The Effect of a Behavioral Intervention on Moderate-to-Vigorous Physical Activity Among Overweight and Obesity Adults with Type 2 Diabetes

Dissertation

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By

Valerie J. Heiss, M.S.
Graduate Program in Kinesiology

The Ohio State University

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Dissertation Committee:

Rick Petosa, PhD, Advisor
Brian Focht, PhD
Randi Love, PhD
Abstract

Given that almost 10% of the population is diagnosed with diabetes, it is critical to understand strategies and techniques to reduce the prevalence of this disease. There is sufficient evidence that regular physical activity (PA) can significantly improve symptoms of type 2 diabetes, however a majority of adults with type 2 diabetes are not regularly active. The purpose of this research study is to evaluate the effectiveness of a brief, 4-week, Social Cognitive Theory (SCT) -based behavioral intervention on moderate-to-vigorous physical activity (MVPA) among a sample of overweight and obese adults with type 2 diabetes. A secondary purpose of this research is to evaluate the effect of a behavioral intervention on dimensions of self-regulation. The intervention group met with researchers once per week and received counseling and exercise logs in order to stimulate changes in self-regulation, self-monitoring, goal setting, time management, social support, self-reward, and overcoming barriers. This group’s MVPA was measured using the BodyMedia Armband at pretest and posttest, and individuals were given information regarding their PA habits. The control group was also measured using the BodyMedia at pretest and posttest, were given information regarding their PA habits, but did not receiving counseling or complete exercise logs. The intervention group reported and increased rate of use of self-regulation strategies beyond that of the control group, but there were no significant changes in PA in either group. The results of this
study suggest that a behavioral intervention can positively stimulate changes in SCT variables among adults with type 2 diabetes, but more research is needed to determine the ability of said variables to stimulate a change in PA behavior as this study did not have a positive impact on dimensions of MVPA.
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Vita

2007 ................................................................. Graduated High School, Mt. Lebanon Pennsylvania

2011 ................................................................. B.S. Health and Physical Activity, University of Pittsburgh

2012 ................................................................. M.S. Health and Physical Activity, University of Pittsburgh

2012-Present ................................................. Graduate Teaching Associate, Department of Kinesiology, The Ohio State University

Publications


Fields of Study

Major Field: Kinesiology
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Chapter 1

Introduction

It is estimated that 29.1 million people in the United States, or 9.3% of the population, have diabetes (Center for Disease Control and Prevention, 2012; Center for Disease Control and Prevention, 2014). Of this 29.1 million, 21 million individuals are diagnosed, and 8.1 million individuals are undiagnosed. Diabetes is a group of metabolic diseases that are characterized by elevated blood glucose (BG) caused by the cessation of insulin secretion or the body’s failure to use insulin (ACSM, 2010). While the prevalence of diabetes accounts for all types (type 1, type 2, gestational, etc.), type 2 diabetes alone accounts for 90-95% of all cases of diabetes (CDC 2012; CDC, 2014). This specific type of diabetes continues to plague the United States, and it is estimated that 1 out of every 3 adults in the U.S. will develop type 2 diabetes in their lifetime.

Type 2 diabetes is characterized by the inability of muscles cells to respond to insulin (insulin resistance) combined with insufficient insulin secretion (ACSM, 2010; Colberg, Sigal, Fernhall, Regensteiner, Blissmer, Rubin, Chasan-Taber, et al, 2010). The primary role of insulin is to aid in the absorption of glucose from the blood into the skeletal muscles and fat tissue. Without insulin, BG remains elevated. The American Diabetes Association (ADA) uses the following criteria when diagnosing individuals with type 2 diabetes:
1. Glycated hemoglobin (AIC) value ≥ 6.5%

2. Fasting plasma glucose ≥ 126 mg/dl

3. 2-hour plasma glucose ≥ 200 mg/dl during an oral glucose tolerance test

4. Classic symptoms of hyperglycemia, such as; polyuria, polydipsia, and unexplained weight loss

Having chronic elevated BG has significant implications, and can result in a multitude of complications for adults with type 2 diabetes, as type 2 diabetes is a precursor for mortality and morbidity related to cardiovascular disease, blindness, kidney disease, and amputations (Colber et al, 2010). For example, 71% of adults with diabetes also have high blood pressure, are 1.7 time more likely to have a heart attack, and 1.5 times more likely to have a stroke compared to adults without diabetes. Additionally, in 2011, diabetes was reported as the primary cause of kidney failure, and 60% of non-traumatic limb amputations occur in adults with diabetes (CDC 2012; CDC 2014). These complications can result in substantial financial burdens, disability, lower quality of life, and even death.

As a result of the rapid increase in the number of adults with type 2 diabetes over the past few decades, doctors, researchers, and other health specialists have invested a significant amount of energy on the management and treatment of type 2 diabetes. Type 2 diabetes treatment is centered around maintaining optimal BG and blood pressure levels, as means to prevent or delay complications of type 2 diabetes. These treatment goals are often achieved through diet, exercise, weight loss, and oral medication. According to the ADA (2010), diet and physical activity should be the centerfold of type 2 diabetes
management, as these lifestyle behaviors help to treat elevated BG, blood pressure, and lipids, as well as aid in the control of excess weight.

There is sufficient evidence to support that exercise has important and lasting effects on BG levels in adults with type 2 diabetes. A joint position statement from the ADA and the American College of Sports Medicine (ACSM)(2010) stated that a single bout of exercise, of at least moderate intensity, improves the uptake of BG into the muscle. This mechanism increases insulin sensitivity, which in turn improves glucose tolerance, resulting decreased BG following exercise. Exercise also provides a mechanism for GLUT 4 translocation independent of insulin. GLUT 4 is the receptor that is responsible for the uptake of glucose from the blood into the skeletal muscle. Muscular contraction via moderate intensity exercise stimulates BG transportation via a separate mechanism than insulin. As a result, GLUT 4 translocation is stimulated and BG is decreased (Colberg et al, 2010). These mechanisms are critical to understand as they have significant implications for the treatment and management of type 2 diabetes. For, the effects of exercise on insulin sensitivity can last for up to 72 hours post exercise. Simply put, adults with type 2 diabetes who exercise regularly can successfully control their BG levels and manage their disease through exercise alone.

Regular exercise in this population is defined by ACSM as 3 to 7 days per week of moderate intensity exercise (50-80% VO₂R or rating of perceived exertion (RPE) of 12 to 16 on a 6 to 20 scale), lasting from 20 to 60 continuous minutes. The duration of activity can also be accumulated in 10-minute bouts to total 150 minutes of activity per week (ACSM, 2010). Although regular activity provides major benefits in terms of BG control and insulin sensitivity, a majority of adults with type 2 diabetes are not engaging
in regular exercise. According to data from the National Health and Nutrition Examination Survey (NHANES III), 31% of adults with type 2 diabetes report no regular physical activity. Additionally, another 38% report less than the recommended amount of activity. This means that up to 70% of adults with type 2 diabetes are considered inactive (Nelson, Reiber, & Boyko, 2002).

Given the evidence for the positive relationship between regular physical activity and BG control in adults with type 2 diabetes, researchers need to direct their focus toward developing and implementing programs that emphasize positive physical activity behavior change. Correlates, or determinants of physical activity, can be defined as variables that have predictive or reproducible relationships with activity (Buckworth, Dishman, O’Connor, & Tomporowski, 2013). Studying correlates of physical activity can help researchers to better design health promotion programs by identifying segments of the population in need of physical activity promotion, uncovering modifiable correlates that can be targeted in interventions, and creating more personalized intervention programs (Bucworth et al, 2013).

Correlates of behavior change are often framed into constructs of a health behavior theory. Social Cognitive Theory (SCT), set forth by Albert Bandura, is one of the most widely used theories in terms of categorizing correlates of behavior change and explaining and predicting physical activity behavior (Biddle & Fuchs, 2009). SCT assumes that human behavior is the product of the mutual interaction between personal characteristics, behavioral characteristics, and environmental characteristics (Biddle & Fuchs, 2009; Buckworth et al, 2013). This theory also assumes that human behavior is learned through social interactions, and is goal directed, purposeful, and under the direct
control of the individual. As a result, SCT posits that humans are capable of self-reflection and self-regulation. This means that individuals anticipate future events and modify their behavior accordingly (Buckworth et al., 2013). Additional constructs, or correlates, within SCT include self-efficacy, outcome expectations, social support, and dimensions of the physical environment.

When developing and implementing physical activity programs for adults with type 2 diabetes, it is important to shape them around a theory. Theories provide researchers with assumptions about human behavior by defining variables and relationships that explain or predict behavior (Buckworth et al., 2013). For adults with type 2 diabetes, being able to identify correlates of behavior change is an important step for creating change. In a review conducted by Heiss and Petosa (2014), a number of psychosocial, biological, and environmental correlates were shown to have a relationship with physical activity in this population, including but not limited to; self-efficacy, self-regulation, perceived behavioral control, social support, and access to facilities. Given that SCT provides researchers with a framework for change and SCT constructs have been related to behavior among adults with type 2 diabetes, it serves as an appropriate and meaningful theory for which a physical activity intervention can be developed and implemented. For, being able to use and target these variables in health promotion programs may have significant implications for individualized behavior change.

In addition to health behavior theory, it also important to conduct research that focuses on valid and reliable measurement. Currently, there are a wide variety of methods to measure physical activity and exercise, such as self-report, heart rate monitors, pedometers, and accelerometers (Strath, Kaminsky, Ainsworth, Ekelund, Freedson, Gary,
Richardson, et al, 2013). The most common methods for physical activity measurement are self-report questionnaires. Specifically, recall questionnaires provide a quick assessment of physical activity, are easy to administer, and can reach a large number of people (Strath et al, 2013). However, self-report methodology relies entirely on the participant’s ability to recall and accurately describe his or her own behavior (Welk, 2002). Individuals may have difficulty remembering their activity from the preceding week, months, or even years. Individuals may also interpret questions differently, and as a result, different dimensions of exercise may go undetected (Welk, 2002). As a result, the use of more direct measures of physical activity has become more desirable in physical activity research. Devices such as accelerometers, heart rate monitors, and BodyMedia Armbands are not objective when compared to self report, but also provide researchers with more valid and reliable data in terms of caloric expenditure, minutes of physical activity, and intensity of physical activity (Welk, 2002). This is significant because in order to change an individual’s behavior, it is important to obtain an accurate picture of their current behavior in order to establish a baseline and metric for change. Therefore, it is important to build this current research study designed to improve physical activity in a sample of adults with type 2 diabetes within the theoretical framework of SCT as well as valid and reliable physical activity measurement.

Significance of Study

Given that almost 10% of the United States population has diabetes, and 90-95% of these cases are type 2 diabetes, it is essential that researchers understand strategies to manage and control diabetes (CDC 2012). Regular physical activity has proven to play a
vital role in BG control and insulin sensitivity, and should therefore be at the cornerstone of type 2 diabetes management. However, a majority of adults with type 2 diabetes are not regularly active. This begs the question; how do we as researchers, exercise specialists, and health educators, get adults with type 2 diabetes to be active? In order to work towards answering this question, research needs to focus on developing and implementing evidence- and theory-based health promotion programs focused on stimulating exercise behavior change.

First, there is evidence that a set of biological, psychosocial, and environmental correlates of physical activity among adults with type 2 diabetes (Heiss & Petosa, 2014). For example, lower BMI, male gender, higher education, and higher income have been associated with higher levels of physical activity (DeGreef, Van Dyck, Deforche, et al, 2011; Plotnikoff, Taylor, Wilson, et al, 2006). Additionally, individuals with a more positive attitude toward activity, higher self-efficacy, higher perceived behavioral control, and fewer perceived barriers are shown to be more likely to engage in regular activity (Plotnikoff, Karunamuni, & Brunet, 2009; Swift et al, 1995; Glasgow, Hampton, & Strycker, 1997; Plotnikoff, Brez, & Hotz; 2000). Finally, weather and access to facilities have been reported as environmental barriers to physical activity, whereas receiving social support from family and friends was associated with higher levels of activity (Swift et al, 1995; Plotnikoff et al, 2000; DeGreef et al, 2011; Krug, Joshu, & Heady; 1991).

While this research provides evidence for potentially modifiable correlates of physical activity behavior, much of this cross-sectional, correlational research is not grounded in health behavior theory. Establishing the utility of theories, such as SCT, is
crucial to understanding how theory-based constructs shape physical activity behavior in this population (Buckworth et al, 2013). However, while this research provides evidence for potentially modifiable correlates of physical activity behavior, it only provides us with associations. Therefore, there is no evidence that a change in behavioral, personal, or environmental correlates result in a change in physical activity.

Given the evidence on correlates of physical activity among adults with type 2 diabetes, it is time to move past associative research in order to establish a cause-and-effect relationship between SCT constructs and physical activity. Once a theory has been tested to have a relationship with physical activity, researchers and health educators can begin to incorporate theoretical constructs in to exercise interventions. For example, a study conducted by DeGreef et al (2011) targeted self-monitoring, self-efficacy, social support, and relapse prevention in a 24-week phone intervention that successfully increased walking behavior in adults with type 2 diabetes. The First Step Program has also incorporated SCT by targeting social support, goal setting, and self-regulation in order to improve walking behavior (Tudor-Locke, Myers, Bell, Stewart, Harris, & Rodger, 2002). While these studies targeted SCT and identified a measurable change in walking behavior via pedometers, SCT constructs were not measured. Therefore, there is no evidence that a change in any of the SCT variables occurred. As a result, researchers cannot establish a cause-and-effect relationship between SCT factors such as social support, self-efficacy, self-regulation, and goal setting and physical activity behavior.

In order to further inform health educators on changing physical activity behavior among adults with type 2 diabetes, targeting theory-based factors, while measuring said constructs as well as behavior can provide researchers and educators with evidence-based
strategies and techniques for stimulating a positive physical activity behavior change. This will provide sound evidence with which to base future health promotion programs for adults with type 2 diabetes in hopes to aid individuals in controlling and managing their disease through regular physical activity.

**Statement of Purpose**

The purpose of this research study is to evaluate the effectiveness of a brief, SCT-based behavioral intervention on moderate-to-vigorous physical activity (MVPA) among a sample of overweight and obese adults with type 2 diabetes. A secondary purpose of this research is to evaluate the effect of a behavioral intervention on dimensions of self-regulation. The 4-week intervention will target SCT variables such as self-regulation, self-monitoring, time management, goal setting, enjoyment, overcoming barriers, and social support in order to positively impact exercise behavior.

**Research Inquiry**

This study will be a 4-week pretest-posttest control group experimental design. 23 overweight and obese adults with type 2 diabetes were measured at baseline, and 21 individuals were measured at the 4th week posttest. The independent variable was the behavioral intervention, focusing on self-regulation. The following dependent variables were measured at pretest and posttest:

- Dimensions of MVPA
  - Minutes of MVPA per week
  - Minutes of MVPA per day
• Number of steps per day
• Caloric Expenditure per day
• Sedentary Time per day

• Dimensions of self-regulation
  • Self-monitoring
  • Goal setting
  • Social support
  • Self-reward
  • Time management
  • Overcoming barriers

Research Questions: MVPA

• What is the effect of the 4-week behavioral intervention on minutes of MVPA per week in a sample of overweight and obese adults with type 2 diabetes?
• What is the effect of the 4-week behavioral intervention on minutes of MVPA per day in a sample of overweight and obese adults with type 2 diabetes?
• What is the effect of the 4-week behavioral intervention on number of steps per day in a sample of overweight and obese adults with type 2 diabetes?
• What is the effect of the 4-week behavioral intervention on caloric expenditure per day in a sample of overweight and obese adults with type 2 diabetes?
• What is the effect of the 4-week behavioral intervention on sedentary time per day in a sample of overweight and obese adults with type 2 diabetes?
Research Questions: Self-Regulation

- What is the effect of the 4-week behavioral intervention on self-regulation in a sample of overweight and obese adults with type 2 diabetes?
- What is the effect of the 4-week behavioral intervention on self-monitoring in a sample of overweight and obese adults with type 2 diabetes?
- What is the effect of the 4-week behavioral intervention on goal setting in a sample of overweight and obese adults with type 2 diabetes?
- What is the effect of the 4-week behavioral intervention on social support in a sample of overweight and obese adults with type 2 diabetes?
- What is the effect of the 4-week behavioral intervention on time management in a sample of overweight and obese adults with type 2 diabetes?
- What is the effect of the 4-week behavioral intervention on self-reward in a sample of overweight and obese adults with type 2 diabetes?
- What is the effect of the 4-week behavioral intervention on overcoming barriers in a sample of overweight and obese adults with type 2 diabetes?

Definition of Terms

Social Cognitive Theory: The theory of human behavior, evolved from social learning theory, in which behavior is a function of social cognitions (Buckworth, et al., 2013).

Correlates: Variables for which there are established reproducible associations or predictive relationships (Buckworth, et al., 2013).

Self-Regulation: The tendency to modify or adjust behavior based on personal goals, cognitions, and feelings (Biddle & Fuchs, 2009).

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**Self-Monitoring:** Paying attention to one’s own thoughts, feelings, and behaviors to assess the antecedents, consequences, and characteristics of attempts to engage in or avoid a target behavior (Lox, Martin Ginis, & Petruzzello, 2010; Buckworth, et al., 2013).

**Goal Setting:** The process by which specific plans are established in order to monitor and achieve an outcome that is specific, measureable, attainable, realistic, and accomplished in a timely manner (Buckworth, et al., 2013).

**Time Management:** The act or process of planning and exercising conscious control over the amount of time spent on specific activities (Glanz, Rimer, & Viswanath, 2008).

**Social Support:** The degree of perceived comfort, caring, assistance, and information that a person receives from others, such as friends and family (Lox, et al., 2010).

**Perceived Barriers** Belief about the tangible and psychological costs of engaging in a particular behavior (Glanz, Rimer, & Viswanath, 2008).

**Physical Activity:** Any bodily movement produced by skeletal muscles that results in energy expenditure (Buckworth, et al., 2013).

**Exercise:** A form of leisure-time physical activity (as opposed to household or occupational physical activity) that is planned, structured, and undertaken in order to improve or maintaining one or more components of physical fitness or health (Lox, Martin Ginis, & Petruzzello, 2010; Buckworth, et al., 2013).

**Assumptions**

- The instruments used to measure the dependent and independent variables in this study were valid and reliable for this population
• The subjects provided honest answers to the self-report measures
• The subjects engaged in an honest amount of physical activity in response to the BodyMedia measurement
• The control group and experimental group were equal on potential confounding variables based on randomization
• Threats to internal validity were controlled through randomization

Limitations
• This study relied on volunteers, and therefore may not be representative of the population
• Subjects were not randomly selected from the population, and therefore may not be representative of the population
• This study relied on self-report data for SCT constructs. Specific dimensions of self-regulation, including self-monitoring, goal setting, social support, self-reward, time management, and overcoming barriers were all measured via self-report.
• Give that this study was over the course of 4 weeks; some subjects were lost due to attrition.
• There may have been bias introduced by the researchers. There were three different researchers who delivered the intervention to the subjects. However, all researchers were trained over the course of 4 to 6 weeks to ensure that all subjects receive the same intervention. Additionally, researchers were not blinded to the selection of individuals to the intervention vs. control group
• There may have be an effect of testing as a threat to internal validity, as subjects were measured with the BodyMedia at pretest, and given their results.

• There may have been high levels of reactivity, as individuals may have engaged in higher levels of physical activity as a result of the novelty of the BodyMedia.

• A response bias may have occurred due the fact that subjects know that they are part of research study. Subjects may have responded in ways they believe to be desirable to the researcher.
Chapter 2
Review of the Literature

The purpose of this section is to review the literature relevant to physical activity among adults with type 2 diabetes. The first section of the chapter discusses the link between regular exercise and the treatment of type 2 diabetes. The second section reviews scientific literature estimating current physical activity levels of adults with type 2 diabetes. The third section is a review of the literature on the correlates of physical activity among adults with type 2 diabetes. This section will review descriptive studies that have identified demographic, biological, psychosocial, and environmental determinants of exercise. The fourth section will include a description of a cross-sectional pilot study conducted prior to this study that sought to identify Social Cognitive Theory correlates of exercise among adults with type 2 diabetes. The fifth section will review the literature on intervention studies designed to stimulate positive physical activity behavior change among adults with type 2 diabetes. Specifically, this section will discuss studies, based on theory, that incorporate theoretical constructs to target physical activity behavior. The sixth and final section will review relevant material on the measurement of physical activity.
Link Between Regular Activity and Type 2 Diabetes Treatment

The purpose of this section is to review literature that links physical activity and
exercise with the treatment of type 2 diabetes. There is currently substantial evidence that
regular physical activity results in a significantly lower risk for chronic diseases such as
obesity, cardiovascular disease, and diabetes (ACSM, 2010). Additionally, there is
evidence for a strong relationship between an increase in physical activity and a decrease
in all-cause mortality (Warburton, Whitney, & Bredin, 2006). Specifically, there is now
research to support regular exercise, in addition to diet and medication regimens, as a
foundation for the management and regulation of type 2 diabetes (Boule, Haddad, Kenny,
Wells, & Sigal, 2001).

In order for individuals to manage their type 2 diabetes, it is essential that they
employ strategies to reduce their blood glucose and improve their insulin sensitivity. In a
review article written by Björntorp and Krotkiewski (1985), researchers discussed how
exercise could cause metabolic changes related to glucose regulation and insulin
sensitivity. First, a single exercise bout, when performed at the appropriate intensity, can
be sufficient for improved uptake of glucose in the muscles and brain in order to store
glycogen. In other words, an individual’s muscles are replenishing glycogen, increasing
the body’s tolerance to glucose. Also, a single bout of exercise is responsible for the
improvement of insulin sensitivity within the muscles. When looking specifically at
individuals with type 2 diabetes, it has been observed that an increase in insulin
sensitivity leads to improvements in glucose tolerance following exercise, leading to a
decrease in blood glucose levels as it is taken up into the muscles and liver (Björntorp &
Krotkiewski, 1985).
An analysis by Goodyear and Kahn (1998) further researched the effect of exercise as treatment for type 2 diabetes, providing evidence for the increase in insulin-stimulated glucose disposal as a result of exercise. This process of glucose uptake is accomplished through the translocation of GLUT4. GLUT4 is the receptor responsible for taking glucose from the blood into the skeletal muscle; a process typically achieved by insulin. However, there is now evidence to support that exercise can provide the mechanism for the translocation of GLUT4 independent of the effects of insulin (Goodyear & Kahn, 1998). Because GLUT4 translocation is a critical part of glucose uptake and regulation, these findings provide significant proof that exercise can directly result in improved glucose tolerance in skeletal muscles. Additionally, Goodyear and Kahn (1998) reported that individuals with diagnosed type 2 diabetes, who engaged in exercise training for a 6-week period, significantly improved their sensitivity to insulin by 25-35%. Such mechanisms and results are key for establishing the use of exercise to control poor insulin sensitivity and glucose tolerance among individuals with type 2 diabetes.

Following the verification of exercise as a physiological mechanism for improving insulin sensitivity and glucose tolerance, it is critical to further apply this notion to persons with type 2 diabetes. An article conducted by Boulé, Haddad, Kenny, Wells, & Sigal (2001) sought to review the literature for control trials intended to establish the effect of exercise on glucose regulation and weight status in adults with type 2 diabetes. The analysis included 14 trials lasting at least 8 weeks that all included an exercise program intended to lower HbA1c levels among subjects. For all studies analyzed, HbA1c values were, on average, 0.66% lower at follow-up among subjects in
the intervention groups compared to control groups. According to the researchers, a 0.66% reduction in HbA1c values is considered clinically significant for glucose-lowering therapy. Also, because no study reported significant amounts of weight loss among its subjects in intervention groups at follow-up, changes in HbA1c were not mediated by changes in weight (Boulé, Haddad, Kenny, Wells, & Sigal, 2001).

The American College of Sports Medicine and the American Diabetes Association released a joint position statement in 2010 as a result of the growing evidence that there is a strong connection between physical activity and type 2 diabetes, connection between physical activity and type 2 diabetes (Colberg, Sigal, Fernhall, Regensteiner, Blissmer, Rubin, et al (2010). Table 1 illustrates a summary from this position statement on the acute and chronic effects of exercise. In conclusion, these results prove that exercise alone can be sufficient to improve glycemic control and insulin sensitivity among individuals with type 2 diabetes.

### Table 2.1 Summary of ACSM and ADA Evidence*

**ACSM and ADA Recommendation Statements**

**Acute effects of exercise**

- PA causes increased glucose uptake into active muscles balanced by hepatic glucose production, with a greater reliance on carbohydrate to fuel muscular activity as intensity increases.
- Insulin-stimulated BG uptake into skeletal muscle predominates at rest and is impaired in type 2 diabetes, while muscular contractions stimulate BG transport via a separate, additive mechanism not impaired by insulin resistance or type 2 diabetes.
- Although moderate aerobic exercise improves BG and insulin action acutely, the risk of exercise-induced hypoglycemia is minimal without use of exogenous insulin or insulin secretagogues. Transient hyperglycemia can follow intense PA.

