilocalories = 190		Kilocalories from Fat = 60	
	% DV*		% DV*
Total Fat 7g	11%	**Sodium** 210mg	9%
Saturated Fat 1g	5%	**Potassium** 500mg	14%
Trans Fat 0g		**Total Carbs** 23g	8%
Polysaturated Fat 2g		Dietary Fiber 3g	12%
Monosaturated Fat 3.5g		Sugars 6g	
Cholesterol 5mg	2%	**Protein** 10g	20%

Vitamins and Minerals %DV*		
Vitamin A = 25%	Vitamin C = 100%	Calcium = 25%
Iron = 25%	Vitamin D = 80%	Vitamin E = 25%
Vitamin K = 25%	Thiamin = 20%	Riboflavin = 25%
Niacin = 25%	Vitamin B6 = 25%	Folate = 25%
Vitamin B12 = 25%	Biotin = 25%	Pantothenic Acid = 25%
Phosphorus = 25%	Iodine = 25%	Magnesium = 25%
Zinc = 25%	Selenium 25%	Copper = 25%
Manganese = 50%	Chromium = 100%	Molybdenum = 50%
Chloride = 8%		

*Percent Daily Values (DV) are based on 2,000 calorie diet.

INGREDIENTS: WATER, CORN MALTODEXTRIN, MILK PROTEIN CONCENTRATE, FRUCTOSE, GLYCERINE, COCOA POWDER (PROCESSED WITH ALKALI), SOY PROTEIN ISOLATE, HIGH OLEIC SAFFLOWER OIL; **LESS THAN 1%** SHORT-CHAIN FRUCTOOLIGOSACCHARIDES, CANOLA OIL, SOY OIL, POTASSIUM CITRATE, CELLULOSE GEL, MAGNESIUM PHOSPHATE, SALT, CHOLINE CHLORIDE, ASCORBIC ACID, CALCIUM PHOSPHATE, CELLUOSE GUM, CALCIUM CARBONATE, NATURAL AND ARTIFICIAL FLAVOR, MONOGLYCERIDES, SOY LECTHIN, SODIUM CITRATE, CARRAGEENAN, POTASSIUM CHLORIDE, POTASSIUM HYDROXIDE, TURMERIC CONCENTRATE, ACESULFAME POTASSIUM, SURCRALOSE, FERROUS SULFATE, dl-ALPHA-TOCOPHERYL ACETATE, GELLIAN GUM, ZINC SULFATE, VITAMIN A PALMITATE, THIAMINE CHLORIDE HYDROCHLORIDE, PRYIDOXINE HYDROCHLORIDE, RIBOFLAVIN, CHROMIUM CHLORIDE, FOLIC ACID, BIOTIN, SODIUM MOLYBDATE, POTASSIUM IODIDE, SODIUM SELENATE, PHYLLQUINONE, VITAMIN D3 AND CYANOCOBALAMIN. **CONTAINS MILK AND SOY INGREDIENTS.** **Abbott Nutrition,** Abbott Laboratories, Columbus, Ohio 43219

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Appendix I

Three 10 Minute Bouts Protocol

Participant: ___________________________ ID: _____________________________________
40% Heart Rate Reserve: ______________ Estimated Max Heart Rate: ______________
60% Heart Rate Reserve: ______________ 80% Heart Rate Reserve: ________________

Physiological Measurements	Pre-Exercise	1st 10 min bout	2nd 10 min bout	3rd 10 min bout	Rest 10 mins	Rest 20 mins	Rest 30 mins	2 Hour Post
Blood Glucose (mg/dL)								
Systolic Blood Pressure (mmHg)								
Diastolic Blood Pressure (mmHg)								
Heart Rate (bpm)								
RPE	x				X	x	x	x

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Appendix J

One Continuous Bout Protocol

Participant: ______________________________ ID: ____
40% Heart Rate Reserve: ________________ Estimated Max Heart Rate: ________________
60% Heart Rate Reserve: ________________ 80% Heart Rate Reserve: ___________________

Physiological Measurements	Pre-Exercise	10 mins	20 mins	30 mins	Rest 10 mins	Rest 20 mins	Rest 30 mins	2 Hour Post
Blood Glucose (mg/dL)								
Systolic Blood Pressure (mmHg)								
Diastolic Blood Pressure (mmHg)								
Heart Rate (bpm)								
RPE	x				X	x	x	x

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Appendix K

Gatorade Nutritional Facts

Serving Size 1 Bottle (355 mL)	
Amount Per Serving	
Kilocalories = 80	Kilocalories from Fat = 0
	%DV*
Total Fat 0g	0%
Sodium 160mg	7&
Potassium 45mg	1%
Total Carbs 21g	7%
Sugar 6g	
Protein 0g	

Not a significant source of calories from fat, saturated fats, trans fat, cholesterol, dietary fiber, vitamin A, vitamin C, calcium, and iron.

*Percent Daily Values are based on 2,000 kilocalorie diet.

INGRIEDENTS: WATER, SUGAR, DEXTROSE, CITRIC ACID, NATURAL FLAVOR, SALT, SODIUM CITRATE, MONOPOTASSIUM PHOSPHATE, MODIFIED FOOD STARCH, GLYCEROL ESTER OF ROSIN, BLUE 1.

THE GATORADE COMPANY: P.O. BOX 049003, Chicago, IL, 60604

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Appendix L

Clif Bar Nutritional Facts

Serving Size 1 Bar (68g)			
Amount Per Serving			
Kilocalories = 250		Kilocalories from Fat = 45	
	% DV*		% DV*
Total Fat 5g	8%	**Sodium** 150mg	6%
Saturated Fat 1.5g	8%	**Potassium** 210mg	6%
Trans Fat 0g		**Total Carbs** 45g	15%
Polysaturated Fat 1.5g		Dietary Fiber 4g	16%
Monosaturated Fat 2g		Sugars 22g	
Cholesterol 5mg	0%	**Protein** 10g	20%

Vitamins and Minerals %DV*		
Vitamin A = 10%	Vitamin C = 10%	Calcium = 20%
Iron = 15%	Vitamin D = 15%	Vitamin E = 10%
Magnesium =20%	Thiamin = 10%	Riboflavin = 10%
Niacin = 10%	Vitamin B6 = 10%	Phosphorus = 25%
Vitamin B12 = 10%		

*Percent Daily Values (DV) are based on 2,000 calorie diet.

INGREDIENTS: ORGANIC BROWN RICE SYRUP, ORGANIC ROLLED OATS, SOY PROTEIN ISOLATE, ORGANIC CANE SYRUP, ORGANIC ROASTED SOYBEANS, RICE FLOUR, DRIED CANE SYRUP, ORGANIC OAT FIBER, UNSWEETENED CHOCOLATE, ORGANIC SOY FLOUR, ORGANIC SUNFLOWER OIL, ORGANIC DATE PASTE, COCOA BUTTER, MOLASSES POWDER, ORGANIC SOYBEAN OIL, BARLEY MALT EXTRACT, SALT, VANILLA EXTRACT, SOY LECITHIN, NATURAL FLAVORS, CINNAMON. **CONTAINS SOY. MAY CONTAIN TRACES OF MILK PEANUTS, WHEAT AND TREE NUTS.**

CLIF BAR & COMPANY Emeryville, CA, 94608

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