*Continued*
The acute effects of resistance exercise in type 2 diabetes have not been reported, but result in lower fasting BG levels for at least 24 h post exercise in individuals with IFG.

A combination of aerobic and resistance exercise training may be more effective in improving BG control than either alone; however, more studies are needed to determine whether total caloric expenditure, exercise duration, or exercise mode is responsible.

Milder forms of exercise (e.g., tai chi, yoga) have shown mixed results.

PA can result in acute improvements in systemic insulin action lasting from 2 to 72 h.

Chronic effects of exercise

- Both aerobic and resistance training improve insulin action, BG control, and fat oxidation and storage in muscle.
- Resistance exercise enhances skeletal muscle mass.
- Blood lipid responses to training are mixed but may result in a small reduction in LDL cholesterol with no change in HDL cholesterol or triglycerides. Combined weight loss and PA may be more effective than aerobic exercise training alone on lipids.
- Aerobic training may slightly reduce systolic BP, but reductions in diastolic BP are less common, in individuals with type 2 diabetes.
- Observational studies suggest that greater PA and fitness are associated with a lower risk of all-cause and CV mortality.
- Recommended levels of PA may help produce weight loss. However, up to 60 min/day may be required when relying on exercise alone for weight loss.
- Individuals with type 2 diabetes engaged in supervised training exhibit greater compliance and BG control than those undertaking exercise training without supervision.
- Increased PA and physical fitness can reduce symptoms of depression and improve health-related QOL in those with type 2 diabetes.


*PA = physical activity, BG = blood glucose, IFG = impaired fasting glucose, CV = cardiovascular, QOL = quality of life

Physical Activity Rates Among Adults with Type 2 Diabetes

While there is evidence that engaging in exercise has a direct and positive impact on glucose regulation and insulin sensitivity, a majority of U.S. adults are not currently meeting the minimum recommendations for physical activity. According to the American
College of Sports Medicine (ACSM), adults with type 2 diabetes should participate in moderate aerobic activity (50%-80% HRR) on at least 3, and up to 7 days per week. This activity should be 20-60 minutes in duration, and can be accumulated in bouts of at least 10 minutes to total 150 minutes per week of moderate physical activity (ACSM, 2010).

Based on the 2003 Behavioral Risk Factor Surveillance Survey (BRFSS), only 23% to 37% of adults with type 2 diabetes were successfully meeting the guidelines for physical activity. Additional data from the National Health and Nutrition Examination Survey (Nelson, Rieber, & Boyko, 2002) demonstrated that 38% of individuals with type 2 diabetes were not meeting the minimum recommendations for physical activity, and an additional 31% reported zero minutes of leisure time physical activity. This number is higher when compared to the 25.1% of American adults who reported no leisure-time physical activity (CDC, 2004; Nelson et al, 2002; CDC, 2011).

Despite the documented substantial benefits of physical activity, a majority of adults with type 2 diabetes are not regular exercisers. With less than one third of American adults with type 2 diabetes engaging in regular exercise, these individuals may not be effectively managing their disease. This suggests that there is still a need for effective techniques that stimulate positive behavior change among adults with type 2 diabetes. In order to accomplish this goal, it is critical to first review the literature regarding what has been established in terms of increasing physical activity participation among adults with type 2 diabetes.
Correlates of Physical Activity

The purpose of this section is to review the correlates of physical activity among adults with type 2 diabetes. While the evidence is clear for the benefits of physical activity and exercise for this population, it is unclear as to why there is such a disparity in the number of individuals actually meeting physical activity guidelines. Exercise is a complicated behavior, and the factors that determine an individuals’ engagement in physical activity are equally as complex. Determinants, or correlates, can be defined as those factors that either increase or decrease the likelihood that an individual will participate in regular exercise (Buckworth, Dishman, O’Connor, & Tomporowski, 2013). These factors are used to establish associations or predictive relationships with behavior. Identifying correlates can be useful in providing evidence to build and refine theories of regular exercise behavior. A theory can be defined as a set of interrelated constructs that provide a systematic representation of relationships among variables in order to explain or predict a phenomenon (Glanz, Rimer, & Viswanath, 2008). Specifically, theories related to humans make assumptions regarding human behavior by establishing variables that can be used to both explain and predict behavior (Buckworth, Dishman, O’Connor, & Tomporowski, 2013). Specifically for physical activity behavior, behavioral theories give us a framework to both understand and predict exercise. Researchers and practitioners can organize theoretical constructs into a model that can be tested for its ability to explain or predict physical activity behavior. Additionally, these theories can provide researchers and practitioners with a model for physical activity interventions designed to target theoretical constructs in order to change behavior (Cox, Martin Ginis, & Petruzzello, 2010). Using health behavior theory can allow researchers to identify
potentially modifiable correlates of exercise is crucial to evidence-based intervention
development and implementation. Considering individuals with type 2 diabetes have
health concerns such as glycemic control, overweight or obesity, and the potential for
complications, it is reasonable to postulate that this population has a set of unique factors
that predict and contribute to the adoption and maintenance of physical activity and
exercise (Sigal, Kenny, Wasserman, Castaneda-Sceppa, White, 2006; Wing et al., 2001).

A series of descriptive studies was reviewed to identify potentially modifiable
correlates of activity. ERIC, Alt HealthWatch, Health and Psychosocial Instruments,
MEDLINE, and Google Scholar were used as primary databases. Keywords included
physical activity, exercise, correlates, and type 2 diabetes. To select articles for review
the inclusion criteria were: (a) subjects were at least 18 years of age; (b) subjects were
diagnosed with type 2 diabetes; (c) free living physical activity was a dependent variable;
and (d) demographic, personal, behavioral, and environmental factors were tested for
their relationship with physical activity levels. Previous research focusing on
determinants has categorized correlates into demographic, psychosocial, and
environmental in order to consider a full spectrum of factors contributing to regular
exercise (Buckworth et al, 2013).

**Demographic/Biological Factors**

Demographic correlates can be useful in identifying segments of the population
that are more or less responsive to an exercise regimen (Buckworth et al, 2013). Among
adults with type 2 diabetes, BMI, gender, education, income level, and are consistently
related to physical activity behavior. For example, a study conducted by DeGreef, Van
Dyck, Deforche, et al (2011) surveyed 133 adults with type 2 diabetes. Individuals in this sample were engaging in an average of 24.4 (SD = 28.3) minutes of moderate-to-vigorous activity per day, and walked a mean 5365 (SD = 3070) steps per day, as measured by accelerometer and pedometer. Results from this study indicated that having a higher BMI predicted fewer steps per day, as measured by pedometer ($R^2 = .40$, $p < .001$). Additionally, being female predicted lower levels of accelerometer-based light ($\beta = -.26, p < .001$) and moderate-to-vigorous ($\beta = -.24, p < .05$) physical activity. Finally, older age predicted lower levels of light ($\beta = -.25, p < .001$) and moderate-to-vigorous ($\beta = -.20, p < .05$) physical activity. These results indicated that adults with type 2 diabetes who have a high BMI, are female, and are of older age are less likely to engage in activity than leaner, male, and younger adults with type 2 diabetes.

Another study, conducted by Pearte, Gary, & Brancati (2006) sought to determine the correlates of physical activity in a sample of African American adults with type 2 diabetes ($n = 186$). First, 40% of men and 29% of women in the sample reported exercising regularly. Also, similar to results found by DeGreef et al (2011), BMI was negatively associated with levels of leisure time physical activity ($\beta = -0.2, p < .05$) and blocks walked per week ($\beta = -13.0, p < .05$). This study also measured income level, concluding that individuals with a higher income engage in higher levels of leisure-time physical activity (Pearte et al, 2006).

A third large-scale study conducted by Plotnikoff, Taylor, Wilson, et al (2006) gathered data on 1,614 Canadian adults with type 2 diabetes recruited from the Canadian Diabetes Registry. Researchers measured the ability of gender, income, BMI, and education to predict physical activity levels. However, 71.9% of this sample of adults
with type 2 diabetes reported being inactive. Consistent with the above studies, a lower BMI, (β = -0.10, p < .001), male gender (β = 0.16, p < .001), a higher level of education (β = 0.05, p < .05), and a higher income (β = 0.08, p < .01) predicted higher levels of physical activity (Plotnikoff et al, 2006).

The current research indicates that BMI, age, and female gender are negatively associated with physical activity, and income and education level are positively associated with physical activity among adults with type 2 diabetes. One final factor to consider is disease state/disease severity. First, adults diagnosed with type 2 diabetes engage in lower levels of physical activity compared to individuals without type 2 diabetes (Plotnikoff et al, 2006; Grace et al, 2007; Hays & Clark, 1999). In other words, the disease state of type 2 diabetes may predispose individuals to be less likely to engage in regular physical activity. Furthermore, disease severity can be operationalized as beliefs about how serious a condition (i.e. type 2 diabetes) is. For, not only are adults with type 2 diabetes less active than their health counterparts, but also individuals who perceive to be unhealthy or diseased are also consistently less active (Hays & Clark, 1999). A study conducted by Glasgow, Hampson, Strycker, & Ruggiero (1997) found a negative association between the believed seriousness of type 2 diabetes and physical activity levels. This study of 2,055 adults emphasized, that within a sample that consisted entirely of adults with type 2 diabetes, a greater belief in the seriousness of type 2 diabetes was related to engaging less physical activity behavior. This is critical because health educators need to find strategies in order to aid individuals in overcoming their disease status and severity in order to increase physical activity levels.
Environmental Factors

Both social and physical environmental correlates of physical activity among adults with type 2 diabetes include social support, weather, availability of facilities, and neighborhood walkability.

Plotnikoff, Brez, & Hotz (2000) conducted a sixth month study in order to identify the factors associated with exercise among adults with diabetes (n = 46). Energy expenditure was calculated by asking participants to report the extent to which they engaged in 21 leisure time physical activities (i.e. walking, swimming, cycling, tennis) in the past month. For this sample, weather appeared to be a barrier for physical activity. For, energy expenditure from physical activity was significantly lower during the winter months than the summer months. Additionally, winter explained 20% and summer explained 15% of the variability in energy expenditure from physical activity (Plotnikoff et al, 2000). Similarly, Swift, Armstrong, Beerman, Campbell, & Pond-Smith (1995) compared exercisers (n = 43, exercising at least 3 days per week) versus nonexercisers (n= 40) within a sample of adults with type 2 diabetes. Outside influences such as “[exercise] habits depend on weather” and “only [exercise] when weather is right” were significantly related to exercise behavior. In other words, nonexercisers were less likely to exercise in poor weather and relied more on perfect weather for exercise engagement (Swift et al, 1995). This demonstrates that although weather is a barrier to physical activity, those individuals who engage in regular physical activity are more likely to persevere in order to maintain their activity levels.

In addition to weather, researchers have investigated the role of facilities and neighborhood walkability in physical activity behavior among adults with type 2
diabetes. DeGreef, Van Dyck, and Deforche (2011) sought to determine the relationship between the physical environment and physical activity. As reported above, 133 adults with type 2 diabetes were sampled. Physical activity was measured via pedometer, accelerometry, and self-report. After controlling for sociodemographic variables, access to exercise facilities and equipment explained 15% of the variance in moderate-to-vigorous physical activity. Individuals with access to home equipment were more likely to engage in light-based and moderate-to vigorous accelerometer activity as well as self-reported activity. Additionally, convenience of facilities and walkability were also positively related to self-reported physical activity. Walkability included access to sidewalks and destinations (library, grocery stores, etc.) within walking distance to an individual’s home.

Finally, in addition to physical environmental determinants of physical activity, social support for physical activity has also emerged as an environmental correlate of behavior within this population. Social support can be defined as emotional support and encouragement but also includes instrumental support in which family and friends engage in physical activity together. A study conducted by Krug, Joshu, & Heady (1991) sought to determine the relationship between activity levels and social factors among adults with type 2 diabetes (n = 60). Based on the Exercise History Questionnaire, 36% of adults in this sample engaged in regular aerobic exercise. Also, receiving social support from both family and friends was significantly related to higher levels of activity ($\chi^2 = 3.7, p<.05$). This study also demonstrated that 80% of the sample had experienced exercise relapsed, further suggesting the importance of social support and additional assistance for adoption and maintenance of regular activity. Additionally in a study by Plotnikoff, Brez, & Holz...
(2000), adults with type 2 diabetes who participated in regular physical activity had more support from family and friends compared to those not engaging in regular physical activity. These studies emphasize the importance of social support for engagement of physical activity in this population. However, when compared healthy adults and adults with type 1 diabetes, individuals with type 2 diabetes reported having lower levels of social support for exercise (Plotnikoff, Karunamuni, & Brunet, 2009). Therefore, although social support is associated with physical activity many adults with diabetes report inadequate amounts of social support for physical activity.

**Psychosocial Factors**

Considerable progress has been made in establishing relationships between psychosocial factors and physical activity among adults with type 2 diabetes. Psychosocial factors can be defined as personal and societal factors that are associated with the adoption and maintenance of physical activity (Biddle & Nigg, 2000). These factors, such as perceived behavioral control, self-efficacy, and self-regulation, are often the potentially modifiable correlates targeted in health behavior change interventions (Buckworth et al., 2013). Specifically for adults with type 2 diabetes, attitude toward physical activity, perceived benefits and barriers to physical activity, perceived health, perceived behavioral control, knowledge, and self-efficacy have all been associated with physical activity behavior.

According to Azjen’s Theory of Planned Behavior (TPB), intention immediately precedes behavior. Adults with type 2 diabetes have reported significantly lower intentions for physical activity behavior compared to their healthy counterparts.
(Plotnikoff, Karunamuni, & Brunet, 2009). Also according to TPB, attitude serves as a proximal correlate to intention for behavior. Attitude toward behavior can be defined as the beliefs regarding the behavior (i.e. exercise) and the value placed on the expected outcomes of engaging in the behavior (Biddle & Fuchs, 2009). Plotnikoff, Karunamuni, & Brunet (2009) determined that individuals with type 2 diabetes have a more negative attitude toward physical activity when compared to those without type 2 diabetes. This notion is significant, as Swift et al (1995) found that exercise attitudes explained 43% of the total variance in physical activity. Attitude was measured using 13 items developed from Kenyon’s Attitude Toward Physical Activity Inventory. The original scale contains 59 items for men and 54 items for women. For this study, exercise attitudes were assessed based upon if participants felt exercise to be important, whether or not they prioritized their time for exercise, and whether or not they thought exercise to be beneficial. Because negative attitudes, rather than positive, were related to physical activity in this population, these results suggest that many adults with type 2 diabetes may not believe exercise to be beneficial nor value the positive outcomes associated with exercise. Finally, while attitude impacts intention toward behavior, perceived behavioral control is another determinant within TPB said to have an independent, direct impact on behavior.

Perceived behavioral control is defined as “the perceived ease or difficulty in performing the behavior” (Biddle & Nigg, 2000, p. 295; Biddle & Fuchs, 2009, p. 414). Perceived behavioral control stemmed from the theoretical assumption that all behavior is under direct, personal control (Hagger, Chatzisarantis, & Biddle, 2002). For example, Glasgow, Hampton, & Strycker (1997) demonstrated that adults with type 2 diabetes
understand that self-management techniques will aid in their disease management. In other words, these individuals demonstrate a level of control over their health lifestyle behavior. For, individuals who reported having higher levels of perceived behavioral control were also more likely to engage in physical activity (Boudreau & Godin, 2009). However, individuals with type 2 diabetes have reported having lower perceived behavioral control than adults without diabetes.

Common barriers to physical activity include lack of time, lack of facilities, boredom, and fatigue. As a result, these barriers can negatively influence the participation in regular physical activity (Buckworth & Dishman, 1999). For example, in a study conducted by Glasgow, Hampton, & Strycker (1997), perceived barriers to physical activity among adults with type 2 diabetes were negatively associated with levels of physical activity \( r = -.07, p < .001 \). Additionally, barriers to exercise were more often reported than barriers to diet, medication, and glucose testing. While Glasgow et al (1997) measured total barriers to physical activity, Thomas, Alder, & Leese (2004) identified more specific barriers. For, perceived difficulty of exercise, fatigue, lack of time, and lack of access to facilities were all reported as significant barriers to physical activity among a sample of 406 adults with type 2 diabetes. As a result, those individuals who were engaging in regular exercise were less likely to report exercise as difficult and more likely to continue exercise when feeling tired, depressed, or in pain (Thomas et al., 2004).

Self-efficacy, or an individual’s confidence in their ability to perform a specific behavior, is a psychosocial variable consistently associated with levels of physical activity in this population. Individuals with type 2 diabetes who have higher self-efficacy
for physical activity are more likely to engage in physical activity. Self-efficacy is a construct found in Social Cognitive Theory (SCT). SCT emphasizes the concept of reciprocal determinism, stating that behavior is the result of the mutual interaction between personal, behavioral, and environmental factors. In addition to self-efficacy, SCT include constructs such as social support, self-regulation, and outcome expectations. Research has shown that individuals with type 2 diabetes who have been regularly exercising for 6 months or less have higher self-efficacy than those individuals who were not participating in exercise (Plotnikoff, Brez, & Hotz, 2000). Additionally, self-efficacy has been examined prospectively. Plotnikoff, Lippke, & Courneya (2008) demonstrated that baseline self-efficacy was positively correlated with levels of physical activity at 6-month follow-up. Although self-efficacy has been positively associated with physical activity behavior in this population, adults with type 2 diabetes report having significantly lower self-efficacy for exercise when compared to individuals without disease (Grace, Barry-Bianchi, Stewart, Rukholm, & Nolan, 2007; Plotnikoff, Brez, & Brunet, 2003).

Finally, knowledge of physical activity appears to be unrelated to actual physical activity levels. For example, a study conducted by Hays and Clark (1999) measured knowledge of exercise intensity, psychological benefits of exercise, and health benefits of exercise, finding no correlation between knowledge levels and actual activity. A similar study conducted by Plotnikoff, Brez, & Brunet (2003) found that although participants were knowledgeable in terms of the importance of exercise for disease management, individuals were still failing to meet the minimum guidelines for physical activity. Therefore, regardless of their knowledge in terms of physical activity and disease
management, adults with type 2 diabetes appear to rely on the use of additional psychosocial and environmental factors in terms of their engagement in physical activity.

**Conclusions**

Descriptive studies allow researchers to explore the relationships between potentially modifiable factors and physical activity. Results from descriptive studies suggest that individuals with type 2 diabetes who have higher self-efficacy, higher perceived behavioral control, lower perceived barriers, more social support from family and friends, and higher self-regulation, are more likely to engage in regular physical activity. Focusing on identifying the correlates of behavior is important. Results from these studies can provide researchers with a framework for the development and implementation of intervention studies focusing on physical activity behavior change. We, as researchers, can use this information to develop programs tailored to the needs of adults with type 2 diabetes in order to positively impact psychosocial correlates in order to stimulate behavior change.

Moving forward, it is important to investigate the ability of these theoretical constructs to change behavior. The descriptive studies outlined above provide researchers with a sense of the potentially modifiable variables related to physical activity behavior. These factors are important to understand and relate to behavior. By reviewing the above descriptive studies, researchers are able to use these correlates to build a framework for health promotion programs. In order to understand the utility of these variables, it is important to investigate the techniques and strategies employed to change physical activity behavior among adults with type 2 diabetes.
Pilot Study

Following a review of the literature on descriptive and intervention studies related to physical activity, a pilot study was conducted on the demographic, environmental, and psychosocial correlates of moderate exercise among adults with type 2 diabetes. This study is important because it expands upon the previous descriptive research on correlates of physical activity in this population by incorporating a test of SCT. Many of the descriptive studies reviewed in the previous section were not based on health behavior theory. While many of the studies incorporated constructs from theories such as SCT and the TPB, a majority of these studies were not a true test of theory. By putting the constructs into the theoretical framework, researchers can better test the theory and understand which factors truly explain or predict physical activity behavior (Lox, Martin Ginis, & Petruzzello, 2010). It is critical to use the information from the above studies to develop studies that are based in health behavior theory.

Overview of Social Cognitive Theory

As briefly stated in the previous section, Social Cognitive Theory (SCT) is behavioral theory set forth by Albert Bandura in the mid-1980s. SCT stems from social learning theory, which suggests that behavioral learning is primarily achieved through social interactions (Buckworth et al., 2013; Glanz et al., 2008). SCT assumes that behavior is purposeful and under the direct control of an individual. This also means that an individual is capable of self-reflection and self-regulation. People have the ability to reflect upon their own thoughts and experiences, and alter their behavior and
environment accordingly (Buckworth et al., 2013). SCT also emphasizes the concept of reciprocal determinism, where behavior is the result of the mutual interaction between personal, environmental, and behavioral factors (Figure 1). According to Bandura, while the environment often shapes human behavior, individuals have the potential to alter their environment to suit their behavioral needs. Additionally, people can use social interactions in order to collectively change an environment to benefit their behavior or the behavior of a group (Glanz et al., 2008). The person, behavior, and environment have also been used in SCT to group major theoretical constructs such as outcome expectancies, self-regulation, self-efficacy, collective efficacy, incentive motivation, and facilitation.

![Figure 1. Depiction of Reciprocal Determinism as Defined by Social Cognitive Theory](image)

Outcome expectancies can be defined as the beliefs regarding the consequences of a behavior. In addition to these beliefs, outcome expectancies are also the value associated with these consequences (Glanz et al., 2008). For example, an individual might believe that physical activity will benefit their health, while placing a positive
expectation to feel better following exercise (Biddle & Fuchs, 2009). Self-regulation occurs when individuals use their goals, cognitions, and feelings to regulate their behavior (Biddle & Fuchs, 2009). According to SCT, self-regulation is achieved through goal setting, self-monitoring, feedback, self-reward, and the enlistment of social support (Glanz et al., 2008). Self-efficacy is defined as an individual’s belief in their ability to perform a particular behavior (Glanz et al., 2008; Lox et al., 2010). Self-efficacy is often at the forefront of SCT research, and has been identified as the strongest correlate of physical activity (Rhodes & Nigg, 2011). The four major contributors to self-efficacy (in order of importance) are mastery experience, modeling, verbal persuasion, and physiological and emotional arousal (Biddle & Nigg, 2000). Collective efficacy is an extension of self-efficacy, operationalized as the beliefs of a group to perform a behavior in order to achieve a desired outcome (Glanz et al, 2008). Finally, incentive motivation and facilitation are environmental determinants of behavior. According to SCT, no psychosocial construct (i.e. self-efficacy, self-regulation, outcome expectancies) can achieve behavior change without the support of the environment. Incentive motivation occurs when individuals use external rewards and punishments to modify their behavior. A second environmental determinant is facilitation, or the establishment of resources that enable behavior change (Glanz et al., 2008). It is important for individuals to be able to overcome perceived barriers to physical activity, and facilitation is theorized as a construct that can aid in the removal of perceived barriers (Glanz et al., 2008; Palmeira et al., 2007). Together, theses constructs fit the SCT reciprocal determinism framework that can be tested for ability to explain and predict behavior.
Purpose

All of the SCT variables theoretically interact to influence behavior. Therefore, it is important to understand how all of these constructs influence physical activity among adults with type 2 diabetes. The purpose of this pilot study was to identify SCT correlates of moderate intensity exercise among adults with type 2 diabetes. Specifically, this study determined the ability of self-efficacy, self-regulation, social support, outcome expectations, and aspects of the physical environment to explain the variability in moderate intensity exercise among adults with type 2 diabetes. Together these variables represent a test of potentially modifiable variables from SCT that have implications for the design of diabetes education programs aimed to increase regular, moderate intensity exercise.

Methods

This study was a cross-sectional online survey study with a sample of adults with type 2 diabetes. Adults (≥ 18 years) were recruited from ResearchMatch.org. ResearchMatch.org is a National Institute of Health (NIH) sponsored website that allows individuals to register as study volunteers, while also providing researchers with the opportunity to recruit subjects for their studies. 250 individuals accepted the invitation to participate in the study, and received a secure link to the online survey from the researcher.

The following variables were measured: moderate-intensity exercise, self-efficacy, self-regulation, outcome expectations, social support, and environmental walkability. The Modified Paffenbarger Physical Activity Questionnaire was used to
measure the amount of time individuals spent participating in moderate- and vigorous-intensity exercise over the course of the past seven days. They were specifically asked to list moderate-intensity activities they participated in during the past week, including days per week and average duration per day for each exercise. Moderate exercise was defined as working hard enough to raise your heart rate and break a sweat. Examples included doing water aerobics and riding a bike on level ground (Paffenbarger, Hyde, Wing, Lee, Jung, & Kampert, 1993).

Self-efficacy was measured using The Exercise Confidence Survey (ECS) (Cronbach’s α = .866) and The Multidimensional Self-Efficacy Scale (MSES) (Cronbach’s α = .954). More than one scale was used because self-efficacy is often considered to be multilayered and requires individual skills and competencies to perform a behavior (Rogers, Wilson, Hall, Fraser, & Murray, 2008). The ECS was used to measure how confident individuals were in sticking to their exercise habits (i.e. “Stick to your exercise program when you have excessive demands at work”) and making time for exercise (i.e. “Get up early, even on weekends, to exercise”) for at least 6 months (Sallis, Pinksiki, Grossman, Patterson, & Nader, 1998). The MSES was used to measure how confident individuals are in maintaining their exercise habits for at least 6 months. This scale measured task efficacy (Cronbach’s α = .915), scheduling efficacy (Cronbach’s α = .868), and coping efficacy (Cronbach’s α = .917) using a 10-point Likert scale asking participants to rate their confidence from “Not at all confident” to “Completely confident” (Rogers et al, 2008).

Self-Regulation is the systematic use of strategies to control personal behavior based on personal goals and intentions (Biddle & Fuchs, 2009). The Self-Regulation of
Exercise Scale (Cronbach’s $\alpha = .96$) was used to measure individuals’ perceptions of how well they were able to regulate their exercise habits through a series of behavioral strategies (Hallam & Petosa, 1998). Participants were asked to rate how often they performed these strategies to help them exercise over the past four weeks on a 5-point scale rating from “Never” to “Very Often”. Specific subscales of the self-regulation scale included: self-monitoring (Cronbach’s $\alpha = .926$), goal setting (Cronbach’s $\alpha = .827$), social support (Cronbach’s $\alpha = .918$), self-reward (Cronbach’s $\alpha = .784$), time management (Cronbach’s $\alpha = .908$), and overcoming barriers (Cronbach’s $\alpha = .869$).

The Multidimensional Outcome Expectations for Exercise Scale (Cronbach’s $\alpha = .939$) was used. Respondents rate 15 statements on a 5-point Likert scale from “Strongly Disagree” to “Strongly Agree”. Three subscales included physical (Cronbach’s $\alpha = .921$), social (Cronbach’s $\alpha = .81$), and self-evaluative (Cronbach’s $\alpha = .926$) outcomes of exercise.

The Social Support and Exercise Survey measured social support from family and friends (Sallis, Grossman, Pinski, Patteson, & Nader, 1987). The scale measured support from family (Cronbach’s $\alpha = .951$) and support from friends (Cronbach’s $\alpha = .938$) separately. Participants rated how often individuals living in their household, and how often their friends, acquaintances, or coworkers, had supported their exercise over the past three months.

Three subscales from the Neighborhood Environment Walkability Scale (NEWS) were used to assess participants’ perceptions regarding environmental attributes including access to stores and facilities in their neighborhood (Cronbach’s $\alpha = .956$), access to facilities (Cronbach’s $\alpha = .682$), and places for walking and cycling (Cronbach’s $\alpha = \ldots$)
The first subscale asked individuals to estimate how long it would take for them to walk from their home to a list of business/facilities (i.e. grocery store, library, post office). The other two subscales asked participate to rate the extent to which they believe services and facilities are accessible within their neighborhood, and to which they have place to walk and cycle safely within their neighborhood. All scales used 4-point scale ratings from “Strongly Disagree” to “Strongly Agree” (Cerin et al, 2006; Saelens et al, 2002).

**Results**

Of the 250 adults with type 2 diabetes who agreed to participate in the study, 181 (66% female) participants completed the survey. The mean age was 53.3 years, ranging from 24 to 83. A majority of the participants were white (76.2%), married (57.5%), and had a college degree (31.5%). 60.8% of the sample had been diagnosed with type 2 diabetes for 10 or less years, and the average BMI was 35.5 kg/m². 6.6% of the sample was considering normal weight (BMI range 18.5-24.9 kg/m²), 39% of the sample was categorized as overweight (BMI range 25-29.9 kg/m²), and 70.7% of the sample was categorized as obese (BMI ≥ 30 kg/m²).

On average, participants engaged in 112.83 minutes of moderate intensity exercise per week. 33.1% of individuals reported 0 minutes of moderate-intensity exercise per week, 31.5% of individuals reported at least 150 minutes of moderate-intensity exercise per week, and 13.3% reported greater than 300 minutes of moderate-intensity exercise per week.
Pearson Product Moment Correlation Analysis identified the following correlates to be associated with minutes of moderate exercise per week: self-efficacy for making time for exercise \( (r = .210, p = .007) \), task self-efficacy \( (r = .197, p = .012) \), scheduling self-efficacy \( (r = .257, p = .001) \), coping self-efficacy \( (r = .160, p = .043) \), self-monitoring \( (r = .297, p < .001) \), goal setting \( (r = .305, p < .001) \), social support \( (r = .241, p = .002) \), self-reward \( (r = .214, p = .007) \), time management \( (r = .303, p < .001) \), overcoming barriers \( (r = .320, p < .001) \), and self-regulation \( (r = .322, p < .001) \). These results suggest a relationship between SCT constructs and exercise in this population. These results also suggest that individuals who incorporate behavioral strategies such as setting goals and self-monitoring, and also have self-efficacy for coping with barriers and making time for exercise, engage in more minutes of moderate intensity exercise per week.

Classification and Regression Analysis estimated a decision tree model in order to partition the variance of minutes of moderate intensity per week. Results from this analysis demonstrated that 42.4\% of the variance in minutes of moderate exercise per week can be explained by the combination of the SCT correlates (self-efficacy, self-regulation, social support, outcome expectancies, physical environment). Specifically, the self-regulation subscale of self-monitoring explained the largest portion of the variability, contributing 11.2\% of the 42.4\%. This was followed by social support from family (8.5\%) and social support from friends (8.0\%). Self-efficacy only contributed to a small percentage of the variability. Self-efficacy for making time for exercise and tasks self-efficacy contribute 1.0\% and 1.49\% of the 42.4\%, respectively. Finally, self-evaluative and social outcome expectations contributed to the variability in moderate exercise, explaining 3.68\% and 1.32\% of the variability, respectively. Self-efficacy for sticking to
exercise, scheduling self-efficacy, coping self-efficacy, goal setting, time management, physical outcome expectations, and the physical environment did not contribute to the model.

**Self-Monitoring**

The strongest SCT variable to emerge from this pilot study was self-monitoring. When all of the SCT variables were considered together, self-monitoring contributed the most to the variability in moderate exercise. Previous research has demonstrated the self-regulation is important for type 2 diabetes management (Norris, Engelgau, Venkat, & Narayan, 2001). Individuals with type 2 diabetes are commonly required to monitor their blood glucose on a daily basis. Additionally, this population is often asked to carefully monitor their dietary behavior and its influence on blood glucose levels. As a result, self-regulation and self-management training has historically played a role in type 2 diabetes management and metabolic control (Norris et al, 2001). Research has shown education-based intervention studies designed to improve diabetes self-care. However, these studies often prioritize diet and glucose over exercise, and focus on knowledge acquisition (Bjorntorp & Krotiewski, 1985). First, based on a review of descriptive studies, knowledge appears to be uncorrelated with behavior. There is also evidence that adults with type 2 diabetes may have a set of self-regulatory skills in order to monitor diet and blood glucose. Therefore, health educators may consider focusing on advancing any pre-existing use of self-regulatory strategies to also include exercise behavior. This cross-sectional pilot study provided evidence that individuals who are engaging in higher levels of moderate exercise per week, may be doing so through self-monitoring. Therefore, it is
important to expand upon these findings in order to determine if targeting and changing self-monitoring can have a positive impact on exercise behavior among adults with type 2 diabetes. The above pilot study tested SCT in a sample of adults with type 2 diabetes and concluded that among all SCT constructs, self-monitoring has the potential to be modified to increase exercise behavior in this population. Using results from descriptive studies on the correlates of behavior is important to incorporate potentially modifiable determinants in health promotion programs in order to determine if a change in said correlates can produce a significant and lasting change in behavior.

**Physical Activity Interventions**

The purpose of this section is to review the intervention studies that have been conducted among adults with type 2 diabetes. The previous sections have focused on primarily cross-sectional research designs in order to identify correlates of physical activity behavior among adults with type 2 diabetes. It is important to review studies that have employed experimental research designs in order to determine the impact of different intervention strategies on factors such as physical activity, metabolic control, and theoretical constructs. Upon reviewing intervention studies, there was a major distinction in the primary objectives of intervention studies. Emerged from the literature were either studies that focused on metabolic changes as the major outcome (HbA1c, cholesterol, LDL, etc.) or physical activity behavior changes as the major outcome. Both categories are outlined and discussed below.
**Intervention Studies Focused on Metabolic Changes**

The Italian Diabetes and Exercise Study (IDES), conducted by Balducci et al. (2010), engaged individuals with type 2 diabetes in a twice-a-week supervised aerobic and resistance training for a period of 12 months. Compared to the control group (n = 275), individuals engaging in structured and supervised exercise (n = 288) produced significant improvements in HbA1c, blood pressure, LDL cholesterol, and HDL cholesterol. Additionally, individuals receiving supervised training and structured counseling were engaging in physical activity outside of the twice-per-week program in order to exceed the minimum recommendation of 150 minutes of activity per week (Balducci et al., 2010). In other words, the volume of physical activity was critical to reducing HbA1c values in addition to other cardiovascular risk factors. This notion was also supported by Negri et al. (2007); determining that low walking speed might not be sufficient to produce positive metabolic changes. In this study, individuals in the intervention group (n = 39) engaged in supervised 45 minute walking sessions three times per week. Individuals also participated in individual and group counseling sessions and baseline and 2 months. At 4-month follow-up, the intervention group did show significant improvements in A1C and cholesterol, but there were no significant differences between the intervention and control groups (Negri et al, 2007). However, low compliance with exercise prescription presented itself as a problem as subjects only attended 60% of the three-times-a-week walking sessions. When the analysis was conducted for participants who attended at least 50% of the walking sessions (n = 21), changes in A1C and fasting glucose were significantly greater in these participants when compared to the control group. Another study conducted by Wing, Epstein, Paternostro-Bayles, Kiska, Nowalk, &
Gooding (1988) sought to determine the impact of diet versus diet plus exercise on weight loss and glycemic control among individuals with type 2 diabetes. At 1-year follow-up, those individuals who were engaging in high levels of exercise (≥1372 kcals/week) had the largest amount of weight loss and greatest improvements in HbA1c when compared to subjects reporting low (168-615 kcal/week) and medium (700-1216 kcal/week) levels of activity. For individuals engaging in low exercise levels experienced a 0.5% increase in their HbA1c levels and 2 kg weight loss from pre-treatment to one year. This is significantly different from the 10 kg weight loss and 2.5% decrease in HbA1c in the high exercise level group. The improvements in HbA1c for individuals engaging in high levels of exercise remained significant after controlling for the effects of weight loss (Wing et al., 1988). Results from these studies provide evidence that individuals who engage in higher volumes of exercise may experience greater improvements in weight, glycemic control, and CVD risk factors compared to lower levels of activity or inactivity. The research also suggests that low levels of activity do no provide sufficient benefits in terms of glycemic control and disease management. Therefore, while these studies support an increase in physical activity leading to improvements in glycemic control, ensuring participants are engaging in the proper volume of exercise is critical to produce said changes.

A major study targeting metabolic changes in individuals with type 2 diabetes is the Look AHEAD trial. The Look AHEAD trial combines diet and exercise modifications (intensive lifestyle group) in order to obtain a > 7% loss of initial body weight after 1 year. Specifically, the physical activity intervention gradually progressed individuals to engage in at least 175 minutes of home-based physical activity per week.
After 1 year, participants in the intensive lifestyle group had a higher percentage of weight loss (8.6%) and greater improvements in fitness (20.9%) when compared to the control group. Additionally, the intensive lifestyle group also had a greater decline in fasting glucose and HbA1c levels (Look Ahead Research Group, 2007). Furthermore, when these results were averaged across 4 years, subjects in the intensive lifestyle group produced greater improvements in fitness, HbA1c, and weight loss when compared to the control group (Look Ahead Research Group, 2010). Although these changes were significant at 4-year follow-up, the greatest difference between the groups on these three markers was observed at 1-year follow-up. Even so, results from the Look AHEAD trial provide substantial evidence that lifestyle changes can produce long-term improvements in weight, fitness, and glycemic control among adults with type 2 diabetes.

Intervention studies that focus on changes in exercise through structured or supervised programs have demonstrated that engaging in the proper volume of activity can significantly improve factors such as weight, fasting glucose, cholesterol, blood pressure, and HbA1c among adults with type 2 diabetes. However, these studies have also suggested that program compliance and engagement are critical to ensuring the positive impact of physical activity on metabolic changes (Look Ahead Research Group, 2007; Negri et al, 2007). Therefore, it is also critical to identify intervention studies that focus on ensuring individuals are not only adopting physical activity, but also engaging in behavior that will have a lasting and meaningful lifestyle change. For, these studies took place under supervised, controlled conditions, and additional research is needed to determine if these changes in exercise can be translated into real-world settings.
**Intervention Studies focused on Physical Activity Behavior Change**

Intervention studies targeting metabolic changes often focus on factors such as weight, cholesterol, blood pressure, fasting glucose, and HbA1c. In the studies mentioned above, exercise prescription was often the independent variable manipulated to produce such changes. Among adults with type 2 diabetes, there is another set of intervention studies where physical activity is the primary outcome. These studies use a wide variety of intervention strategies (web-based, internet-based, counseling, etc.) in order to produce changes in physical activity behavior.

There are intervention studies that use telephone support or web-support in order to promote physical activity behavior. For example, De Greef et al. (2011) conducted a 24-week intervention among adults with type 2 diabetes (N= 92). Individuals with type 2 diabetes were recruited and then randomized into an intervention group (n= 60) and control group (n=32). The intervention group received a pedometer and a total of seven 20-minute phone calls that included instruction on goal-setting, self-monitoring, self-efficacy, social support, and relapse prevention. Participants received bi-weekly phone calls for the first four weeks, and then monthly for the remaining 20 weeks. Following the intervention, the intervention group increased their number of steps per day by 2744; a phenomenon that continued with an increase of 1872 steps per day at 1-year follow-up. However, at 1-year follow-up, individuals in the intervention group were not meeting the minimum guidelines for physical activity; walking only 6831 steps per day and engaging in 19 minutes of moderate-to-vigorous physical activity per day (as measured by accelerometer)(De Greef et al., 2011).

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Another study conducted by McKay, King, Eakin, Seeley, & Glasgow (2001) administered an 8-week Internet-based intervention. Upon recruitment, 78 participants were randomized to either receive the intervention (n = 38) or information-only (n = 40). Individuals in the information-only control group received information regarding physical activity benefits, guidelines, and safety precautions. Individuals in the intervention group received a personalized program that identified the benefits of physical activity, their specific goals, and personal barriers to physical activity. Participants also received bi-weekly tailored messages from a personal coach, and were able to communicate with other individuals in the intervention group as a means of social support. The personal coach send a total of 5 tailored messages over the course of 8 weeks, referred participants to intervention website access and links, sent tips and reminders, and provided a schedule of weekly activity. While both groups demonstrated a moderate increase in physical activity, there was no difference between the intervention and control groups at follow-up. A major factor that may have contributed to these results is Internet usage, as there was a step decline in Internet usage over the course of 8 weeks. However, those individuals who did continue to use the program regularly also produced greater improvements in physical activity (McKay et al., 2001). When comparing telephone- and internet-based interventions, the evidence is inconclusive as to which method produces greater changes in physical activity. While the telephone-based methods produced long lasting changes over the course of one year, participants were still not reaching the minimum guidelines for physical activity. Additionally, the internet-based program appeared to have a more significant impact on individuals who actually
used the program, suggesting the need to target compliance in order to produce positive and sustainable changes in behavior.

Among intervention studies, there is also a small set of research that employs the use of behavioral theories in order to stimulate positive behavior change. For example, the First Step Program used the framework of social cognitive theory (SCT) in order to target social support, goal setting, and self-regulation for exercise behavior. A pilot study of this program used group meetings, pedometers, and telephone contact in order to target walking behavior of adults with type 2 diabetes (n= 9). The First Step Program has two phases, each lasting 1 month. The first phase consists of four group meetings. These group meetings consisted of a group walk lasting between 10 and 30 minutes, group discussion on strategy planning, and individualized goal setting. Pedometers were used both as a self-monitoring technique as well as a measurement of physical activity. The second phase of the program consisted of individuals continuing to use the pedometer and monitor their behavior, with little group discussion or professional help. Following the intervention, individuals increased their walking minutes per day to an average of 34.3. Additionally, this change was sustained 2-months after withdrawal of contact (mean of 22.6 minutes of walking per day)(Tudor-Locke, Myers, Bell, Stewart, Harris, & Rodger, 2002).

Another study conducted by Kirk, Mutrie, MacIntyre, & Fisher (2003) used the Transtheoretical Model in order to create personalized, stage-matched interventions for individuals (n= 70). All participants were either in contemplation or preparation. Of the 70 participants, 35 were randomized to receive an exercise consultation and 35 participants received a standard exercise leaflet. Exercise consultations incorporated
techniques known to positively influence self-efficacy, decisional balance, and processes of change in order encourage movement through the stages. The exercise consultation involved a 30-minute discussing with a trained research assistant. The purpose of this consultation was to encourage participants to engage in 30 minutes of moderate activity per day. Follow-up phone calls were given and 1- and 3-month follow-up. These phone calls provided support in terms of setting goals, discuss experienced benefits and barriers to physical activity, and relapse prevention. Physical activity was measured using an accelerometer worn for 7 days. At 6-month follow-up, participants in the intervention group experienced a 28% increase in physical activity counts per week. The control group experienced a 12% decrease in physical activity counts per week. Additionally, 83% of the participants progressed one or more stages in the transtheoretical model (Kirk et al., 2003).

Finally, the Alberta Diabetes and Physical Activity Trial (ADAPT) was a randomized control trial based on both SCT and the transtheoretical model. This study had three groups: a control group, a group that received stage-based print materials, a pedometer, a logbook, and a progress calendar (Group 2), and a group that received the same materials as Group 2 with the addition of physical activity telephone counseling (Plotnikoff et al., 2010). At 12-month follow-up moderate-to-vigorous physical activity in Group 2 and Group 3 did not change significantly when compared to the control group. The only significant change in steps per day was observed in women in Group 3 (Plotnikoff, Karunamuni, Courneya, Sigal, Johnson, & Johnson, 2013).

Intervention studies targeting physical activity behavior change among adults with type 2 diabetes have produced mixed results. For example, Kirk, Barnett, Leese, &
Multrie (2009) did not find a difference between a theory-based consultation delivered by a person versus delivered in written format for increasing 6-and 12-month physical activity. However, the First Step Program was successful in increasing minutes of walking per day following a theory-based pedometer and telephone intervention (Tudor-Locke et al., 2002). Additionally, Kirk et al (2003) demonstrated significant increases in physical activity in their sample following a transtheoretical model-based intervention. These studies, as well as the ones mentioned above, had incorporated the use of different intervention strategies, theories, measurement techniques, and time lines in order to yield inconsistent results in physical activity behavior change. However, there is evidence to support that interventions based on health behavior theory are more successful in changing physical activity behavior. Unfortunately, many of these studies did not report changing theoretical constructs. For example, although the First Step Program was based on social cognitive theory, the researchers did not measure if there was a change in theoretical constructs. Without this evidence, it is difficult to discern the presence of a cause-and-effect relationship between theoretical constructs and physical activity behavior change. For, while there is evidence that health behavior interventions can change physical activity behavior among adults with type 2 diabetes, it is still unclear the extent to which the use of theoretical constructs influence behavior change.

**Conclusion**

The review of the literature demonstrated that the interventions designed to produce behavior change are often unfocused. Among adults with type 2 diabetes, there have been a wide variety of methods and strategies targeting in attempts to stimulate
behavior change. Additionally, many of these interventions are not truly grounded in theory and therefore lack an evidence-based framework as a building block for their program. Moving forward, this is a summary of factors that need to be considered when conduction physical activity intervention research for adults with type 2 diabetes:

- The intervention studies outlined in the review above that focused on metabolic changes were successful in concluding that increases in exercise can produce improvements in glycemic control. However, these studies took place under supervised, controlled conditions. Additional research is needed to determine if these changes in exercise can be translated into real-world settings.

- The intervention studies that focused on physical activity behavior change produced mixed results in their effectiveness to stimulate behavior change. The following research needs are require to address this issue:
  - Research needs to focus on having individuals reach the minimum guidelines for physical activity in order to stimulate metabolic changes. Unless individuals are meeting these requirements, their participation in activity may not produce the desired changes.
  - Research needs to focus on not just physical activity adoption, but also physical activity maintenance. Therefore, research should focus on determining an appropriate length of time that an intervention needs to be in order to truly stimulate a positive change that will lead to physical activity maintenance over the long-term.
  - The above review outlined a variety of intervention delivery methods (print materials, telephone-based, Internet-based, etc.). Research needs to direct
focus on determining if there is a method of intervention delivery that produces more positive results above those produced by other delivery methods.

• The above review provided evidence that the use of behavioral theories may be useful in producing behavior change. The following research needs are required to improve theory-based studies
  o Research needs to focus on known correlates of physical activity in this population. Evaluating results from descriptive and prospective studies can aid researchers in targeting variables and theories that have known relationships with activity among adults with type 2 diabetes.
  o Research needs to focus on better measurement of theoretical constructs. For example, studies reviewed above based their interventions on SCT, using self-efficacy, goal setting, and social support as major contributors to behavior change. However, these constructs were not measured. It is critical for researchers to measure theoretical constructs in order to determine their true impact on behavior change.
  o Theoretical frameworks are based on the foundation that theoretical constructs are an antecedent to behavior. In order to truly test a theory, a change in a construct (i.e. self-efficacy) needs to precede a change in behavior. Therefore, research needs to focus on determining if positive changes in theoretical constructs produce positive changes in physical activity behavior.
Physical Activity Measurement

The final section of this chapter will introduce the concept of physical activity measurement as well as review the validation studies conducted specifically on the BodyMedia Armband. There are many ways to quantify physical activity behavior. First, activity can be categorized by type, duration, frequency, and time. Additionally, activity can be described as occupational, leisure, structured, free-living, and so on (Welk, 2002). Understanding these different dimensions of activity is important for physical activity epidemiology. In order to examine the relationships between physical activity and variables such as disease, determinants, and other behaviors, it is critical to have an accurate depiction of a population’s activity levels (Welk, 2002).

Research has demonstrated a wide variety of methods in terms of measuring physical activity behavior, including self-report questionnaires, pedometers, heart rate monitors, and activity monitors. Self-report measures are the most commonly used measurement technique. For example, in a literature review conducted on the correlates of physical activity among adults with type 2 diabetes, all 18 studies reviewed used self-report measures (Heiss & Petosa, 2014). These measures are inexpensive, allow a large sample size, can be administered quickly, and have a low burden to the participant. However, the limitations of self-report are also well documented (Welk, 2002). First, many self-report instruments require participant recall. For example, the modified Paffenbarger requires participants to recall their walking activity, stairs climbed, and moderate- and vigorous-intensity exercise from the previous seven days (Paffenbarger et al, 1993). Participants may have difficulty recalling all activity, especially in terms of duration and intensity. Additionally, different self-report measures may have different
assessments in terms of their ability to detect the different dimensions of activity. While self-report measures have advantages as well as their place in health behavior research, it is important that researchers are prioritizing more direct measures of physical activity and exercise.

The BodyMedia (also called, SenseWear) Armband has gained popularity and attention in recent years for its consumer technology and ability to help individuals manage their caloric expenditure for weight management. As a result, it has become an interest in health behavior research in order to determine its ability to objectively measure free-living physical activity and exercise. The BodyMedia Armband, placed on the triceps, uses multiple sensors to capture skin temperature, heat flux, and galvanic skin response. The device also contains a 3-axis-accelerometer. As a result, the Armband can be used to track caloric expenditure, minutes of physical activity, physical activity intensity, number of steps taken, and sleep duration. There have also been a series of publications validating this device. First, a study conducted by St-Onge, Mignault, Allison, and Rabasa-Lhoret (2007) sought to compare energy expenditure measure via BodyMedia with doubly labeled water among 45 free-living adults. Over a 10-day period, mean energy expenditure measured with the armband was 2375 kcal/day and 2493 kcal/day with doubly labeled water; resulting in an intraclass correlation of 0.81 (p < .01)(St-Onge et al., 2007). A similar study by Jakicic, Marcus, Gallagher, Randall, Thomas, Goss, and Robertson (2004) assessed the accuracy of the BodyMedia armband during exercise. 40 participants were asked to engage in 20-30 minutes of walking, cycling, stepping, and arm ergometry. Energy expenditure was measured via indirect open-circuit calorimetry (used as the criterion) in addition to the BodyMedia. Results
indicated that there were no significant differences in the total energy expenditure between indirect calorimetry and the armband across each of the four exercise modes (Jakicic et al., 2004). In addition to energy expenditure, research has also sought to compare the minutes of moderate-to-vigorous physical activity measured via BodyMedia with other physical activity assessments (Berntsen, Hageberg, Aandstad, Mowinckel, Anderssen, Carlsen, & Andersen, 2010). Following 120 minutes of physical activity, the armband overestimated minutes of moderate-to-vigorous activity by 2.9%. The Armband also demonstrated a significant intraclass correlation with indirect calorimetry and ikcal heart rate monitor (Berntsen et al., 2010). Finally, a validation study was also conducted in a sample of adults with type 2 diabetes. Mignault, St.-Onge, Karelis, Allison, and Rabasa-Lhoret (2005) found no significant difference in energy expenditure between the armband and DLW during a 10-day period. Additionally the intraclass correlation (ICC) between the two measurement techniques reached ICC = 0.9696 (Mignault, et al, 2005).

Given the extensive validation studies on this device, researchers may want to incorporate the use of the BodyMedia Armband in order to get a more direct measure of free-living behavior. As researchers and educators develop health promotion programs, it is critical to understand individuals’ behavior. First, assessing physical activity behavior accurately plays an important role in describing the differing activity levels of certain segments of the population. It allows us to understand whether or not individuals are meeting the minimum guidelines for physical activity. Additionally, knowing an individual’s current behavior (or baseline behavior) can help determine the level of intervention they may need to improve upon physical activity behavior. Without accurate measurement, it is difficult to discern how much guidance individuals require and if they
are truly meeting the physical activity guidelines. As a result, quality measurement should be prioritized when developing behavior change programs for physical activity.

**Summary**

The purpose of this section was to review the benefits of physical activity for adults with type 2 diabetes, as well as review the current literature on determinants of physical activity as well as physical activity interventions in this population. First, there is sufficient evidence to suggest that engaging in regular moderate-to-vigorous activity can significantly improve insulin sensitivity and glycemic control among adults with type 2 diabetes. This evidence emphasizes that regular exercise should be at the forefront of type 2 diabetes management. However, a majority of adults with type 2 diabetes are not regularly active, with less than a third of this population reporting regular engagement in physical activity. These factors suggest a need to bridge this gap and develop strategies to increase exercise in this population.

This section reviewed the demographic, psychosocial, and environmental correlates of physical activity among adults with type 2 diabetes. When seeking to assess or change physical activity in a particular population, it is important to understand the factors associated with physical activity behavior. From the review conducted on descriptive studies, researchers can understand that self-efficacy, social support, perceived behavioral control, attitude, and intention are some of the factors associated with exercise behavior among adults with type 2 diabetes. Understanding associations between these factors and behavior serves as an important framework to develop and implement health promotion programs. This section also stressed the importance of
physical activity measurement in the context of behavior change interventions. Based upon intervention studies, health promotion programs have employed a variety of strategies to change behavior among adults with type 2 diabetes. Studies that incorporated theoretical constructs appeared to have some success in terms of changing behavior. However, these studies were not always a true test of theory, often failing to measure theoretical constructs or determining the impact of changing variables on changing behavior. This section also reviewed a cross-sectional pilot study seeking to determine the SCT correlates of moderate exercise among adults with type 2 diabetes. This pilot study explored SCT correlates of moderate exercise among adults with type 2 diabetes added to the descriptive research by identifying potentially modifiable, theory-based constructs related to exercise. Additionally, as self-monitoring emerged, as the strongest contributor to behavior, there is evidence to suggest that incorporating self-monitoring into a health behavior intervention may produce positive behavior change within this population. Therefore, the next chapter will seek to outline a study intended to determine the impact of a self-monitoring intervention on exercise behavior among a sample of adults with type 2 diabetes.

The following study is based upon the findings from descriptive studies and a pilot study that built upon said descriptive studies by testing social cognitive theory in order to identify correlates of moderate exercise. These findings suggested that self-monitoring may be an important potentially modifiable determinant of behavior. Based upon the review of intervention studies, it is important to base programs off of findings from descriptive studies. Additionally, it is important to measure theoretical constructs in order to determine their impact on behavior. The following study will add to the rigor of
the above intervention studies by focusing on the ability of a behavioral intervention to impact theoretical constructs as well as MVPA. Additionally, this study will emphasize quality measurement of physical activity by incorporating the BodyMedia Armband. Without valid and reliable measurement, it is difficult to both describe behavior as well as determine the true impact of an intervention. It is expected that the following study will provide evidence that incorporating theoretical-based constructs into intervention development and focusing on sound, objective measurement will pave the way for theory-drive health promotion programs intended to promote regular exercise among adults with type 2 diabetes.
Chapter 3

Methods

The literature review conducted in the previous chapter emphasized the need for theory-based interventions that objectively measure physical activity in order to stimulate behavior change among adults with type 2 diabetes. As stated in Chapter 2, research has repeatedly shown that engagement in regular physical activity can significantly improve insulin sensitivity and decrease blood glucose levels (Bjorntorp & Krotkiewski, 1985). This evidence suggests that physical activity and exercise should be placed at the forefront of type 2 diabetes treatment, and that researchers and health educators need to prioritize identifying effective strategies to stimulate a positive, and lasting, behavior change among adults with type 2 diabetes.

Research has suggested focusing on psychosocial correlates of behavior in order to aid adults with type 2 diabetes in adopting regular physical activity (Heiss & Petosa, 2014). Health educators may use variables that are associated with physical activity in order to promote behavior change in their interventions. For example, among adults with type 2 diabetes, self-efficacy, social support, self-regulation, and perceived behavioral control have all been positively correlated with physical activity (Heiss & Petosa, 2014). Additionally, a pilot study based upon Social Cognitive Theory (SCT) explored the extent to which self-regulation, social support, self-efficacy, outcome expectations, and the environment explained the variability in moderate exercise among 181 adults with
type 2 diabetes. Results demonstrated that self-monitoring contributed a higher percentage of variability (11.2%) in moderate exercise than any other SCT variable. This suggests that targeting self-monitoring may have a positive influence on physical activity behavior within this population. However, a limitation of the current research on psychosocial correlates of physical activity within this population is that a majority of the studies on cross-sectional (Heiss & Petosa, 2014). As a result, the findings from this research can only be interpreted as associations between psychosocial factors and activity (Thomas, Nelson, & Silverman, 2011). In order to move closer to the cause-and-effect relationship between psychosocial correlates and physical activity, it is important to conduct experimental research in order to determine if a change in said correlates results in a positive impact on behavior.

In order to increase rates of regular physical activity among adults with type 2 diabetes, it is important to understand the current exercise levels of adults with type 2 diabetes. For example, although evidence suggests that engaging in exercise has a direct and positive impact on glucose regulation and insulin sensitivity, a majority of U.S. adults diagnosed with type 2 diabetes are not currently meeting the minimum recommendations for physical activity. According to the National Health and Nutrition Examination Survey (NHANES III), 31% of individuals with type 2 diabetes reported zero minutes of leisure time physical activity, and an additional 38% reported physical activity levels that were not meeting the minimum recommendations. However, a major limitation in this data is that physical activity levels are measured via self-report. Self-report and recall instruments often result in an overestimation of true physical activity levels. Additional limitations to self-reporting include that individuals may misinterpret
the questions, or the questions may not be able to detect the different dimensions of physical activity (frequency, intensity, time, type) (Welk, 2002). Therefore, while this data presents evidence that a majority of adults with type 2 diabetes are not regularly active, it is important to ensure that valid, reliable, and objective measurement techniques are incorporated in physical activity measurement research. These measurement techniques can help researchers and educators understand the current physical activity levels of adults with type 2 diabetes, and use that information as a baseline when designing and implementing health promotion programs. Therefore, the following chapter outlines a study that was intended to target the exercise behavior of adults with type 2 diabetes.

Purpose

The primary purpose of this research study is to evaluate the effectiveness of a brief, SCT-based behavioral intervention on moderate-to-vigorous physical activity (MVPA) among a sample of overweight and obese adults with type 2 diabetes. We intend to evaluate the effectiveness of the intervention on dimensions of MVPA; minutes of MVPA per week, minutes of MVPA per day, number of steps per day, caloric expenditure per day, and sedentary time per day.

A secondary purpose of this research is to evaluate the effect of a behavioral intervention on dimensions of self-regulation. Exercise logs were used in order to promote behavioral strategies to self-monitor exercise behavior. Specifically, the research study observed changes in self-regulation, self-monitoring, goal setting, self-reward, social support, time management, and overcoming barriers.
Participants

Selection of Subjects

A review of the inclusion and exclusion criteria is outlined below

• Inclusion Criteria
  o Adults ≥ 18 years of age
  o Diagnosed with type 2 diabetes
  o BMI ≥ 25 kg/m²
  o Physically able to engage in exercise
  o Not currently engaging in regular physical activity

• Exclusion Criteria
  o Engaging in regular exercise for at least 6 months
    ▪ Regular exercise is defined as participating in activity on 3 or more
days per week for at least 30 minutes per day, or at least 150
   minutes of exercise per week
    ▪ Maintenance phase of the Transtheoretical Model
  o Having any medical complications to exercise

The target population was overweight and obese (BMI ≥ 25 40 kg/m²) adults (≥ 18
years) with diagnosed type 2 diabetes. Participants must have been physically able to
engage in exercise of at least moderate intensity. Individuals with any contraindications
to exercise were excluded from the study. A Physical Activity Readiness Questionnaire
(PAR-Q) was used order to assess an individual’s ability to safely engage in exercise
(Appendix A). The PAR-Q is a seven-question screening tool that will serve to alert the
researcher of participants with an elevated risk to participating in physical activity (Thompson et al, 2010). Participants responded to seven “YES” or “NO” questions, and those who answered “YES” to one or more questions were ineligible to participate in the study.

The study also recruited individuals who were not in the maintenance stage of the Transtheoretical Model. According to the Transtheoretical Model (TTM), individuals change their behavior through a gradual process. In order to undergo a behavior change, individuals need to progress through a series of stages: precontemplation, contemplation, preparation, action, and maintenance (Lox, Martin Ginis, & Petruzzello, 2010). The contemplation stage is defined as intending to take action (i.e. engage in exercise) within the next 6 months. Subsequently, the following three stages are described as intending to take action in the next 30 days (preparation), changed overt behavior for less than 6 months (action), and changed overt behavior for more than 6 months (maintenance) (Glanz, Rimer, Viswanath, 2008). Therefore, although individuals were not selected based upon their current level of exercise, it was important that individuals were not engaging in regular exercise. Individuals who have been engaging in regular exercise for at least 6 months define the maintenance phase. Because the purpose of this study was to promote exercise and change behavior, it was important to recruit individuals who were not regular exercisers. This will aid in determining if the intervention truly stimulates a change.
Recruitment

This study used purposive sampling. Purposive sampling means that the researchers established criterion necessary for the study, and then found a sample that met that criteria (Thomas, Nelson, & Silverman, 2011). The criterion for participation in this study included: overweight and obese (BMI $\geq 25$ kg/m$^2$) adults ($\geq 18$ years) who are diagnosed with type 2 diabetes who are not experiencing any contraindications to exercise or engaging in regular exercise as defined by the maintenance stage of the Transtheoretical Model. The recruitment materials were tailored to individuals who are motivated to engage in exercise activity. The following methods were used to recruit subjects:

- ResearchMatch
  - ResearchMatch is a National Institute of Health (NIH)-sponsored website that is a secure place for individuals to register as potential volunteers for research. Researchers can register their study on ResearchMatch, and then conduct what is called a “feasibility search”. This search allows the researcher to set parameters for whom they wish to recruit. As a result, ResearchMatch will then provide a contact list of individuals registered with the site as potential research volunteers who meet the criterion for the study.
  - Specifically for this study, the researcher sent a recruitment email to 185 individuals within 50 miles of OSU, who are adults with diagnosed diabetes. These registered ResearchMatch.org individuals received an IRB approved ResearchMatch message that included information regarding the study, through their email account that they have registered to Research Match. Once
candidates who meet the eligibility criteria received information regarding the study, they had the opportunity to indicate they are interested in hearing more about the study by clicking “yes” or ignore or decline the invitation. Only those volunteers who clicked “yes” had their identities released to the researcher. 28 volunteers agreed to be contacted. The researcher then identified herself to the potential volunteers via email and invited them to participate in the study.

• StudySearch
  o StudySearch (studysearch.osumc.edu) is the public facing listing of IRB approved studies at OSU that are seeking volunteers. Any person who searches this listing will have study staff contact information. StudySearch™ is a web-based application designed to provide an easily readable, publicly accessible, and searchable listing of IRB-approved protocols that are accruing study subjects. StudySearch was developed by the Regulatory Support and the Biomedical Informatics Cores of the Center for Clinical and Translational Science (CCTS) at The Ohio State University. Postings include basic descriptive information: study title, purpose of the study, eligibility criteria, and study personnel contact information. Language concerning benefits and/or inducements is not included; therefore, while IRB approval for a study to be listed on StudySearch™ is required, IRB approval of the posted language is not.

• Craigslist
  o This study also used Craigslist Columbus (www.columbus.craigslist.org) to
recruit eligible subjects. Craigslist is a classified advertisements website devoted to jobs, housing, personals, for sale, as we as research volunteers. The researchers posted an IRB-approved advertisement to Craigslist to recruit subjects. The advertisement included study title, purpose of the study, eligibility criteria, and study personnel contact information. Interested volunteers had the ability to contact the primary researcher directly through the Craigslist advertisement.

- Advertisements
  - Flyers were posted throughout campus buildings and public community sites that granted permission for posting (such as libraries, local businesses, grocery stores, etc.) stating the purpose of the study and what criteria individuals need to meet in order to participate. Contact information for the study staff was posted in these advertisements. Verbiage from the flyers was also posted in two electronic campus newsletters.

**Estimates for Sample Size**

Estimates of effect size, alpha, and power were used in order to calculate the desired sample size. For a repeated measures ANOVA F test, using an effect size .5, power of .8, and alpha of .05, a sample size of at least 20 individuals per group was needed for this study (Kramer & Thiemann, 1987). Effect size is calculated by taking the difference between the two groups on mean physical activity and then dividing this by the standard deviation of one of the groups. Because this was not calculated until after the study, an effect size of .5 was used to denote a moderate effect (Cohen, 1988).
Instrumentation

**BodyMedia Armband**

Physical activity was measured through the BodyMedia Armband. Individuals wore the BodyMedia Armband for 7 days at baseline and 4-week follow-up. The BodyMedia device measured physical activity, energy expenditure, number of steps, and sleep duration. The armband first acts as an accelerometer, measuring transverse, forward, and vertical, and longitudinal motion. Additionally, sensors on the armband (worn on an individual’s triceps) also measured heat flux, galvanic skin response, skin temperature, and near-body temperature. From these measurements, algorithms are used to estimate total physical activity duration, energy expenditure, and number of steps per day. The BodyMedia also senses when the body is not in motion, and is able to record time lying down and sleeping. For this study, researchers will use caloric expenditure, steps per day, duration of moderate-to-vigorous intensity exercise in order to describe the current activity level of the sample. Specifically, researchers collected data in terms of average daily energy expenditure (kcal), average minutes per day of physical activity (min), and average number of steps per day.

This device has been shown to be a valid and reliable measure of free-living activity among adults with type 2 diabetes. For example, criterion validity was established between the armband and doubly labeled water (DLW). DLW has often been considered the gold standard for measuring energy expenditure, but is unfortunately extremely expensive and requires a high level of technical expertise (Mignault, St.-Onge, Karelis, Allison, & Rabasa-Lhoret, 2005). In a small sample of adults with type 2 diabetes, the armband was shown to have criterion validity with DLW, with a correlation coefficient of 0.75. Further, the armband has been shown to have acceptable intra-class correlation coefficients (ICC) for physical activity, energy expenditure, and sleep duration, indicating that it is a reliable measure of these variables.
diabetes, there was not significant different in energy expenditure between the armband and DLW during a 10-day period (Mignault, et al, 2005). Additionally, the intraclass correlation (ICC) between the two measurement techniques reached ICC = 0.9696. Additionally, a study conducted by Bersten, Hagenberg, Aandstad, Mowinckel, Anderssen, Carlsen, and Andersen (2008) compared moderate-to-vigorous physical activity measured by the BodyMedia, Actigraph, ikcal, and ActiReg devices to indirect calorimetry. Results from this study indicated that the BodyMedia Armband overestimated physical activity by less than 3%, and produced similar results to the Actigraph and ikcal (Bersten et al, 2008). Research has also established test-retest reliability, showing significant intraclass correlations for sedentary activity, walking activity, and structured exercise over the duration of 2 days of testing (Brazeau, Karelis, Mignault, Lacroix, Prud’homme, & Rabasa-Lhoret, 2011). This evidence suggests that using a BodyMedia Armband to measure free-living energy expenditure, minutes of moderate-to-vigorous activity, and number of steps is a reliable and accurate measurement tool.

**Self-Regulation for Exercise Questionnaire**

Self-Regulation is the systematic use of strategies to control personal behavior based on personal goals and intentions (Biddle & Fuchs, 2009). The Self- Regulation of Exercise Scale developed Petosa (1998) will be used to measure individuals’ perceptions of how well they are able to regulate their exercise activities through behavioral strategies such as goal-setting, self-monitoring, time management, overcoming barriers, and planned social support. Researchers will be looking for patterns of self-regulation across
these subscales. Participants will be asked to rate how often they performed a series of behavioral techniques they may have used to help them exercise over the past four weeks on a 5-point scale rating from “Never” to “Very Often”. Specific subscales of the self-regulation scale included: self-monitoring, goal setting, social support, self-reward, time management, and overcoming barriers. Participants completed this questionnaire at pre- and post-test, during Visits #1 and #4 of the study. The instrument had been tested for face and content validity using a 3-stage expert panel review process until consensus was reached. Subscales were refined using confirmatory factor analysis (Hallam & Petosa, 1998).

**Research Design**

The design of this study was a 4-week pretest-posttest control group design. Upon recruitment, individuals were randomized into either the control or experimental group. Individuals in both groups were measured at pretest and posttest. There was no long-term follow-up for this study. The independent variable in this study was the behavioral intervention. The dependent variables were dimensions of MVPA and self-regulation. Dimensions of MVPA included minutes of MVPA per week, minutes of MVPA per day, number of steps per day, caloric expenditure per day, and sedentary time per day. Dimensions of self-regulation included goal setting, self-monitoring, time management, overcoming barriers, social support, and self-reward. Outlined below are the procedures for enrollment, intervention protocol, and specific procedures for both the control group and experimental group.
Procedures

Enrollment

The target sample for this population was overweight and obese adults with type 2 diabetes. Individuals who responded to the various recruitment methods were sent an email containing information regarding the purpose and their time commitment for this study. The email outlined that individuals would attend four sessions over the course of four weeks at the Physical Activity and Educational Services (PAES) building.

The first five minutes of the first session were spent completing the enrollment process. Individuals were given an informed consent and were asked to read through and sign it. Following consent, individuals were given a brief survey containing demographic information, the PAR-Q, and the Stages of Change Questionnaire (Appendix A). Participants were asked to give their height, weight, age, gender, race, and ethnicity. Additionally, this section asked four questions to determine the current physical activity levels of the potential subjects. First, “How many days did you exercise last week?” and “How many days a week to you typically exercise?” Then, “On these days, for how many minutes on average did you exercise?” Finally, “What is your typical mode of exercise?”

Next, this survey included a Physical Activity Readiness Questionnaire (PAR-Q). The PAR-Q screened to ensure that participants were medically cleared to engage in exercise. Finally, the Stages of Change Questionnaire ensured that participants were not in the maintenance stage of the Transtheoretical Model.

Following the informed consent and brief survey, the researchers began the study procedures. The procedures are outlined below by each of the four visits that the
participants will make to the PAES Building at The Ohio State University. Each of the visits outlines the procedures for both the experimental and control group.

**Visit #1:**

*Experimental Group and Control Group*

The first visit was conducted using the same procedures for the experimental and control groups. The first visited last approximately 30 minutes. The first five minutes were spent completing the enrollment procedures (see above). After participants were officially enrolled in the study, the researcher proceeded to set participants up with a BodyMedia Armband to wear for the next seven days.

The next 10 minutes were spent instructing participants on how to wear the BodyMedia Armband. First, participants were given specific instructions on how to wear the BodyMedia. The Armband was to be worn securely on their left or right triceps with the strap on their biceps. The participants were instructed to wear the armband during waking hours only, putting it on when they wake up in the morning, and taking it off before bed. Although the BodyMedia can be worn during sleeping hours, the researchers were not interested in hours of sleep for the purposes of this study. When the BodyMedia has been placed correctly, it will vibrate and make a beeping noise; indicating that is has turned on and initiated measurement. During waking hours, the only time the participant should remove the device is when they are taken a shower or otherwise submerged in water (i.e. swimming), or when they need to clean the device. When the device has been removed, it may vibrate and beep, indicating that it has turned off. If this occurs, participants needed to ensure that it again vibrates and beeps when they replace the
BodyMedia to guarantee that measurement is not interrupted. The researchers then placed the BodyMedia on the participant’s arm in order to demonstrate how the band was to be worn. Finally, participants were given a handout with the Instructions for Wearing the Body Media (Appendix B) to take home.

The next five minutes were spent setting up the Online Activity Manager. In addition to instructions pertaining to how to wear the BodyMedia, the researcher walked each participant through the Online Activity Manager that accompanies each armband. Because the armband does not display information on its own, BodyMedia works in conjunction with the Online Activity Manager. The activity manager allows data from the armband to be downloaded and analyzed. The researcher will first entered personal body parameters for each participant including gender, age, height, weight, daily bed time, daily wake up time, and whether or not they were a smoker. Participants were then informed that the researchers would go over their results in detail during their next visit (See Visit #2). They were told that they would be given information about how many calories they burn everyday, how many minutes of physical activity they engage in everyday, and how many steps they take everyday. Participants were then told to wear the BodyMedia for the next seven days and engage in what they consider to be a ‘typical week’ in terms of their daily activities and exercise. Researchers did not encourage participants to engage in any level of exercise.

• A demonstration of how the BodyMedia Online Activity Manager works can be found at: [http://www.bodymedia.com/activity_manager_demo.html](http://www.bodymedia.com/activity_manager_demo.html)

Finally, participants spent the last five minutes completing a Self-Regulation of Exercise Questionnaire. This survey consisted of 43 questions that asked the participants
how often they incorporated different self-regulatory techniques (i.e. self-monitoring, goal setting, time management) over the past four weeks. Ratings were made on a 5-point Likert Scale from “Never” to “Very Often”.

Visit #2:

Experimental Group

Visit #2 took place one week following Visit #1 and lasted approximately 30 minutes.

During the first five minutes, the researcher downloaded the BodyMedia data from the previous week onto the Online Activity Manager. The researcher first went through each individual day on the Online Activity Manager. Each individual day provides information on caloric expenditure, minutes of physical activity, moderate versus vigorous physical activity, and number of steps. The Online Activity Manager also shows the time of day when participants were burning calories, engaging in activity, and taking steps. The researcher talked participants through each day, providing them information on the variables from the Online Activity Manager. The researcher then printed off a “summary sheet” for the participant. The BodyMedia Summary Sheet provided the participants with averages for calories burned, minutes of activity, and number of steps for the week. The summary sheet also provided bar graphs for each day of the week, allowing participants to see which days there were more or less active in terms of caloric expenditure, minutes of activity, and number of steps. The participants were told that they could keep their copy of the summary sheet, and the researchers saved a second copy for their records.
After discussing the results from the BodyMedia, the next 15 minutes of this meeting involved administering a brief behavioral intervention. First, the researcher gave participants a handout (Appendix C) outlining the following American College of Sports Medicine (ACSM) guidelines for physical activity.

- According to the American College of Sports Medicine (ACSM), adults with type 2 diabetes should participate in at moderate aerobic activity (50%-80% HRR) on at least 3, and up to 7 days per week.
  - Moderate can also be described as working hard enough to raise your heart rate and break a sweat. Another way to tell is that you can still talk or hold a conversation.
- This activity should be 20-60 minutes in duration, and can be accumulated in bouts of at least 10 minutes to total 150 minutes per week of moderate physical activity (ACSM, 2010).
- Also, it is recommended try to achieve a minimum of 8,000-10,000 steps per day.
- Aerobic-based activities include types such as bicycling, brisk walking, or swimming that engage the whole body using major muscle groups.

After going through the physical activity guidelines, researchers gave participants 2 weekly exercise logs (Appendix D) as well as a handout providing directions on how to complete the exercise logs (Appendix E). Each log had two components; one for planning and one for actual activity. The planning component included a table with the days of the week and columns to fill in details regarding participants’ intended activity (type,
location, duration, etc.). The actual exercise log then had the same format, but asked participants to log the details of the true activity they engaged in.

Together, the researcher worked with participants to fill out the planned exercise log for one week. See Appendix E for the detailed instructions on how participants will complete the exercise plan. The steps for completion are as follows:

1. Participants were asked on how many days they wished to be active
   a. The goal should be between 3 and 7 days
   b. They were told to circle the days on their log that they intended to be active
   c. Researchers told them to focus on their weekly schedule and come up with the days of the week that work best

2. Participants were asked what type of exercise they wanted to perform, and then filled the type into the exercise plan next to corresponding days.

3. Participants decided on location of their exercise, and then wrote the location into the exercise log for the corresponding days.

4. Participants decided what time of day they will engage in exercise, and then wrote the time into the exercise log for the corresponding days.

5. Participant chose the intended intensity for their exercise on an RPE scale of 0-10
   a. The researcher suggested activities that are at least moderate, and explained the RPE scale
      i. Moderate exercise will be defined as physical activity done to enhance health or fitness that mildly elevates your heart rate
and breathing rate. Examples include, bicycling, brisk walking, hiking, and doubles tennis.

ii. Moderate intensity translates to between a 3 and 5 on the RPE Scale

6. Participants set a goal for the number of steps they planned to take everyday.
   a. Researchers suggested a step goal based off of the participants step count from the BodyMedia data. For example, if a participant was taking an average of 5,000 steps per day, the researcher suggested an increased to 8,000 steps per day
   b. Participants were given a pedometer to use to count their daily steps

7. Participants were asked if they wish to exercise with anyone else.
   a. If yes, participants wrote in with whom they intended to exercise
   b. If no, participants were told that they could leave that section blank.

Following this goal setting and planning session with the researcher, participants had planned out the day, type, location, time of day, duration, and intensity of their exercise for the next week. After the planned exercise log is complete, participants were told that they needed to track their daily exercise over the course of the next week (Appendix D). They were encouraged to stick to their plan the best they can, and record their exercise each day. The following information will be included in the actual exercise log:

1. Activity Type
2. Location of activity
3. Time of day
4. Duration

75
5. Intensity (0-10)

6. Number of Steps
   a. Recorded from the pedometer that will be given to participants by the researchers

7. Exercise Enjoyment (0-10)
   a. Rating how much participants enjoyed the exercise from not at all (0) to a lot (10).

8. Exercise Social Support
   a. Recording if they exercise with someone. If so, who?

After careful instruction on how to complete the exercise logs, participants were told that after one week, they need to complete a planned exercise log for a second week. They were told that they would receive an email reminder from the researcher, exactly one week from the current session, encouraging them to continue reaching their goals, and to complete the second exercise plan on their own. They will be told to again use the directions for the exercise plan (Appendix E) to complete their plan. Then, participants will log their activity for the following week. This means, that during visit #3, participants were to return with two completed planned exercise logs and two complete actual exercise logs.

The researcher emphasized that monitoring and recording their behavior could help participants acquire the skills to manage their daily physical activity levels. By consistently self-monitoring, participants will not only have a clear picture of their current activity levels, but also be able to determine areas for improvement (Glanz et al, 2008). Finally, participants were asked to bring their completed exercise logs to Visit #3.
The session concluded with giving participants their first installment of the incentive ($20), and setting up their third visit in two weeks.

**Control Group**

Visit #2 for the control group lasted approximately 15 minutes. Similar to the experimental group, participants in the control group visited the PAES building and returned the BodyMedia device. During the first five minutes, the researcher downloaded the BodyMedia data from the previous week onto the Online Activity Manager. The researchers told the participants that this serves to inform them of their physical activity over the past week. The researcher first went through each individual day on the Online Activity Manager. Each individual day provides information on caloric expenditure, minutes of physical activity, moderate versus vigorous physical activity, and number of steps. The Online Activity Manager also shows the time of day when participants were burning calories, engaging in activity, and taking steps. The researcher talked participants through each day, providing them information on the variables from the Online Activity Manager. The researcher then printed off a “summary sheet” for the participant. The BodyMedia Summary Sheet provided the participants with averages for calories burned, minutes of activity, and number of steps for the week. The summary sheet also provided bar graphs for each day of the week, allowing participants to see which days there were more or less active in terms of caloric expenditure, minutes of activity, and number of steps. The participants were told that they could keep their copy of the summary sheet, and the researchers saved a second copy for their records.

After reviewing this information, the researchers told the participants that it is important to look at their behavior one more time with the BodyMedia. They were told
that they would come back in two weeks, and once again receive the armband. Researchers emphasized the need to have a more comprehensive look at their activity before they could discuss any potential room for behavior change. The researcher did not discuss whether or not the participant has met the guidelines for physical activity, and did not encourage the participant to increase their physical activity levels. Researchers told participants that at the conclusion of the study, they will receive information regarding exercise recommendations and tips on how to potentially change their physical activity levels. At the conclusion of the session, participants were given $20 of the incentive, and set up their next session in two weeks.

Visit #3:

Experimental Group

Visit #3 took place two weeks after the second visit and last approximately 30 minutes. First, participants turned in their 2-week exercise logs to the researcher, and spent the initial 5-10 minutes reviewing the completed plans and logs. The researchers asked the participant to tell them about the past two weeks in terms of how complete the logs were, whether or not participants stuck to their plans, how often they engaged in activity, and how the participants felt about planning and monitoring their activity. This served as a more open discussion, where the participants were able to reflect upon and discuss their goals and behavior with the researcher.

The researchers then gave the participants one more weekly log (Appendix D). The next 5-10 minutes were spent having the researchers and the participants will fill in the planned exercise log together. First, the researcher asked the participant to reflect
upon the last two weeks and discuss any additional areas for change or improvement. Then, the researcher took the participant through the same steps and directions as Visit #2 to fill out the exercise plan. See Visit #2 and Appendix E for specific instructions on how the exercise plan was completed. Then, participants were asked to log their activity in the exercise log for one more week (See Visit #2).

Finally, researchers redistributed the BodyMedia devices. Participants received the same BodyMedia device as visit #1, and were asked to wear it again for the next seven days. See Visit #1 for the directions and procedures for the BodyMedia Armband. Participants were encouraged to keep up their exercise levels, meet their weekly goals, and engage in the recommended amount of physical activity.

**Control Group**

Visit #3 for the control group will take place two weeks after the second visit and last approximately 10 minutes. The primary purpose of Visit #3 was to have researchers redistribute the BodyMedia devices. Participants received the same BodyMedia device as Visit #1, and were asked to wear it again for the next seven days. See Visit #1 for the directions and procedures for the BodyMedia Armband. Participants were not encouraged to engage in any specific level of exercise. Again, if participants asked about their exercise they were told that they would receive more information following the final one-week measurement.
Visit #4 (Posttest):

*Experimental Group.*

Visit #4 took place one week after Visit #3 and lasted approximately 15 minutes. Researchers first asked participants to describe the final week of planning and logging their activity. Researchers then downloaded the exercise and physical activity data from the BodyMedia Armband to the Online Activity Manager. Similar to Visit 2, the researcher and participant discussed the results in terms of minutes of exercise, exercise intensity, exercise bouts, number of steps, and so on. The researcher first went through each individual day on the Online Activity Manager. Then, the researcher printed a BodyMedia Summary Sheet to provide the participants with averages for calories burned, minutes of activity, and number of steps for the week. The researcher told participants that they could keep one copy of the summary sheet, and kept another copy for their records. Finally, the researcher spent a few minutes comparing the two BodyMedia Summary Sheets (pre and post). They discussed any differences or changes made in terms of weekly caloric expenditure, minutes of physical activity, and number of steps. As a wrap-up, the researcher reemphasized the importance of regular physical activity and the recommendations for physical activity in hopes that the participants continue being active in their daily lives.

During the final five minutes, participants once again took the Self-Regulation for Exercise Questionnaire. The session ended with participants receiving their second $20 incentive. This served as the final meeting with the participants, and they were not to be contacted again.
Control Group

Visit #4 took place one week after Visit #3 and lasted approximately 15 minutes. Researchers first downloaded exercise and physical activity data from the BodyMedia Armband to the Online Activity Manager. Similar to Visit 2, the researcher and participant discussed the results in terms of minutes of exercise, exercise intensity, exercise bouts, number of steps, and so on. The researcher first went through each individual day on the Online Activity Manager. Then, the researcher printed a BodyMedia Summary Sheet to provide the participants with averages for calories burned, minutes of activity, and number of steps for the week. The researcher told participants that they could keep one copy of the summary sheet, and kept another copy for their records. Finally, the researcher spent a few minutes comparing the two BodyMedia Summary Sheets (pre and post). They discussed any differences or changes made in terms of weekly caloric expenditure, minutes of physical activity, and number of steps.

Following a review of the BodyMedia data, the control group received a printout that reviewed the ACSM and ADA Guidelines for physical activity (Appendix C). The researcher then went over following information regarding physical activity:

- According to the American College of Sports Medicine (ACSM), adults with type 2 diabetes should participate in at moderate aerobic activity (50%-80% HRR) on at least 3, and up to 7 days per week.
  - Moderate can also be described as working hard enough to raise your heart rate and break a sweat. Another way to tell is that you can still talk or hold a conversation.
• This activity should be 20-60 minutes in duration, and can be accumulated in bouts of at least 10 minutes to total 150 minutes per week of moderate physical activity (ACSM, 2010).

• Also, it is recommended try to achieve a minimum of 8,000-10,000 steps per day.
  
  o The researchers also gave participants pedometers as a way to track their steps in the future.

• Aerobic-based activities include types such as bicycling, brisk walking, or swimming that engage the whole body using major muscle groups.

  If applicable, researchers used the BodyMedia data to help participants understand areas for improvement. For example, if an individual was engaging in some level of physical activity everyday, but for bouts less than 10 minutes, the researcher would suggest that the individual make changes that focusing on increasing single bouts of activity to at least 10 minutes in duration.

  During the final five minutes, participants once again took the Self-Regulation for Exercise Questionnaire. The session ended with participants receiving their second $20 incentive. This served as the final meeting with the participants, and they were not to be contacted again.

  **Intervention Protocol**

  Along with the procedures for each individual visit, researchers followed a strict protocol in terms of ensuring retention and completeness across all subjects in the two groups. A total of three researchers aided in the intervention delivery. The researchers were not blinded to the selection of individuals into the control group or experimental
group. In order to remain in the study, participants needed to adhere to the following set
guidelines set forth by the researchers.

**Cancelled or Missed Visits**

If a participant failed to show up to their visit with no warning, then researchers emailed or called that participant immediately to figure out why the visit was missed, and when they could reschedule. If a participant reached out to researchers to cancel their visit, then researchers worked with them to reschedule. All rescheduled conducted *within 7 days* of the original appointment time. If a participant failed to show up or reschedule within 7 days of their original visit date and time, they were dismissed from the study.

**Complete Data: BodyMedia**

In order for both pre-and post- BodyMedia data to be incorporated into the study and used by the researchers, it must meet both of the following criteria:

- During the seven days of measurement, participants must have worn the BodyMedia for *at least four days*

- One the days in which the BodyMedia was worn, participants must have worn the device for *at least eight hours*.

In the event that a participant did not complete the BodyMedia protocol, they were allowed to wear the BodyMedia for one more week. If, after two attempts, a participant still failed to wear the BodyMedia for at least eight hours on at least four days, then they were dismissed from the study. It should be noted that the BodyMedia battery life lasts only 7 to 10 days. In the event that the battery expired, and data was lost, participants were given a charged BodyMedia and asked to redo the measurement.
Complete Data: Planned and Actual Exercise Logs

During the study, participants in the intervention group were asked to complete a total of six exercise logs: three planned and three actual. Two of the three planned logs were completed at the PAES building with the study researchers. This means that participants completed four total logs (1 planned, 3 actual) on their own. Therefore, in order to ensure that participants are completing the steps for the intervention, the following criteria were used to determine completeness of the exercise logs. However, because participants completed the final actual exercise log during the final week of the study, this criterion only applied to the three logs completed during the middle two weeks of the study (1 planned, 2 actual):

- Participants must have planned or logged their exercise for at least 3 of the 7 days*
  
  o *Note: Even if an individual wrote phrases such as “nothing” or “rest day” to indicate no exercise, this still demonstrated completeness. For, although a participant didn’t exercise, they still took note and tracked their behavior

- Participants must have at least 3 of the 8 columns completed.
  
  o Columns denoted type, duration, intensity, location, time of day, enjoyment, steps per day, and social support for exercise.

- The above criteria must be met for at least two of the three logs.

These criteria were established because it is important to ensure that participants are following the directions of the intervention. If they are not completing the logs, then researchers could conclude that they are not receiving and participating in the
intervention piece to the study. The final actual exercise log was not included for completeness, because participants at this point will have already received the intervention. Also, because information from this log will not be used as data, it is unreasonable to remove someone from the study and not provide them with the incentives if they have successfully completed every other stage of the intervention. During Visit #3, if a participant presents exercise logs that are incomplete, then they were dismissed from the study.

Data Analysis

Data Collecting and Recording

Data was collected from February 2015 to May 2015. All demographic and self-regulation was collected on paper questionnaires completed by the participants. After participants filled out these questionnaires at pretest and posttest (self-regulation questionnaire only), researchers transferred the data to both Excel and SPSS IBM Statistics. The paper copies of the questionnaires were kept in individualized folders with participants’ unique ID numbers. BodyMedia data was downloaded from the armband to the BodyMedia Online Activity Manager. The Online Activity Manager allowed researchers to export the previous seven days of data into Excel. From here, researchers saved the excel spreadsheets as “Subject#_BodyMedia#_PRE” and “Subject#_BodyMedia#_POST”. Then, the following information was transferred from the individual’s Excel into the master Excel and IBM SPSS Statistics; total minutes of physical activity per week, total minutes of moderate physical activity per week, total minutes of vigorous physical activity per week, average minutes of physical activity per
day, average minutes of moderate physical activity per day, average minutes of vigorous physical activity per day, average number of steps per day, average caloric expenditure per day (kcal), and average amount of sedentary activity (in hours: minutes) per day.

**Statistical Procedures**

Five 2 x 2 Split-Plot ANOVAs were conducted (minutes of MVPA per week, minutes of MVPA per day, number of steps per day, caloric expenditure per day, and sedentary time) to determine the effect of the intervention across time on dimensions of physical activity. Another seven 2 x 2 Split-Plot ANOVAs were conducted (total self-regulation, self-monitoring, goal setting, time management, overcoming barriers, social support, and self-reward) to determine the effect of the intervention across time on dimensions of perceived self-regulation. The significance level was set at $p < .05$. Two-Factor Split Plot ANOVA models allow the data to be analyzed both within subjects (pretest vs. posttest) and between subjects (intervention vs. control). For each test, if the assumption of sphericity was met, then the Sphericity Assumed Statistic was reported. If the assumption of sphericity was not met, the Greenhouse-Geisser statistic was used. Finally, in the event that the ANOVA test had low power ($< 0.8$), the statistical significance could not be concluded as insufficient power increases the likelihood of a Type II Error (Vincent, 2005). As a result, researchers focused on the effect sizes in order to better understand the practical significance of the intervention over time.

Cohen’s $d$ was calculated also for each ANOVA test in order to determine the practical significance of the intervention on MVPA and self-regulation over time. Cohen’s $d$ is defined as the ratio of the mean difference divided by the standard deviation.
of the control group (Vincent, 2005). For this analysis, three effect size measures were calculated per ANOVA to examine (1) the intervention group changes from pre-to post-test, (2) the control group changes from pre- to post-test, and (3) the difference between the intervention and control group at posttest. An effect size of 0.2 is considered low, 0.5 is considered medium, and 0.8 is large.

Finally, an intention-to-treat analysis was conducted for each ANOVA. For the intention-to-treat analysis, researchers followed a conservative approach and imputed the last value carried forward for the two individuals who dropped out from pretest to posttest. The results (Chapter 4) for each variable include analyses for both intention-to-treat (n = 23) as well as a completer analysis (n= 21). The completer analysis includes only those individuals who completed all aspects of the study from pretest to posttest.
Chapter 4
Analysis and Results

Purpose

The purpose of this chapter is to evaluate the effectiveness of a behavioral intervention to impact self-regulation and moderate-to-vigorous physical activity (MVPA) among a sample of overweight and obese adults with type 2 diabetes. This study was a 4-week pretest posttest control group design. The primary purpose of this research study is to evaluate the effectiveness of a brief, SCT-based behavioral intervention on moderate-to-vigorous physical activity (MVPA) among a sample of overweight and obese adults with type 2 diabetes. A secondary purpose of this research is to evaluate the effect of a behavioral intervention on dimensions of self-regulation. Individuals in both groups met with researchers on a one-on-one basis four times over the course of four weeks. The intervention group engaged in a behavioral intervention that targeted SCT variables such as self-regulation, self-monitoring, social support, overcoming barriers, time management, self-reward, and goal setting, by incorporating exercise diaries to plan and log weekly physical activity. The control group was measured at pretest and posttest, and given information regarding their physical activity habits based on results from the BodyMedia Armband. The BodyMedia Armbands measured the following variables at pretest and posttest; minutes of physical activity per week, average minutes of physical
activity per day, average caloric expenditure per day, average number of steps per day, and time spent sedentary. Individuals in both groups received a summary sheet at pretest and posttest with weekly averages for these physical activity variables.

**Description of Sample**

**Recruitment, Retention, and Attrition**

A total of 24 participants enrolled in the study. A majority of subjects were recruited through ResearchMatch.org. ResearchMatch.org contacted 185 potentially eligible volunteers to participate in this study. Of the 185 volunteers, 28 agreed to be contacted. Of the 28 volunteers who agreed to be contacted, 6 did not respond to recruitment emails, 3 were ineligible to participate, 3 declined to participate, and 16 enrolled in the study. The remaining eight subjects who enrolled in the study were recruited through campus advertisements. A random numbers table from 1-40 was generated in Excel. Upon enrollment, subjects were randomized into either the intervention (n = 13) or control group (n = 11). Out of the 24 subjects enrolled in the study, one individual from the intervention group did not complete all baseline data. This individual did not comply with study procedures as was therefore dismissed from the study. Her data was not kept or analyzed at pre- or post-test. Two other individuals completed all pre-test data, but were lost to the 4th week posttest. One participant dropped out citing time constraints. This subject stated that although she wished she could complete the study, balancing work, school, and family prohibited her from completing all aspects of the study. The second participant dropped out due to emergency surgery that resulted in indefinite hospitalization. Because these two individuals completed at
least half of the study before dropping out, their pre-test data was retained, but there is no posttest information for these two participants. Therefore, at the 4th week posttest, 21 participants completed all aspects of the study, including 10 individuals in the intervention group and 11 individuals in the control group.

**Intervention Description**

12 individuals were randomized into the intervention group. Of these 12 individuals, 2 participants were lost to follow-up. Therefore, 10 individuals completed all intervention procedures. These individuals received the behavioral intervention during Visit #2 to the PAES Building. Individuals were asked to plan their physical activity behavior for a total of three weeks. Individuals specifically planned their days of activity, as well as the type, location, time of day, duration, and number of steps. Of the 10 individuals in the intervention group, 9 individuals planned to walk as their primary mode of exercise. One individual chose dance classes. Modes of exercise in addition to walking included the elliptical and resistance training via physical therapy. Six participants planned to engage in activity on between 4 and 5 days per week; the remaining four planned for 6-7 days per week. The duration for all individuals ranged from 15 minutes (n=2) to 30 minutes (n = 5), and up to 60 minutes (n = 3).

Individuals were also asked to log their actual physical activity behavior over the course of three weeks. The actual activity logs also asked individuals to track their days of activity, mode, duration, time of day, perceived intensity, number of steps, and enjoyment. Similar to the exercise plans, 9 out of the 10 participants walked as their primary mode of activity. One participant attended dance classes as their local senior
center. The number of days of activity ranged from 3 to 7, with 5 individuals engaging in at least 4 days per week. The duration of activity ranged from 15-60 minutes. Therefore, overall, the majority of participants in this study chose to engage in walking behavior on at least 4 days per week for at least 30 minutes in order to meet the recommendations for physical activity.

Baseline Characteristics

Demographic Information

At baseline, there were 23 participants in this study (intervention = 12, control = 11). Demographic information for both groups is presented in Table 4.1. The intervention group was, on average, 57.75 (SD= 9.82) years old, obese (BMI = 34.38, SD = 4.38), 75% female (n= 9), 58.3% white (n =7) and 33.3% black or African American (n= 4). 66.7% of the intervention group were married or partnered (n= 8), and most had either some college education (n = 6) or a college degree (n= 4). Similarly, the control group had an average age of 57.09 (SD= 9.09) years, was also considered obese (BMI = 39.5, SD = 8.89), was 63.6% female (n = 7), and 90.9% white (n = 10). 63.6% of the control group were married or partnered (n=7), and most either had some college education (n=3), a college degree (n= 5), or graduate degree (n =2).
Table 4.1 Baseline Characteristics for the Intervention and the Control Group

<table>
<thead>
<tr>
<th></th>
<th>Intervention (n = 12)</th>
<th>Control (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD)</td>
<td>57.75 (9.818)</td>
<td>57.09 (9.093)</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>34.38 (4.38)</td>
<td>39.5 (8.89)</td>
</tr>
<tr>
<td>Gender, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>9 (75)</td>
<td>7 (63.6)</td>
</tr>
<tr>
<td>Male</td>
<td>3 (25)</td>
<td>4 (36.4)</td>
</tr>
<tr>
<td>Race, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>7 (58.3)</td>
<td>10 (90.9)</td>
</tr>
<tr>
<td>Black or African American</td>
<td>4 (33.3)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td>Other</td>
<td>1 (8.3)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Ethnicity, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>0 (0)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td>Not Hispanic or Latino</td>
<td>12 (100)</td>
<td>10 (90.9)</td>
</tr>
<tr>
<td>Martial Status, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>1 (8.3)</td>
<td>2 (18.2)</td>
</tr>
<tr>
<td>Married/Partnered</td>
<td>8 (66.7)</td>
<td>7 (63.6)</td>
</tr>
<tr>
<td>Divorced</td>
<td>2 (16.7)</td>
<td>2 (18.2)</td>
</tr>
<tr>
<td>Widowed</td>
<td>1 (8.3)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Education, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School Diploma</td>
<td>0 (0)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td>Some College</td>
<td>6 (50)</td>
<td>3 (27.3)</td>
</tr>
<tr>
<td>College Degree</td>
<td>4 (33.3)</td>
<td>5 (45.5)</td>
</tr>
<tr>
<td>Graduate Degree</td>
<td>1 (8.3)</td>
<td>2 (18.2)</td>
</tr>
<tr>
<td>Professional Degree</td>
<td>1 (8.3)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Physical Activity Variables

Tables 4.2 through Table 4.5 present the frequency tables for all dimensions of MVPA at pretest and posttest for both the intervention group and control group. The tables include the intention-to-treat analysis values (N = 23). At both pretest and posttest, a majority of individuals in both groups were engaging in more than 150 minutes per week of MVPA. Additionally, a majority of individuals in both groups were participating in at least 20 minutes of MVPA per day. According to ACSM, more than half of the participants in this study were meeting the guidelines for physical activity at both pre-
and post-test. At posttest, a majority of individuals in the intervention group were engaging in more than 150 minutes of activity per week, and more than 20 minutes of activity per day. A majority of individuals in the control group were engaging in less than 150 minutes per week of MVPA and less than 20 minutes of MVPA per day at posttest. At baseline, a majority of individuals in both groups were exceeding 4,000 steps per day, and at posttest 25% of individuals in the intervention group were walking more than 8,000 steps per day. A majority of individuals burned between 2,000-3,000 kcal per day at both baseline and posttest. Finally, all individuals in both groups were sedentary for 19 hours or more each day at both pretest and posttest.
Table 4. 2 Frequency Table for Dimensions of MVPA at Pretest in the Intervention Group

*Minutes of MVPA Per Week*

<table>
<thead>
<tr>
<th>Minutes</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-149</td>
<td>2</td>
<td>18.2</td>
<td>18.2</td>
</tr>
<tr>
<td>150-299</td>
<td>5</td>
<td>45.4</td>
<td>63.6</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>4</td>
<td>36.4</td>
<td>100</td>
</tr>
</tbody>
</table>

*Minutes of MVPA Per Day*

<table>
<thead>
<tr>
<th>Minutes</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>2</td>
<td>18.2</td>
<td>18.2</td>
</tr>
<tr>
<td>21-40</td>
<td>3</td>
<td>27.3</td>
<td>45.5</td>
</tr>
<tr>
<td>41-60</td>
<td>3</td>
<td>27.2</td>
<td>72.7</td>
</tr>
<tr>
<td>&gt; 60</td>
<td>3</td>
<td>27.3</td>
<td>100</td>
</tr>
</tbody>
</table>

*Number of Steps Per Day*

<table>
<thead>
<tr>
<th>Steps</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2000</td>
<td>2</td>
<td>16.7</td>
<td>16.7</td>
</tr>
<tr>
<td>2001-4000</td>
<td>4</td>
<td>33.3</td>
<td>50</td>
</tr>
<tr>
<td>4001-6000</td>
<td>3</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>6001-8000</td>
<td>2</td>
<td>16.7</td>
<td>91.7</td>
</tr>
<tr>
<td>8001-10,000</td>
<td>1</td>
<td>8.3</td>
<td>100</td>
</tr>
</tbody>
</table>

*Caloric Expenditure Per Day*

<table>
<thead>
<tr>
<th>kcal</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500-2000</td>
<td>2</td>
<td>16.7</td>
<td>16.7</td>
</tr>
<tr>
<td>2001-2500</td>
<td>4</td>
<td>41.6</td>
<td>58.3</td>
</tr>
<tr>
<td>2501-3000</td>
<td>2</td>
<td>16.7</td>
<td>75</td>
</tr>
<tr>
<td>3001-3500</td>
<td>2</td>
<td>16.7</td>
<td>91.7</td>
</tr>
<tr>
<td>3501-4000</td>
<td>1</td>
<td>8.3</td>
<td>100</td>
</tr>
</tbody>
</table>

*Sedentary Time Per Day*

<table>
<thead>
<tr>
<th>Hours: Minutes</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>19:00-20:00</td>
<td>3</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>20:01-21:00</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>21:01-22:00</td>
<td>3</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>22:01-23:00</td>
<td>4</td>
<td>33.2</td>
<td>83.2</td>
</tr>
<tr>
<td>23:01-24:00</td>
<td>2</td>
<td>16.8</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 4.3 Frequency Table for Dimensions of MVPA at Posttest for the Intervention Group

### Minutes of MVPA Per Week

<table>
<thead>
<tr>
<th>Minutes</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-149</td>
<td>4</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td>150-299</td>
<td>3</td>
<td>25</td>
<td>58.3</td>
</tr>
<tr>
<td>&gt;300</td>
<td>5</td>
<td>41.7</td>
<td>100</td>
</tr>
</tbody>
</table>

### Minutes of MVPA Per Day

<table>
<thead>
<tr>
<th>Minutes</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>4</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td>21-40</td>
<td>2</td>
<td>16.7</td>
<td>50</td>
</tr>
<tr>
<td>41-60</td>
<td>2</td>
<td>16.7</td>
<td>66.7</td>
</tr>
<tr>
<td>&gt;60</td>
<td>4</td>
<td>33.3</td>
<td>100</td>
</tr>
</tbody>
</table>

### Number of Steps Per Day

<table>
<thead>
<tr>
<th>Steps</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2000</td>
<td>2</td>
<td>16.7</td>
<td>16.7</td>
</tr>
<tr>
<td>2001-4000</td>
<td>2</td>
<td>16.6</td>
<td>33.3</td>
</tr>
<tr>
<td>4001-6000</td>
<td>3</td>
<td>25</td>
<td>58.3</td>
</tr>
<tr>
<td>6001-8000</td>
<td>2</td>
<td>16.7</td>
<td>75</td>
</tr>
<tr>
<td>8001-10,000</td>
<td>2</td>
<td>16.7</td>
<td>91.7</td>
</tr>
<tr>
<td>&lt;10,000</td>
<td>1</td>
<td>8.3</td>
<td>100</td>
</tr>
</tbody>
</table>

### Caloric Expenditure Per Day

<table>
<thead>
<tr>
<th>kcal</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500-2000</td>
<td>2</td>
<td>16.7</td>
<td>16.7</td>
</tr>
<tr>
<td>2001-2500</td>
<td>5</td>
<td>41.6</td>
<td>58.3</td>
</tr>
<tr>
<td>2501-3000</td>
<td>4</td>
<td>33.4</td>
<td>91.7</td>
</tr>
<tr>
<td>3001-3500</td>
<td>1</td>
<td>8.3</td>
<td>100</td>
</tr>
</tbody>
</table>

### Sedentary Time Per Day

<table>
<thead>
<tr>
<th>Hours: Minutes</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>20:01-21:00</td>
<td>1</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td>21:01-22:00</td>
<td>4</td>
<td>25</td>
<td>41.7</td>
</tr>
<tr>
<td>22:01-23:00</td>
<td>4</td>
<td>33.3</td>
<td>75</td>
</tr>
<tr>
<td>23:01-24:00</td>
<td>3</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 4.4 Frequency Table for Dimensions of MVPA at Pretest for the Control Group

*Minutes of MVPA Per Week*

<table>
<thead>
<tr>
<th>Minutes of MVPA Per Week</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-149</td>
<td>5</td>
<td>45.5</td>
<td>45.5</td>
</tr>
<tr>
<td>150- 299</td>
<td>2</td>
<td>18.1</td>
<td>63.6</td>
</tr>
<tr>
<td>&gt; 300</td>
<td>2</td>
<td>36.4</td>
<td>100</td>
</tr>
</tbody>
</table>

*Minutes of MVPA Per Day*

<table>
<thead>
<tr>
<th>Minutes of MVPA Per Day</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>4</td>
<td>36.4</td>
<td>36.4</td>
</tr>
<tr>
<td>21-40</td>
<td>3</td>
<td>27.2</td>
<td>63.6</td>
</tr>
<tr>
<td>41-60</td>
<td>0</td>
<td>0</td>
<td>63.6</td>
</tr>
<tr>
<td>&gt; 60</td>
<td>4</td>
<td>36.4</td>
<td>100</td>
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</table>

*Number of Steps Per Day*

<table>
<thead>
<tr>
<th>Number of Steps Per Day</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0- 2000</td>
<td>3</td>
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<td>27.3</td>
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<tr>
<td>2001-4000</td>
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<td>63.6</td>
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<td>18.2</td>
<td>81.8</td>
</tr>
<tr>
<td>6001- 8000</td>
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<td>0</td>
<td>81.8</td>
</tr>
<tr>
<td>8001- 10,000</td>
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<td>18.2</td>
<td>100</td>
</tr>
<tr>
<td>&lt; 10,000</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

*Caloric Expenditure Per Day*

<table>
<thead>
<tr>
<th>Caloric Expenditure Per Day</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500-2000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2001-2500</td>
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<tr>
<td>3501-4000</td>
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<td>9.1</td>
<td>100</td>
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</table>

*Sedentary Time Per Day*

<table>
<thead>
<tr>
<th>Sedentary Time Per Day</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>19:00- 20:00</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20:01-21:00</td>
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<td>9.1</td>
<td>9.1</td>
</tr>
<tr>
<td>21:01-22:00</td>
<td>4</td>
<td>25</td>
<td>45.5</td>
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<td>81.8</td>
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<td>23:01-24:00</td>
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<td>18.2</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 4.5 Frequency Table of Dimensions of MVPA at Posttest for the Control Group

### Minutes of MVPA Per Week

<table>
<thead>
<tr>
<th>Minutes</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-149</td>
<td>8</td>
<td>72.7</td>
<td>72.7</td>
</tr>
<tr>
<td>150-299</td>
<td>2</td>
<td>18.2</td>
<td>90.9</td>
</tr>
<tr>
<td>&gt;300</td>
<td>1</td>
<td>9.1</td>
<td>100</td>
</tr>
</tbody>
</table>

### Minutes of MVPA Per Day

<table>
<thead>
<tr>
<th>Minutes</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>8</td>
<td>72.7</td>
<td>72.7</td>
</tr>
<tr>
<td>21-40</td>
<td>2</td>
<td>18.2</td>
<td>90.9</td>
</tr>
<tr>
<td>41-60</td>
<td>0</td>
<td>0</td>
<td>90.9</td>
</tr>
<tr>
<td>&gt;60</td>
<td>1</td>
<td>9.1</td>
<td>100</td>
</tr>
</tbody>
</table>

### Number of Steps Per Day

<table>
<thead>
<tr>
<th>Steps</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2000</td>
<td>3</td>
<td>27.3</td>
<td>27.3</td>
</tr>
<tr>
<td>2001-4000</td>
<td>3</td>
<td>27.2</td>
<td>54.5</td>
</tr>
<tr>
<td>4001-6000</td>
<td>2</td>
<td>18.2</td>
<td>72.7</td>
</tr>
<tr>
<td>6001-8000</td>
<td>2</td>
<td>18.2</td>
<td>90.9</td>
</tr>
<tr>
<td>8001-10000</td>
<td>1</td>
<td>9.1</td>
<td>100</td>
</tr>
<tr>
<td>&lt;10,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Caloric Expenditure Per Day

<table>
<thead>
<tr>
<th>kcal</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500-2000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2001-2500</td>
<td>5</td>
<td>45.5</td>
<td>45.5</td>
</tr>
<tr>
<td>2501-3000</td>
<td>4</td>
<td>36.3</td>
<td>81.8</td>
</tr>
<tr>
<td>3001-3500</td>
<td>2</td>
<td>18.2</td>
<td>100</td>
</tr>
<tr>
<td>3501-4000</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

### Sedentary Time Per Day

<table>
<thead>
<tr>
<th>Hours: Minutes</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>19:00-20:00</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20:01-21:00</td>
<td>1</td>
<td>9.1</td>
<td>9.1</td>
</tr>
<tr>
<td>21:01-22:00</td>
<td>0</td>
<td>0</td>
<td>9.1</td>
</tr>
<tr>
<td>22:01-23:00</td>
<td>6</td>
<td>54.5</td>
<td>63.6</td>
</tr>
<tr>
<td>23:01-24:00</td>
<td>4</td>
<td>36.4</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 4.6 displays baseline values for MVPA in the intervention group and the control group. While moderate and vigorous physical activity has been lumped into MVPA, it should be noted that less than 1% of the volume of physical activity for both groups was vigorous intensity. Additionally, upon inspection for normality, an outlier was observed for baseline minutes of MVPA per week and minutes of MVPA per day. These data points were subsequently removed from the analysis of minutes of MVPA per week and minutes of MVPA per day only, because of undue influence. Number of steps per day, caloric expenditure per day, and sedentary time were retained for this subject. There were no significant differences between the intervention and control group at baseline for the following variables: minutes of MVPA per week, minutes of MVPA per day, steps per day, caloric expenditure per day (kcal), and sedentary time per day (hours: minutes). The intervention group engaged in an average 364 minutes of MVPA per week (SD = 280.02), averaging 52.45 minutes of MVPA per day (SD = 39.63). This group also took an average of 4345.92 steps per day (SD = 2525.51), expended 2611.83 calories per day (SD = 639.94), and spent 21 hours and 46 minutes being sedentary (SD = 1:28). Similarly, the control group engaged in 304.45 minutes of MVPA per week (SD = 327.08) and 44.09 minutes of MVPA per day (SD = 46.36), took 3915.09 steps per day (SD = 2635.76), burned 2840.91 calories per day (SD = 461.69), and spent 22 hours and 16 minutes being sedentary (SD = 1:00).
Table 4.6 Baseline Values for Dimensions of Physical Activity for the Intervention Group and the Control Group

<table>
<thead>
<tr>
<th></th>
<th>Intervention Group</th>
<th>Control Group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M \pm SD$</td>
<td>$M \pm SD$</td>
<td></td>
</tr>
<tr>
<td>Minutes of MVPA per week</td>
<td>364.00 ± 280.02</td>
<td>304.45 ± 327.08</td>
<td>0.651</td>
</tr>
<tr>
<td>Minutes of MVPA per day</td>
<td>52.45 ± 39.63</td>
<td>44.09 ± 46.36</td>
<td>0.654</td>
</tr>
<tr>
<td>Steps per day</td>
<td>4345.92 ± 2525.51</td>
<td>3915.09 ± 2635.76</td>
<td>0.693</td>
</tr>
<tr>
<td>Caloric Expenditure per day (kcal)</td>
<td>2611.83 ± 639.94</td>
<td>2840.91 ± 461.69</td>
<td>0.34</td>
</tr>
<tr>
<td>Sedentary Time per day (hour: min)</td>
<td>21:46 ± 1:28</td>
<td>22:16 ± 1:00</td>
<td>0.362</td>
</tr>
</tbody>
</table>

Self-Regulation Variables

Table 4.7 displays the values for dimensions of baseline self-regulation for the intervention group and the control group. The Self-Regulation for Exercise Questionnaire was scored by taking the average score for the entire questionnaire as well as the average score for each individual subscale. Therefore, values for the total self-regulation as well as each subscale (self-monitoring, goal setting, social support, self-reward, time management, and overcoming barriers) were on a scale of 1 to 5 according to how often individuals perceived themselves to use a series of techniques to engage in exercise over the past 4 weeks. A score of 1 indicated “never”, or low levels of perceived self-regulation, and a score of 5 signified “very often”, or high levels of perceived self-regulation. At baseline, there were no significant differences between groups on total self-regulation or the following subscales: self-monitoring, goal setting, social support, self-reward, time management, and overcoming barriers. The intervention group had mean score of 1.72 for total self-regulation (SD = 0.581), 1.62 for self-monitoring (SD = 0.606), 1.83 for goal setting (SD = 0.718), 1.48 for social support (SD = 0.528), 1.97 for self-reward (SD= 0.748), 1.67 for time management (SD = 0.835), and 1.65 for
overcoming barriers ($SD = 0.595$). Likewise, the control group had a mean score of 1.85 for total self-regulation ($SD = 0.589$), 1.87 for self-monitoring ($SD = 0.75$), 2.04 for goal setting ($SD = 0.946$), 1.48 for social support ($SD = 0.565$), 2.10 for self-reward ($SD = 0.881$), 1.70 for time management ($SD = 0.67$), and 1.79 for overcoming barriers ($SD = 0.558$).

**Table 4.7 Baseline Values for Dimensions of Self-Regulation for the Intervention Group and the Control Group**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Intervention Group $M + SD$</th>
<th>Control Group $M + SD$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Self-Regulation</td>
<td>$1.72 \pm 0.581$</td>
<td>$1.85 \pm 0.589$</td>
<td>0.609</td>
</tr>
<tr>
<td>Self-Monitoring</td>
<td>$1.62 \pm 0.606$</td>
<td>$1.87 \pm 0.75$</td>
<td>0.376</td>
</tr>
<tr>
<td>Goal Setting</td>
<td>$1.83 \pm 0.718$</td>
<td>$2.04 \pm 0.946$</td>
<td>0.558</td>
</tr>
<tr>
<td>Social Support</td>
<td>$1.48 \pm 0.528$</td>
<td>$1.48 \pm 0.565$</td>
<td>0.988</td>
</tr>
<tr>
<td>Self-Reward</td>
<td>$1.97 \pm 0.748$</td>
<td>$2.10 \pm 0.881$</td>
<td>0.708</td>
</tr>
<tr>
<td>Time Management</td>
<td>$1.67 \pm 0.835$</td>
<td>$1.70 \pm 0.67$</td>
<td>0.906</td>
</tr>
<tr>
<td>Overcoming Barriers</td>
<td>$1.65 \pm 0.595$</td>
<td>$1.79 \pm 0.558$</td>
<td>0.575</td>
</tr>
</tbody>
</table>

**Research Questions**

The subsequent analyses served to answer the following research questions:

**Research Questions: MVPA**

- What is the effect of the 4-week behavioral intervention on minutes of MVPA per week in a sample of overweight and obese adults with type 2 diabetes?
- What is the effect of the 4-week behavioral intervention on minutes of MVPA per day in a sample of overweight and obese adults with type 2 diabetes?
- What is the effect of the 4-week behavioral intervention on number of steps per day in a sample of overweight and obese adults with type 2 diabetes?
• What is the effect of the 4-week behavioral intervention on caloric expenditure per day in a sample of overweight and obese adults with type 2 diabetes?

• What is the effect of the 4-week behavioral intervention on sedentary time per day in a sample of overweight and obese adults with type 2 diabetes?

Research Questions: Self-Regulation

• What is the effect of the 4-week behavioral intervention on self-regulation in a sample of overweight and obese adults with type 2 diabetes?

• What is the effect of the 4-week behavioral intervention on self-monitoring in a sample of overweight and obese adults with type 2 diabetes?

• What is the effect of the 4-week behavioral intervention on goal setting in a sample of overweight and obese adults with type 2 diabetes?

• What is the effect of the 4-week behavioral intervention on social support in a sample of overweight and obese adults with type 2 diabetes?

• What is the effect of the 4-week behavioral intervention on time management in a sample of overweight and obese adults with type 2 diabetes?

• What is the effect of the 4-week behavioral intervention on self-reward in a sample of overweight and obese adults with type 2 diabetes?

• What is the effect of the 4-week behavioral intervention on overcoming barriers in a sample of overweight and obese adults with type 2 diabetes?
Physical Activity Results

Total Minutes of MVPA Per Week

Descriptive statistics for both the intention-to-treat and completer analyses are presented in Table 4.8. Descriptive statistics suggest that the total minutes of MVPA per week decreased over the course of the 4-week intervention for both the control group and the intervention group.

Table 4.8 Descriptive Statistics for Pre- and Post-Test Total Minutes of MVPA in the Intervention and Control Groups for Intention-to-Treat and Completer Analysis

<table>
<thead>
<tr>
<th>Descriptive Statistics: Total Minutes of MVPA Per Week</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>364.00</td>
<td>280.022</td>
<td>11</td>
</tr>
<tr>
<td>Control</td>
<td>304.45</td>
<td>327.075</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>334.23</td>
<td>298.68</td>
<td>22</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>315.82</td>
<td>249.543</td>
<td>11</td>
</tr>
<tr>
<td>Control</td>
<td>187.27</td>
<td>266.248</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>251.55</td>
<td>260.263</td>
<td>22</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>411.33</td>
<td>281.518</td>
<td>9</td>
</tr>
<tr>
<td>Control</td>
<td>304.45</td>
<td>327.075</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>352.55</td>
<td>304.384</td>
<td>20</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>352.44</td>
<td>254.242</td>
<td>9</td>
</tr>
<tr>
<td>Control</td>
<td>187.27</td>
<td>266.248</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>261.60</td>
<td>267.644</td>
<td>20</td>
</tr>
</tbody>
</table>

Note. ITT = Intention-to-treat analysis, CA = Completer analysis

Results of the intention-to-treat two-factor split-plot ANOVA (Table 4.9) showed a significant main effect of Time at the .05 level, $F(1,18) = 4.796, p = .041$, with a large effect size (partial $\eta^2 = .193$) and moderate power (.549). This implies that there were significant differences in total minutes of MVPA per week from pretest to posttest. In both groups, the minutes of MVPA per week decreased from pretest to posttest. The main effect of the intervention was not significant at the .05 level, $F(1,18) = .678, p = .430$, with a small effect size (partial $\eta^2 = .033$) and inadequate power (.123). The interaction
between Time and Group was also not significant, \( F(1, 18) = .835, p = .372 \), with a small effect size (partial \( \eta^2 = .040 \)) and low observed power (.140). Due to insufficient power, the group and interaction hypotheses could not be tested and conclusions cannot be made.

Using Cohen’s \( d \) effect sizes, the intervention showed a low effect on total minutes of MVPA from pretest to posttest (\( d = .18 \)). There were also small differences in total minutes of MVPA in the control group from pretest to posttest (\( d = .39 \)). There were moderate differences in total minutes of MVPA between the intervention and control group at posttest (\( d = .50 \)), suggesting a moderate effect of the intervention on weekly MVPA at follow-up. Overall, effect size calculations show that the decrease in MVPA from pretest to posttest in both groups was small.

**Table 4.9 Time, Interaction, and Group Effects for Intention-to-Treat Analysis of Minutes of MVPA Per Week**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>( F )</th>
<th>Sig</th>
<th>Partial ( \eta^2 )</th>
<th>Observed Power*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>75199.114</td>
<td>1</td>
<td>75199.114</td>
<td>4.796</td>
<td>0.041</td>
<td>0.193</td>
<td>0.549</td>
</tr>
<tr>
<td>Time * Group</td>
<td>13092.75</td>
<td>1</td>
<td>13092.75</td>
<td>0.835</td>
<td>0.372</td>
<td>0.040</td>
<td>0.140</td>
</tr>
<tr>
<td>Tests of Between-Subject Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>97290.023</td>
<td>1</td>
<td>97290.023</td>
<td>0.678</td>
<td>0.42</td>
<td>0.033</td>
<td>0.123</td>
</tr>
</tbody>
</table>

*Note. Measure: Total Minutes of MVPA Per Week a Computed using alpha = .05*

Results from the completer analysis are presented in Table 4.10. There was a significant main effect of Time at the .05 level, \( F(1, 18) = 4.44, p = .049 \), with a large effect size (partial \( \eta^2 = .198 \)) and moderate power (.514). This implies that there were significant differences in total minutes of MPVA per week from pretest to posttest. The main effect of the intervention was not significant at the .05 level, \( F(1, 18) = 1.259, p = .277 \), with a medium effect size (partial \( \eta^2 = .065 \)) and inadequate power (.186), and the
interaction between Time and Group was also not significant, $F(1, 18) = .487, p = .494$, indicating that changes in total minutes of MVPA per week from pretest to posttest did not depend on the intervention. Effect size was small (partial $\eta^2 = .026$) and observed power was low (.101). Similar to the intention-to-treat analysis, due to low levels of power, statistical conclusions cannot be drawn for the main effect or interaction effect.

Using Cohen’s $d$ effect sizes, there were small differences in the intervention group on total minutes of MVPA per week from pretest to posttest ($d = .22$). There were also small differences in total minutes of MVPA in the control group from pretest to posttest ($d = .39$). Finally, there were moderate differences in total minutes of MVPA at posttest between the intervention and control group at posttest ($d = .64$). Again, while the effect of time was significant on minutes of MVPA per week, effect size calculations show that the decrease in MVPA from pretest to posttest in both groups was small. Also, the medium effect between the intervention and control group at posttest suggests that those who completed the intervention were participating in higher levels of MVPA per week at posttest than members of the control group.

Table 4. 10 Time, Interaction, and Group Effects for Completer Analysis of Minutes of MVPA Per Week

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>76727.212</td>
<td>1</td>
<td>76727.212</td>
<td>4.444</td>
<td>0.049</td>
<td>0.198</td>
<td>0.514</td>
</tr>
<tr>
<td>Time * Group</td>
<td>8410.212</td>
<td>1</td>
<td>8410.212</td>
<td>0.487</td>
<td>0.494</td>
<td>0.026</td>
<td>0.101</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects

| Group           | 183178.406  | 1  | 183178.406  | 1.259 | 0.277 | 0.065           | 0.186              |

Note. Measure: Total Minutes of MVPA Per Week a Computed using alpha = .05
Minutes of MVPA Per Day

Descriptive statistics for both the intention-to-treat and completer analyses for average minutes of MVPA per day are presented in Table 4.11. Descriptive statistics suggest that the average minutes of MVPA per day for both groups declined from baseline to 4-week posttest.

Table 4.11 Descriptive Statistics for Pre- and Post-Test Minutes of MVPA Per Day in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

Descriptive Statistics: Minutes of MVPA Per Day

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>52.45</td>
<td>39.632</td>
<td>11</td>
</tr>
<tr>
<td>Control</td>
<td>44.09</td>
<td>46.356</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>48.27</td>
<td>43.202</td>
<td>22</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>45.27</td>
<td>35.65</td>
<td>11</td>
</tr>
<tr>
<td>Control</td>
<td>26.64</td>
<td>37.874</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>35.95</td>
<td>37.145</td>
<td>22</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>59.22</td>
<td>39.749</td>
<td>9</td>
</tr>
<tr>
<td>Control</td>
<td>44.09</td>
<td>46.356</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>50.9</td>
<td>43.08</td>
<td>20</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>50.44</td>
<td>36.394</td>
<td>9</td>
</tr>
<tr>
<td>Control</td>
<td>26.64</td>
<td>37.874</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>37.35</td>
<td>38.214</td>
<td>20</td>
</tr>
</tbody>
</table>

Note. ITT = Intention-to-treat analysis, CA= Completer's analysis

Results of the intention-to-treat two-factor split-plot ANOVA (Table 4.12) showed a significant main effect of Time at the .05 level, $F(1,20)=5.518, p = .029$, with a large effect size ($\eta^2 = .216$) and moderate power (.608). This implies that there were significant differences in minutes of MVPA per day from pretest to posttest. The main effect of the intervention was not significant at the .05 level, $F(1,20)= .689, p = .416$, with a small effect size ($\eta^2 = .033$) and inadequate power (.124). The interaction between Time and Group was also not significant, $F(1, 20) = .959, p = .339,$
with a small effect size (partial $\eta^2 = .046$) and low power (.154). Similar to minutes of MVPA per week, insufficient power for the main effect and interaction effect on minutes of MVPA per day mean that statistical conclusions cannot be drawn.

Based upon Cohen’s D effect sizes, the intervention showed a low effect on minutes of MVPA per day from pretest to posttest ($d= .19$). There were also small differences in minutes of MVPA per week in the control group from pretest to posttest ($d=.41$). This suggests that although there was a significant effect of time on minutes of MVPA per day in both groups, decreases were small. There were moderate differences in minutes of MVPA per day between the intervention and control group at posttest ($d= .51$), suggesting that the intervention group had moderately higher levels of MVPA per day at posttest than the control group.

Table 4.12 Test of Time, Interaction, and Group Effects for Intention-to-Treat Analysis of Minutes of MVPA Per Day

<table>
<thead>
<tr>
<th>Tests of Within-Subjects Effects: Greenhouse-Geisser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Time</td>
</tr>
<tr>
<td>Time * Group</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test of Between-Subject Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Group</td>
</tr>
</tbody>
</table>

*Note. Measure: Minutes of MVPA Per Day a Computed using alpha =.05

Results from the completer analysis are presented in Table 4.13. There was a significant main effect of Time at the .05 level, $F(1,18) = 5.120$, $p = .036$ with a large effect size (partial $\eta^2 = .221$) and moderate power (.572). This implies that there were significant differences in minutes of MVPA per day from pretest to posttest. The main effect of the intervention was not significant at the .05 level, $F(1,18) = 1.273$, $p = .274$, .
with a medium effect size (partial $\eta^2 = .066$) and inadequate power (.188). The interaction between Time and Group was also not significant, $F(1, 18) = .560, p = .464$, with a small effect size was small (partial $\eta^2 = .030$) and low observed power (.109). Therefore, these values cannot be statistically interpreted due to insufficient power.

Using Cohen’s $d$ effect sizes, there were small differences in the intervention group on minutes of MVPA per day from pretest to posttest ($d = .23$). There were also small differences in total minutes of MVPA in the control group from pretest to posttest ($d = .41$). Low effect sizes suggest that the decrease in MVPA per day from pretest to posttest in both groups was not practically significant. There were moderate differences in total minutes of MVPA at posttest between the intervention and control group at posttest ($d = .64$), suggesting that individuals who completed the intervention were engaging in moderately more MVPA per day that individuals in the control group at posttest.

Table 4.13 Tests of Time, Interaction, and Group Effects for Completer Analysis of MVPA Per Day

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>1703.134</td>
<td>1</td>
<td>1703.134</td>
<td>5.12</td>
<td>0.036</td>
<td>0.221</td>
<td>0.572</td>
</tr>
<tr>
<td>Time * Group</td>
<td>186.334</td>
<td>1</td>
<td>186.334</td>
<td>0.56</td>
<td>0.464</td>
<td>0.03</td>
<td>0.109</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects

| Group | 3752.784 | 1  | 3752.784 | 1.273| 0.274| 0.066| 0.188 |

Note. Measure: Minutes of MVPA Per Day a Computed using alpha =.05

Number of Steps Per Day

Means and standard deviations for number of steps per day are presented in Table 4.14. Descriptive statistics are presented for both the intention-to-treat analysis and the
completer analysis. These values suggest that both the intervention group and the control group increased their number of steps from pretest to posttest.

Table 4. 14 Descriptive Statistics for Number of Steps per Day in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>4345.92</td>
<td>2525.505</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>3915.09</td>
<td>2635.761</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>4139.87</td>
<td>2528.901</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>5696.08</td>
<td>2998.585</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>4108.82</td>
<td>2475.443</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>4936.96</td>
<td>2817.51</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>4594.5</td>
<td>2660.81</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>3915.09</td>
<td>2635.761</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>4238.62</td>
<td>2603.934</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>6214.79</td>
<td>2982.089</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>4108.82</td>
<td>2475.443</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>5111.62</td>
<td>2868.395</td>
<td>21</td>
</tr>
</tbody>
</table>

Note. ITT = Intention-to-treat analysis, CA= Completer's analysis

The results of the intention-to-treat 2 x 2 split plot ANOVA for number of steps per day (Table 4.15) showed a significant main effect of time, $F(1,21) = 8.34, p = .009$ with a large effect size (partial $\eta^2 = .284$) and adequate power (.786). This suggests a significant difference in number of steps from pretest to posttest, as both groups increased their number of steps from pretest to posttest. However, the interaction effect between the group and time was also significant, $F(1, 21)= 4.679, p = .042$, with a large effect size (partial $\eta^2 = .182$) and moderate power (.541). This suggests that increase in number of steps from pretest to posttest was dependent upon the group (intervention vs. control).
However, the main effect of the intervention was not significant, $F(1, 21) = 0.868, p = 0.362$, with a small effect size (partial $\eta^2 = 0.040$) and inadequate power (0.144). However, due to insufficient power, the main effect of the intervention cannot be adequately interpreted.

Cohen’s $d$ effect sizes were calculated in order to interpret the practical significance of the intervention on number of steps per day. Cohen’s $d$ effect size calculations showed a moderate effect of the intervention from pretest to posttest (0.49), and small differences in the control group from pretest to posttest (0.08). These values suggest that the intervention group experienced moderate increases in their number of steps per day from pre to post, while the control group increase was not practically significant. There were also moderate differences between the intervention and control group at posttest (0.58), suggesting that the intervention group was taking moderately more steps at posttest compared to the control group.

**Table 4.15 Tests of Time, Interaction, and Group Effects for Intention-to-Treat Analysis for Number of Steps Per Day**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>6839920.032</td>
<td>1</td>
<td>6839920.032</td>
<td>8.34</td>
<td>0.009</td>
<td>0.284</td>
<td>0.786</td>
</tr>
<tr>
<td>Time * Group</td>
<td>3837618.989</td>
<td>1</td>
<td>3837618.989</td>
<td>4.67</td>
<td></td>
<td>0.182</td>
<td>0.541</td>
</tr>
</tbody>
</table>

**Test of Between-Subject Effects**

| Group       | 11686852.2      | 1   | 11686852.2 | 8    | 0.362| 0.04           | 0.144             |

*Note. Measure: Number of Steps Per Day a Computed using alpha = .05*

The results of the completer analysis 2 x 2 split plot ANOVA for number of steps per day (Table 4.16) showed a significant main effect of time, $F(1,19) = 10.89, p = 0.004$
with a large effect size (partial $\eta^2 = .364$) and adequate power (.879). This suggests a significant difference in number of steps from pretest to posttest, as both groups increased their number of steps. The interaction effect between the group and time was also significant, $F(1, 19)= 6.735, p = .018$, with a large effect size (partial $\eta^2 = .262$) and moderate power (.692). This suggests that change in number of steps from pretest to posttest was dependent upon the group (intervention vs. control). However, the main effect of the intervention was not significant, $F(1, 19) = 1.488, p = .237$, with a small effect size (partial $\eta^2 = .073$) and inadequate power (.212), meaning that the main effect of the intervention could not be statistically concluded.

Similar to the intention-to-treat analysis, Cohen’s $d$ effect size calculations showed a moderate effect of the intervention from pretest to posttest (.57), with small differences in the control group from pretest to posttest (.08). This suggests that individuals completing the intervention were taking moderately more steps from pretest to posttest, while the change from pre to post in the control group was not practically significant. There were also moderate-to-large differences between the intervention and control group at posttest (.77). This suggests a high practical significance of the intervention as those in the intervention group were taking more steps at posttest than the control group.
Table 4. 16 Tests of Time, Interaction, and Group Effects for Completer Analysis of Number of Steps Per Day

Tests of Within-Subjects Effects: Greenhouse-Geiser

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>8617536.585</td>
<td>1</td>
<td>8617536.585</td>
<td>10.89</td>
<td>0.004</td>
<td>0.364</td>
<td>0.879</td>
</tr>
<tr>
<td>Time * Group</td>
<td>5329302.109</td>
<td>1</td>
<td>5329302.109</td>
<td>6.735</td>
<td>0.018</td>
<td>0.262</td>
<td>0.692</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects

| Group       | 20318166.65 | 1  | 20318166.65 | 1.488 | 0.237| 0.073          | 0.212              |

Note. Measure: Number of Steps Per Day a Computed using alpha =.05

Caloric Expenditure Per Day

Means and standard deviations for caloric expenditure per day are presented in Table 4.13. Descriptive statistics are presented for both the intention-to-treat analysis and the completer analysis. According to Table 4.13, caloric expenditure decreased slightly in both groups from pretest to posttest.

Table 4. 17 Descriptive Statistics for Caloric Expenditure Per Day in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

Descriptive Statistics: Caloric Expenditure Per Day

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>2611.82</td>
<td>639.941</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>2840.91</td>
<td>461.689</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2721.39</td>
<td>561.552</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>2463.17</td>
<td>485.505</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>2610.73</td>
<td>431.546</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2533.74</td>
<td>456.277</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>2666.1</td>
<td>666.466</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>2840.91</td>
<td>461.689</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2757.67</td>
<td>560.769</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>2487.79</td>
<td>497.356</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>2610.73</td>
<td>431.546</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2552.14</td>
<td>456.501</td>
<td>21</td>
</tr>
</tbody>
</table>

Note. ITT = Intention-to-treat analysis, CA= Completer's analysis
The results of the intention-to-treat 2 x 2 split plot ANOVA for caloric expenditure per day (Table 4.18) showed a significant main effect of time, $F(1, 21) = 4.9$, $p = .038$ with a large effect size (partial $\eta^2 = .189$), and moderate power (.560). This suggests a significant difference in caloric expenditure from pretest to posttest. The interaction effect between the group and time was not significant, $F(1, 21)= .227, p = .639$, with a small effect size (partial $\eta^2 = .011$) and inadequate power (.074), The main effect of the intervention was not significant, $F(1, 21) = .917, p = .349$, with a small effect size (partial $\eta^2 = .042$) and inadequate power (.150). Inadequate power suggests that the hypothesis for the intervention effect and interaction effect could not be statistically supported.

Cohen’s $d$ effect size calculations showed small difference in the intervention group from pretest to posttest (.26). This suggests that the effect of time on caloric expenditure was not practically significant, as the decrease in caloric expenditure from pretest to posttest in the intervention group was small. There was a moderate decrease in caloric expenditure in the control group from pretest to posttest (.52). There were also small differences between the intervention and control group at posttest (.32). This suggests that the posttest differences in groups for caloric expenditure was not practically important.
Table 4.18 Tests of Time, Interaction, and Group Effects for Intention-to-Treat Analysis of Caloric Expenditure Per Day

Tests of Within-Subjects Effects: Greenhouse-Geiser

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta²</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>411857.718</td>
<td>1</td>
<td>411857.718</td>
<td>4.9</td>
<td>0.038</td>
<td>0.189</td>
<td>0.56</td>
</tr>
<tr>
<td>Time * Group</td>
<td>19067.457</td>
<td>1</td>
<td>19067.457</td>
<td>0.227</td>
<td>0.639</td>
<td>0.011</td>
<td>0.074</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects

| Group       | 407062.032  | 1  | 407062.032  | 0.917| 0.349| 0.042        | 0.15           |

Note. Measure: Caloric Expenditure Per Day a Computed using alpha =.05

The results of the completer analysis 2 x 2 split plot ANOVA for caloric expenditure per day (Table 4.19) showed a significant main effect of time, $F(1, 19) = 4.778, p = .042$ with a large effect size (partial $\eta^2 = .201$) and moderate power (.546). This suggests a significant difference in caloric expenditure per day from pretest to posttest. The interaction effect between the group and time was not significant, $F(1, 19)= .077, p = .785$, with a small effect size (partial $\eta^2 = .004$) and inadequate power (.058). The main effect of the intervention was also not significant, $F(1, 19) = .521, p = .479$, with a small effect size (partial $\eta^2 = .027$) and inadequate power (.105). Inadequate power suggests that the hypothesis for the intervention effect and interaction effect could not be statistically supported.

Similar to the intention-to-treat analysis, Cohen’s $d$ effect size calculations showed a small effect of the intervention from pretest to posttest (.30). This suggests that the effect of time on caloric expenditure was not practically significant, as the decrease in caloric expenditure from pretest to posttest in the intervention group was small. There was also a moderate decrease in caloric expenditure per day in the control group from
pretest to posttest (.52). Finally, there were also small differences between the intervention and control group at posttest (.26).

Table 4.19 Tests of Time, Interaction, and Group Effects for Completer Analysis of Caloric Expenditure Per Day

<table>
<thead>
<tr>
<th>Tests of Within-Subjects Effects: Greenhouse-Geiser</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source</strong></td>
</tr>
<tr>
<td>Time</td>
</tr>
<tr>
<td>Time *</td>
</tr>
<tr>
<td>Group</td>
</tr>
</tbody>
</table>

*Note. Measure: Caloric Expenditure Per Day a Computed using alpha = .05

Sedentary Time Per Day

The final physical activity variable recorded by the BodyMedia Armband was average sedentary time per day. Sedentary time was recorded in hours and minutes. Descriptive statistics are presented in Table 4.20. The amount of time being sedentary per day appeared to increased in both the intervention and control groups from pretest to posttest.
Table 4. 20 Descriptive Statistics for Sedentary Time Per Day in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>21:46</td>
<td>1:28</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>22:16</td>
<td>1:00</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>22:00</td>
<td>1:17</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>22:13</td>
<td>1:06</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>22:45</td>
<td>1:03</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>22:28</td>
<td>1:05</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>21:49</td>
<td>1:36</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>22:16</td>
<td>1:00</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>22:03</td>
<td>1:19</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>22:22</td>
<td>1:09</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>22:45</td>
<td>1:03</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>22:34</td>
<td>1:05</td>
<td>21</td>
</tr>
</tbody>
</table>

*Note. ITT = Intention-to-treat analysis, CA= Completer's analysis*

The results of the intention-to-treat 2 x 2 split plot ANOVA for sedentary time per day (Table 4.21) did not show a significant main effect of time, $F(1, 21) = 2.974, p = .099$ with a medium effect size (partial $\eta^2 = .124$), and low power (.377). The interaction effect between the group and time was not significant, $F(1, 21)= .003, p = .954$, with a small effect size (partial $\eta^2 = .000$) and inadequate power (.050). The main effect of the intervention was also not significant, $F(1, 21) = 1.516, p = .232$, with a small effect size (partial $\eta^2 = .067$) and inadequate power (.217). Due to insufficient power across the effect of time, the effect of the intervention, and the interaction effect, we cannot draw statistical conclusions regarding sedentary time per day.

Cohen’s $d$ effect sizes were calculated in order to determine the practical significance of the intervention from pretest to posttest on sedentary time per day. Effect size calculations showed small difference in the intervention group from pretest to
posttest (.35) and small differences in the control group pretest to posttest (.47). This suggests that while the means demonstrate an increase in sedentary time per day from pretest to posttest in both groups, this change was not of practical importance.

Additionally, moderate differences between the intervention and control group at posttest (.50 suggest that the intervention group was engaging in moderately less sedentary time per day than the intervention group following the intervention.

Table 4.21 Tests of Time, Interaction, and Group Effects for Intention-to-Treat Analysis for Sedentary Time Per Day

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial η²</th>
<th>Observed Power²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>31690150.79</td>
<td>1</td>
<td>31690150.79</td>
<td>2.974</td>
<td>0.099</td>
<td>0.124</td>
<td>0.377</td>
</tr>
<tr>
<td>Time * Group</td>
<td>36759.486</td>
<td>1</td>
<td>36759.486</td>
<td>0.003</td>
<td>0.954</td>
<td>&lt; 0.001</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects

| Group        | 39004933.4 | 1    | 39004933.4   | 1.516 | 0.232| 0.067      | 0.217           |

Note. Measure: Sedentary Time Per Day a Computed using alpha = .05

The results of the completer analysis 2 x 2 split plot ANOVA for sedentary time per day were similar to that of the intention-to-treat analysis (Table 4.22). There was no significant main effect of time, $F(1, 19) = 2.995, p = 1.00$ with a medium effect size (partial η² = .136), and low power (.376). The interaction effect between the group and time was not significant, $F(1, 19) = .010, p = .922$, with a small effect size (partial η² = .001) and inadequate power (.051). The main effect of the intervention was also not significant, $F(1, 19) = .845, p = .379$, with a small effect size (partial η² = .043) and inadequate power (.141). Similar to above, due to insufficient power across the effect of
time, the effect of the intervention, and the interaction effect, we cannot draw statistical conclusions regarding sedentary time per day.

Cohen’s $d$ effect size calculations showed small difference in the intervention group from pretest to posttest (.39), and small differences in the control group from pretest to posttest (.47). These values suggest that while the amount of time spent being sedentary increased for both groups, this change was not practically important. Finally, there were small differences between the intervention and control group at posttest (.35).

**Table 4.22 Tests of Time, Interaction, and Group Effects for Completer Analysis of Sedentary Time Per Day**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>$df$</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>3478112.4</td>
<td>47</td>
<td>3478112.4</td>
<td>2.99</td>
<td>0.1</td>
<td>0.136</td>
<td>0.376</td>
</tr>
<tr>
<td>Time * Group</td>
<td>113112.46</td>
<td>8</td>
<td>113112.468</td>
<td>0.01</td>
<td>0.922</td>
<td>0.001</td>
<td>0.051</td>
</tr>
<tr>
<td>Test of Between-Subject Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>23068426.7</td>
<td>75</td>
<td>23068426.7</td>
<td>0.84</td>
<td>0.37</td>
<td>0.043</td>
<td>0.141</td>
</tr>
</tbody>
</table>

*Note. Measure: Sedentary Time Per Day a Computed using alpha = .05*

**Self-Regulation Results**

**Total Self-Regulation**

Dimensions of self-regulation were analyzed, beginning with total self-regulation. This was the score on the entire self-regulation questionnaire. Descriptive statistics for the intention-to-treat and completer analysis are presented in Table 4.23. The mean self-regulation for the intervention group increased from between pretest and posttest. The
self-regulation in the control group also increased, but only slightly, from pretest to posttest.

Table 4. 23 Descriptive Statistics for Self-Regulation in the Interventions and Control Groups for Intention-to-Treat and Completer Analyses

<table>
<thead>
<tr>
<th>Descriptive Statistics: Self-Regulation</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.72</td>
<td>0.581</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>1.85</td>
<td>0.589</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.78</td>
<td>0.575</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.28</td>
<td>0.744</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>2.02</td>
<td>0.614</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.68</td>
<td>0.925</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.63</td>
<td>0.588</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>1.85</td>
<td>0.589</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.74</td>
<td>0.584</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.49</td>
<td>0.594</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>2.02</td>
<td>0.614</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.72</td>
<td>0.954</td>
<td>21</td>
</tr>
</tbody>
</table>

*Note. ITT = Intention-to-treat analysis, CA = Completer's analysis*

Results from the 2 x 2 split plot ANOVA intention-to-treat analysis are presented in Table 4.24. The main effect of time was significant, $F(1, 21) = 29.171, p < .001$ with a moderate large size (partial $\eta^2 = .581$) and adequate power (.999), indicating a significant change in perceived self-regulation from pretest to posttest. The interaction effect was also significant, $F(1, 21) = 18.431, p < .001$, with a large effect size (partial $\eta^2 = .467$) and adequate power (.983). This suggests that the change in self-regulation of exercise from pretest to posttest was dependent upon the intervention group. Finally, the main effect of the intervention was also significant, $F(1, 21) = 7.011, p = .015$ with a large effect size (partial $\eta^2 = .250$) and moderate power (.714). This implies that there were significant differences in self-regulation between the intervention and control groups.
Cohen’s d effect sizes were calculated in order to evaluate the practical importance of the intervention on self-regulation. Cohen’s $d$ effect size calculations showed a large effect of the intervention from pretest to posttest (2.34), with small differences in the control group from pretest to posttest (.28). There were also large differences between the intervention and control group at posttest (1.85), suggesting that the intervention group had meaningfully higher self-regulation than the control group at posttest.

Table 4. 24 Tests of Time, Interaction, and Group Effects for Intention-to-Treat Analysis of Self-Regulation

<table>
<thead>
<tr>
<th>Tests of Within-Subjects Effects: Greenhouse-Geiser</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source</strong></td>
</tr>
<tr>
<td>Time</td>
</tr>
<tr>
<td>Time * Group</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test of Between-Subject Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group</strong></td>
</tr>
</tbody>
</table>

*Note.* Measure: Self-Regulation  a Computed using alpha = .05

Results from the 2 x 2 split plot ANOVA completer analysis are presented in Table 4.25. The main effect of time was significant, $F(1, 19) = 62.975, p < .001$ with a large effect size (partial $\eta^2 = .768$) and adequate power (1.0), indicating a significant change in perceived self-regulation over time, as both groups increased from pretest to posttest. The interaction effect was also significant, $F(1, 19) = 42.975, p < .001$, with a large effect size (partial $\eta^2 = .693$) and adequate power (1.0). This suggests that the increase self-regulation of exercise from pretest to posttest was dependent upon the intervention group, with the intervention group having higher self-regulation at posttest.
than the control group. Finally, the main effect of the intervention was also significant, $F(1, 19) = 7.557, p = .013$ with a large effect size (partial $\eta^2 = .285$) and moderate power (.741). This implies that there were significant differences in self-regulation between the intervention and control groups.

Cohen’s $d$ effect size calculations showed a large effect of the intervention from pretest to posttest (3.15), suggesting that the intervention stimulated meaningful increases in self-regulation over time. There were small differences in the control group from pretest to posttest (.28). Finally, large differences between the intervention and control group at posttest (2.43) suggest that those individuals who complete the intervention meaningfully higher self-regulation than those in the control group at posttest.

Table 4.25 Tests of Time, Interaction, and Group Effects for Completer Analysis of Self-Regulation

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>10.924</td>
<td>1</td>
<td>10.924</td>
<td>62.975</td>
<td>&lt;.001</td>
<td>0.768</td>
<td>1.0</td>
</tr>
<tr>
<td>Time * Group</td>
<td>7.455</td>
<td>1</td>
<td>7.455</td>
<td>42.975</td>
<td>&lt;.001</td>
<td>0.693</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*Test of Between-Subject Effects*

| Group         | 4.072       | 1  | 4.072       | 7.557   | 0.013 | 0.285          | 0.741             |

*Note.* Measure: Self-Regulation a Computed using alpha =.05

**Self-Monitoring**

Following an analysis of total self-regulation, the subsequent subscales of the Exercise Self-Regulation Questionnaire were analyzed, beginning with self-monitoring. Descriptive statistics for the intention-to-treat and completer analysis are presented in Table 4.26. The mean self-monitoring for the intervention group increased from pretest to
posttest, whereas the average self-monitoring in the control group increased only slightly from pretest to posttest.

Table 4.26 Descriptive Statistics for Self-Monitoring in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

<table>
<thead>
<tr>
<th>Descriptive Statistics: Self-Monitoring</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.62</td>
<td>0.606</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>1.87</td>
<td>0.75</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.74</td>
<td>0.675</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.85</td>
<td>1.06</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>1.98</td>
<td>0.654</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.96</td>
<td>1.29</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.56</td>
<td>0.609</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>1.87</td>
<td>0.75</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.72</td>
<td>0.688</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>4.24</td>
<td>0.548</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>1.98</td>
<td>0.654</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>3.06</td>
<td>1.3</td>
<td>21</td>
</tr>
</tbody>
</table>

Note. ITT = Intention-to-treat analysis, CA= Completer's analysis

Results from the 2 x 2 split plot ANOVA intention-to-treat analysis are presented in Table 4.27. The main effect of time was significant, $F(1, 21) = 29.821, p < .001$ with a large effect size (partial $\eta^2 = .587$) and adequate power (.999), indicating a significant change in self-monitoring from pretest to posttest. The interaction effect was also significant, $F(1, 21) = 25.524, p < .001$, with a large effect size (partial $\eta^2 = .539$) and adequate power (.997), suggesting the increase in self-monitoring of exercise from pretest to posttest was dependent upon the intervention group. Finally, the main effect of the intervention was also significant, $F(1, 21) = 10.319, p = .004$ with a large effect size (partial $\eta^2 = .329$) and adequate power (.865). This implies that the intervention
significantly improved self-monitoring in the intervention group beyond that of the control group.

Cohen’s $d$ effect sizes were calculate to determine the practical significance of the intervention on self-monitoring. Effect size calculations showed a large effect of the intervention on self-monitoring from pretest to posttest (2.58), with small differences in the control group from pretest to posttest (.16). This suggests that the intervention group meaningfully improved their self-monitoring over time, while the control group increase in self-monitoring was not of practical importance. There were also large differences in self-monitoring between the intervention and control group at posttest (2.12), suggesting that the intervention group had significantly higher levels of self-monitoring at posttest than the control group.

Table 4. 27 Tests of Time, Interaction, and Group Effects Intention-to-Treat Analysis of Self-Monitoring

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>$d$</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>15.745</td>
<td>1</td>
<td>15.745</td>
<td>29.821</td>
<td>&lt;.001</td>
<td>0.587</td>
<td>0.999</td>
</tr>
<tr>
<td>Time * Group</td>
<td>12.949</td>
<td>1</td>
<td>12.949</td>
<td>24.524</td>
<td>&lt;.001</td>
<td>0.539</td>
<td>0.997</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects
| Group           | 7.458       | 1   | 7.458       | 10.319| 0.004 | 0.329            | 0.865             |

Note. Measure: Self-Monitoring a Computed using alpha =.05

Results from the 2 x 2 split plot ANOVA completer analysis were similar to the intention-to-treat analysis (Table 4.28). The main effect of time was significant, $F(1, 19) = 75.864, p < .001$ with a large effect size (partial $\eta^2 = .800$) and adequate power (1.0), indicating a significant change in self-monitoring from pretest to posttest. The interaction effect was also significant, $F(1, 19) = 65.459, p < .001$, with a large effect size (partial $\eta^2$ = .800).
and adequate power (1.0), suggesting the change in exercise self-monitoring from pretest to posttest was dependent upon the intervention group. Finally, the main effect of the intervention was significant, $F(1, 19) = 17.369, p = .001$ with a large effect size (partial $\eta^2 = .478$) and adequate power (.977). This implies that there were significant differences in self-monitoring between the intervention and control groups.

Cohen’s $d$ effect size calculations showed a large effect of the intervention on self-monitoring from pretest to posttest (4.63), with small differences in the control group from pretest to posttest (.16). This suggests that the intervention group meaningfully improved their self-monitoring over time, while the control group increase in self-monitoring was not of practical importance. There were also large differences in self-monitoring between the intervention and control group at posttest (3.75), suggesting that the intervention group had significantly higher levels of self-monitoring at posttest than the control group.

**Table 4. 28 Tests of Time, Interaction, and Group Effects for Completer Analysis of Self-Monitoring**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III</th>
<th>df</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial Eta²</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>20.374</td>
<td>1</td>
<td>20.374</td>
<td>75.864</td>
<td>&lt; .001</td>
<td>0.8</td>
<td>1.00</td>
</tr>
<tr>
<td>Time * Group</td>
<td>17.311</td>
<td>1</td>
<td>17.311</td>
<td>64.459</td>
<td>&lt; .001</td>
<td>0.772</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*Test of Between-Subject Effects*

| Group           | 9.913    | 1  | 9.913       | 17.369| 0.001  | 0.478        | 0.977          |

*Note. Measure: Self-Monitoring a Computed using alpha =.05*
Goal Setting

Descriptive statistics for the intention-to-treat and completer analysis for goal setting are presented in Table 4.29. The mean goal setting for the intervention group increased from pretest to posttest, whereas the average goal setting in the control group increased only slightly from pretest to posttest.

Table 4. 29 Descriptive Statistics for Goal Setting in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.83</td>
<td>0.718</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>2.04</td>
<td>0.946</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.93</td>
<td>0.822</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.66</td>
<td>0.917</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>2.49</td>
<td>1.11</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>3.12</td>
<td>1.16</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.78</td>
<td>0.779</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>2.04</td>
<td>0.946</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.92</td>
<td>0.859</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.99</td>
<td>0.604</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>2.49</td>
<td>1.11</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>3.21</td>
<td>1.17</td>
<td>21</td>
</tr>
</tbody>
</table>

Note. ITT = Intention-to-treat analysis, CA= Completer's analysis

Results from the 2 x 2 split plot ANOVA intention-to-treat analysis are presented in Table 4.30. The main effect of time was significant, $F(1, 21) = 22.998, p < .001$ with a large effect size (partial $\eta^2 = .523$) and adequate power (.995), indicating a significant change in goal setting from pretest to posttest, and that goal setting improved in both groups over time. However, the interaction effect was also significant, $F(1, 21)= 8.44, p = .008$, with a large effect size (partial $\eta^2 = .287$) and adequate power (.791). This suggests that improvement in goal setting from pretest to posttest was dependent upon the
intervention group. The main effect of the intervention was not significant, $F(1, 21) = 2.627, p = .120$ with a small effect size (partial $\eta^2 = .111$) and inadequate power (.340). The low observed power for the main effect of the intervention indicates that we cannot draw statistically conclusions regarding the effect of the intervention on goal setting.

Cohen’s $d$ effect sizes were calculated in order to determine the practical significance of the intervention over time on goal setting. There was a large effect of the intervention on goal setting from pretest to posttest (2.22), with small differences in the control group from pretest to posttest (.44). There were also large differences in goal setting between the intervention and control group at posttest (1.15). This suggests that the mean goal setting in the intervention group was meaningfully higher than the mean goal setting in the control group at posttest.

Table 4.30 Tests of Time, Interaction, and Group Effects for Intention-to-Treat Analysis of Minutes of Goal Setting

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>15.262</td>
<td>15.262</td>
<td>22.998</td>
<td>&lt; .001</td>
<td>0.523</td>
<td>0.995</td>
</tr>
<tr>
<td>Time * Group</td>
<td>5.601</td>
<td>5.601</td>
<td>8.44</td>
<td>0.008</td>
<td>0.287</td>
<td>0.791</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects

| Group          | 2.773       | 2.773       | 2.627 | 0.12       | 0.111            | 0.34           |

Note. Measure: Goal Setting a Computed using alpha = .05

Results from the 2 x 2 split plot ANOVA completer analysis are presented in Table 4.31. The main effect of time was significant, $F(1, 19) = 36.295, p < .001$ with a large effect size (partial $\eta^2 = .656$) and adequate power (1.00), indicating a significant change in goal setting from pretest to posttest. The interaction effect was also significant,
$F(1, 19) = 15.827, p = .001$, with a large effect size (partial $\eta^2 = .454$) and adequate power (.965), suggesting the change in goal setting from pretest to posttest was dependent upon the intervention group. The main effect of the intervention was not significant, $F(1, 19) = 3.82, p = .066$ with a medium effect size (partial $\eta^2 = .167$) and inadequate power (.459). Similar to the intention-to-treat analysis, The low observed power for the main effect of the intervention indicates that we cannot draw statistically conclusions regarding the effect of the intervention on goal setting.

However, Cohen’s $d$ effect size calculations suggest a meaningful impact of the intervention on goal setting over time. There was a large effect of the intervention on goal setting from pretest to posttest (3.17), with small differences in the control group from pretest to posttest (.44). There were also large differences in goal setting between the intervention and control group at posttest (1.68). This suggests that the mean goal setting for individuals who completed the intervention meaningfully higher than the mean goal setting in the control group at posttest.

Table 4.31 Tests of Time, Interaction, and Group Effects for Completer Analysis of Goal Setting

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>18.763</td>
<td>18.763</td>
<td>36.295</td>
<td>&lt;.001</td>
<td>0.665</td>
<td>1.00</td>
</tr>
<tr>
<td>Time * Group</td>
<td>8.182</td>
<td>8.182</td>
<td>15.827</td>
<td>0.001</td>
<td>0.454</td>
<td>0.965</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects

| Group           | 4.041       | 4.041       | 3.82  | 0.066 | 0.167           | 0.459               |

Note. Measure: Goal Setting a Computed using alpha = .05
Social Support

Descriptive statistics for the intention-to-treat and completer analysis for social support are presented in Table 4.32. Upon visual inspection, social support for the intervention group increased from pretest to posttest, and the perceived social support for the control group decreased slightly from pretest to posttest.

Table 4.32 Descriptive Statistics for Social Support in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT) Intervention</td>
<td>1.48</td>
<td>0.528</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>1.48</td>
<td>0.565</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.48</td>
<td>0.533</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT) Intervention</td>
<td>2.45</td>
<td>1.11</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>1.43</td>
<td>0.426</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.97</td>
<td>0.983</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA) Intervention</td>
<td>1.42</td>
<td>0.541</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>1.48</td>
<td>0.565</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.45</td>
<td>0.541</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA) Intervention</td>
<td>2.59</td>
<td>1.16</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>1.43</td>
<td>0.426</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.98</td>
<td>1.92</td>
<td>21</td>
</tr>
</tbody>
</table>

Note. ITT = Intention-to-treat analysis, CA= Completer's analysis

Results from the 2 x 2 split plot ANOVA intention-to-treat analysis are presented in Table 4.33. The main effect of time was significant, $F(1, 21) = 5.482, p = .029$ with a large effect size (partial $\eta^2 = .207$) and moderate power (.608), indicating a significant change in social support from pretest to posttest. The interaction effect was also significant, $F(1, 21) = 6.749, p = .017$, with a large effect size (partial $\eta^2 = .243$) and moderate power (.698). This suggests that the change social support from pretest to posttest was dependent upon the intervention group. The main effect of the intervention
was also significant, $F(1, 21) = 5.087, p = .035$ with a large effect size (partial $\eta^2 = .195$) and moderate power (.576), suggesting that social support in the intervention group was significantly higher than social support in the control group.

Cohen’s $d$ effect sizes were calculated in order to determine the practical significance of the intervention on social support over time. There was a large effect of the intervention on social support from pretest to posttest (1.12). This suggests that the intervention made a meaningful impact on social support over time. There was also a small decrease in social support in the control group from pretest to posttest (.10). There were also large differences in social support between the intervention and control group at posttest (1.21). This implies that the intervention group had meaningfully higher levels of social support than the control group at posttest.

**Table 4.33 Tests, Interaction, and Group Effects for Intention-to-Treat Analysis of Social Support**

*Tests of Within-Subjects Effects: Greenhouse-Geiser*

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>2.438</td>
<td>1</td>
<td>2.438</td>
<td>5.482</td>
<td>0.029</td>
<td>0.207</td>
<td>0.608</td>
</tr>
<tr>
<td>Time *</td>
<td>3.001</td>
<td>1</td>
<td>3.001</td>
<td>6.749</td>
<td>0.017</td>
<td>0.243</td>
<td>0.698</td>
</tr>
<tr>
<td>Group</td>
<td>2.962</td>
<td>1</td>
<td>2.962</td>
<td>5.087</td>
<td>0.035</td>
<td>0.195</td>
<td>0.576</td>
</tr>
</tbody>
</table>

*Test of Between-Subject Effects*

| Group      | 2.962       | 1  | 2.962       | 5.087 | 0.035| 0.195          | 0.576             |

*Note. Measure: Social Support a Computed using alpha = .05*

Results from the 2 x 2 split plot ANOVA completer analysis are presented in Table 4.34. The main effect of time was significant, $F(1, 19) = 7.556, p = .013$ with a large effect size (partial $\eta^2 = .285$) and moderate power (.741), indicating a significant change in social support from pretest to posttest. The interaction effect was also...
significant, \( F(1, 19) = 8.985, p = .007 \), with a large effect size (partial \( \eta^2 = .321 \)) and moderate power (.811), suggesting change in social support from pretest to posttest was dependent upon the intervention group. Lastly, the main effect of the intervention was significant, \( F(1, 19) = 5.110, p = .036 \) with a large effect size (partial \( \eta^2 = .212 \)) and moderate power (.574), suggesting that social support in the intervention group was significantly higher than social support in the control group.

Cohen’s \( d \) effect size calculations for the completer analysis were similar to the intention-to-treat analysis. There was large effect of the intervention on social support from pretest to posttest (1.29). There were also small differences in the control group from pretest to posttest (.10), suggesting that the slight decrease in social support over time was not practically important. There were also large differences in social support between the intervention and control group at posttest (1.33). This suggests that individuals who complete the intervention had meaningfully higher social support at posttest than individuals in the control group.

| Table 4. 34 Tests of Time, Interaction, and Group Effects for Completer Analysis of Social Support |

<p>| Tests of Within-Subjects Effects: Greenhouse-Geiser |</p>
<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>( F )</th>
<th>Sig.</th>
<th>Partial Eta(^2)</th>
<th>Observed Power(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>3.263</td>
<td>1</td>
<td>3.263</td>
<td>7.556</td>
<td>0.013</td>
<td>0.285</td>
<td>0.741</td>
</tr>
<tr>
<td>Time * Group</td>
<td>3.88</td>
<td>1</td>
<td>3.88</td>
<td>8.985</td>
<td>0.007</td>
<td>0.321</td>
<td>0.811</td>
</tr>
</tbody>
</table>

<p>| Test of Between-Subject Effects |</p>
<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>( F )</th>
<th>Sig.</th>
<th>Partial Eta(^2)</th>
<th>Observed Power(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>3.123</td>
<td>1</td>
<td>3.123</td>
<td>5.11</td>
<td>0.036</td>
<td>0.212</td>
<td>0.574</td>
</tr>
</tbody>
</table>

\( Note. \) Measure: Social Support a Computed using alpha = .05
Self-Reward

Descriptive statistics for the intention-to-treat analysis and completer analysis of self-reward are presented in Table 4.35. Upon observation of means, perceived self-reward increased in the intervention group from pretest to posttest. The control group also had an increase in self-reward, but only slightly.

Table 4.35 Descriptive Statistics for Self-Reward in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.97</td>
<td>0.748</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>2.10</td>
<td>0.881</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.03</td>
<td>0.798</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.28</td>
<td>0.872</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>2.35</td>
<td>0.697</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.84</td>
<td>0.907</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.89</td>
<td>0.762</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>2.10</td>
<td>0.881</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.00</td>
<td>0.813</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.45</td>
<td>0.814</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>2.35</td>
<td>0.697</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.88</td>
<td>0.927</td>
<td>21</td>
</tr>
</tbody>
</table>

Note. ITT = Intention-to-treat analysis, CA = Completer’s analysis

Results from the 2 x 2 split plot ANOVA intention-to-treat analysis are presented in Table 4.36. The main effect of time was significant, $F(1, 21) = 23.134, p < .001$ with a moderate large size (partial $\eta^2 = .524$) and adequate power (.996), indicating a significant change in self-reward from pretest to posttest. The interaction effect was also significant, $F(1, 21) = 10.567, p = .004$, with a large effect size (partial $\eta^2 = .335$) and adequate power (.873). This suggests that the change in self-reward from pretest to posttest was dependent upon the intervention group. Lastly, the main effect of the intervention was not
significant, $F(1, 21) = 1.832, p = .190$ with a medium effect size (partial $\eta^2 = .080$) and low power (.253). With inadequate power, we cannot draw statistical conclusions regarding the main effect of the intervention of self-reward.

Therefore, Cohen’s $d$ effect sizes were calculated in order to determine the practical importance of the intervention on self-reward over time. There was a large effect of the intervention on self-reward from pretest to posttest (1.61), with small differences in the control group from pretest to posttest (.31). There were also large differences in self-reward between the intervention and control group at posttest (1.18). This implies that at posttest, the intervention group had meaningfully higher levels of self-reward than the control group.

Table 4.36 Tests of Time, Interaction, and Group Effects for Intention-to-Treat Analysis of Self-Reward

<table>
<thead>
<tr>
<th>Tests of Within-Subjects Effects: Greenhouse-Geiser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
</tr>
<tr>
<td>Time</td>
</tr>
<tr>
<td>Time * Group</td>
</tr>
<tr>
<td>Test of Between-Subject Effects</td>
</tr>
<tr>
<td>Group</td>
</tr>
</tbody>
</table>

*Note. Measure: Self-Reward a Computed using alpha = .05

Results from the 2 x 2 split plot ANOVA completer analysis are presented in Table 4.37. The main effect of time was significant, $F(1, 19) = 38.493, p < .001$ with a large effect size (partial $\eta^2 = .670$) and adequate power (1.0), indicating a significant change in self-reward from pretest to posttest. The interaction effect was also significant, $F(1, 19) = 20.087, p < .001$, with a large effect size (partial $\eta^2 = .514$) and adequate power (.989). This suggests that the change in self-reward from pretest to posttest was
dependent upon the intervention group. Lastly, the main effect of the intervention was not significant, $F(1, 19) = 2.017, p = .172$ with a medium effect size (partial $\eta^2 = .096$) and low power (.271). Similar to the intention-to-treat analysis, we cannot draw statistical conclusions regarding the main effect of the intervention of self-reward due to inadequate power.

Cohen’s $d$ effect size calculations for the completer analysis showed a large effect of the intervention on self-reward from pretest to posttest (1.98), with small differences in the control group from pretest to posttest (.31). There were also large differences in self-reward between the intervention and control group at posttest (1.45). This suggests that at posttest, the individuals who completed the intervention had meaningfully higher levels of self-reward than individuals in the control group.

Table 4.37 Tests of Time, Interaction, and Group Effects for Completer Analysis of Self-Reward

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df  Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>8.668</td>
<td>1</td>
<td>8.668</td>
<td>38.493</td>
<td>&lt; .001</td>
<td>0.67</td>
</tr>
<tr>
<td>Time * Group</td>
<td>4.523</td>
<td>1</td>
<td>4.523</td>
<td>20.087</td>
<td>&lt; .001</td>
<td>0.514</td>
</tr>
</tbody>
</table>

*Note. Measure: Self-Reward $^a$ Computed using alpha = .05

**Time Management**

Table 4.38 presents descriptive statistics for time management for the intervention and control groups at pretest and posttest. For the intervention group, the mean time management increased from pretest to posttest. The values for time management also
increased in the control group from pretest to posttest, but not to the same degree at the intervention group.

Table 4. 38 Descriptive Statistics for Time Management in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.67</td>
<td>0.835</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>1.7</td>
<td>0.669</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.68</td>
<td>0.743</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.6</td>
<td>0.777</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>2.02</td>
<td>0.728</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.85</td>
<td>1.09</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.42</td>
<td>0.657</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>1.7</td>
<td>0.669</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.57</td>
<td>0.662</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.75</td>
<td>0.745</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>2.02</td>
<td>0.728</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.84</td>
<td>1.14</td>
<td>21</td>
</tr>
</tbody>
</table>

Note. ITT = Intention-to-treat analysis, CA= Completer's analysis

Results from the 2 x 2 split plot ANOVA intention-to-treat analysis are presented in Table 4.39. The main effect of time was significant, $F(1, 21) = 32.229, p < .001$ with a large effect size (partial $\eta^2 = .605$) and adequate power (1.00), indicating a significant change in time management from pretest to posttest. Over time, both groups increased their mean time management. However, the interaction effect was also significant, $F(1, 21) = 16.610, p = .001$, with a large effect size (partial $\eta^2 = .442$) and adequate power (.973). This suggests that the increase in time management from pretest to posttest was dependent upon the intervention group. Lastly, the main effect of the intervention significant, $F(1, 21) = 9.906, p = .005$ with a large effect size (partial $\eta^2 = .321$) and
sufficient power (.851), suggesting that the intervention group had higher levels of time management than the control group.

Cohen’s *d* effect size calculations showed a large effect of the intervention on time management from pretest to posttest (2.39). There were moderate differences in the control group from pretest to posttest (.46), suggesting that the slight increase in time management over time was not practically important. Finally, there was also a large difference in time management between the intervention and control group at posttest (2.10). This implies that the intervention group had meaningfully higher levels of time management overtime when compared to the control group.

**Table 4.39 Tests of Time, Interaction, and Group Effects for Intention-to-Treat Analysis of Time Management**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial η²</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>14.601</td>
<td>1</td>
<td>14.601</td>
<td>32.229</td>
<td>&lt; .001</td>
<td>0.605</td>
<td>1.00</td>
</tr>
<tr>
<td>Time * Group</td>
<td>7.525</td>
<td>1</td>
<td>7.525</td>
<td>16.61</td>
<td>0.001</td>
<td>0.442</td>
<td>0.973</td>
</tr>
</tbody>
</table>

**Test of Between-Subject Effects**

| Group         | 6.837       | 1   | 6.837       | 9.906 | 0.005 | 0.321      | 0.851          |

*Note.* Measure: Time Management a Computed using alpha = .05

Results from the 2 x 2 split plot ANOVA completer analysis are presented in Table 4.40. The main effect of time was significant, *F*(1, 19) = 69.409, *p* < .001 with a large effect size (partial η² = .785) and adequate power (1.00), indicating a significant change in time management from pretest to posttest. The interaction effect was also significant, *F*(1, 19) = 40.011, *p* < .001, with a large effect size (partial η² = .678) and adequate power (1.00). This suggests that the improvement in time management from pretest to posttest was dependent upon the intervention group. Lastly, the main effect of
the intervention was significant, $F(1, 19) = 7.637, p = .012$ with a large effect size ($\eta^2 = .287$) and moderate power (.746), suggesting that the intervention group had higher levels of time management than the control group.

Cohen’s $d$ effect size calculations showed a large effect of the intervention on time management from pretest to posttest (4.41), with small differences in the control group from pretest to posttest (.46). There were also large differences in time management between the intervention and control group at posttest (2.35). This implies that the intervention group had meaningfully higher levels of time management from pretest to posttest when compared to the control group.

Table 4.40 Tests of Time, Interaction, and Group Effects for Completer Analysis of Time Management

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>$df$</th>
<th>Mean Square</th>
<th>$F$</th>
<th>Sig.</th>
<th>Partial $\eta^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>18.298</td>
<td>1</td>
<td>18.298</td>
<td>69.409</td>
<td>&lt; .001</td>
<td>0.785</td>
<td>1.00</td>
</tr>
<tr>
<td>Time * Group</td>
<td>10.548</td>
<td>1</td>
<td>10.548</td>
<td>40.011</td>
<td>&lt; .001</td>
<td>0.678</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects

| Group   | 5.489       | 1    | 5.489       | 7.637 | 0.012 | 0.287            | 0.746             |

Note. Measure: Time Management a Computed using alpha =.05

**Overcoming Barriers**

Overcoming barriers was the final variable analyzed in the Self-Regulation of Exercise Questionnaire. Descriptive statistics are presented in Table 4.41. Upon visual inspection of the means, the perception to overcome barriers to exercise increased in the intervention group, and saw no change in the control group, from pretest to posttest.
Table 4.41 Descriptive Statistics for Overcoming Barriers in the Intervention and Control Groups for Intention-to-Treat and Completer Analyses

<table>
<thead>
<tr>
<th>Descriptive Statistics: Overcoming Barriers</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.65</td>
<td>0.595</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>1.79</td>
<td>0.558</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.72</td>
<td>0.57</td>
<td>23</td>
</tr>
<tr>
<td>Posttest (ITT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.19</td>
<td>1.03</td>
<td>12</td>
</tr>
<tr>
<td>Control</td>
<td>1.78</td>
<td>0.617</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.52</td>
<td>1.11</td>
<td>23</td>
</tr>
<tr>
<td>Pretest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>1.51</td>
<td>0.523</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>1.79</td>
<td>0.558</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1.66</td>
<td>0.547</td>
<td>21</td>
</tr>
<tr>
<td>Posttest (CA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>3.36</td>
<td>1.04</td>
<td>10</td>
</tr>
<tr>
<td>Control</td>
<td>1.78</td>
<td>0.617</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>2.53</td>
<td>1.15</td>
<td>21</td>
</tr>
</tbody>
</table>

*Note. ITT = Intention-to-treat analysis, CA= Completer's analysis*

Results from the 2 x 2 split plot ANOVA intention-to-treat analysis are presented in Table 4.42. The main effect of time was significant, $F(1, 21) = 14.013, p = .001$ with a large effect size (partial $\eta^2 = .400$) and adequate power (.946), indicating a significant change in overcoming barriers from pretest to posttest. The interaction effect was also significant, $F(1, 21)= 14.495, p = .001$, with a large effect size (partial $\eta^2 = .408$) and adequate power (.952). This suggests that the change in overcoming barriers from pretest to posttest was dependent upon the intervention group. Lastly, the main effect of the intervention was also significant, $F(1, 21) = 7.823, p = .011$ with a large effect size (partial $\eta^2 = .271$) and moderate power (.760), suggesting there were significant differences in overcoming barriers between the intervention and control groups.

Cohen’s $d$ effect size calculations for showed a large effect of the intervention on overcoming barriers from pretest to posttest (1.83). There were also small differences in
the control group from pretest to posttest (.02), suggesting that the slight decrease in
overcoming barriers over time was not practically important. Finally, there was a large
difference in overcoming barriers between the intervention and control group at posttest
(1.66). This implies that the intervention group had meaningfully higher levels of
overcoming barriers over time when compared to the control group.

Table 4.42 Tests of Time, Interaction, and Group Effects for Intention-to-Treat
Analysis of Overcoming Barriers

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial η²</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>6.654</td>
<td>1</td>
<td>6.654</td>
<td>14.013</td>
<td>0.001</td>
<td>0.4</td>
<td>0.946</td>
</tr>
<tr>
<td>Time * Group</td>
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<td>1</td>
<td>6.883</td>
<td>14.495</td>
<td>0.001</td>
<td>0.408</td>
<td>0.952</td>
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</table>

Test of Between-Subject Effects

<table>
<thead>
<tr>
<th>Group</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial η²</th>
<th>Observed Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.656</td>
<td>1</td>
<td>4.656</td>
<td>7.823</td>
<td>0.011</td>
<td>0.271</td>
<td>0.76</td>
</tr>
</tbody>
</table>

*Note. Measure: Overcoming Barriers a Computed using alpha =.05

Results from the 2 x 2 split plot ANOVA completer analysis are presented in
Table 4.43. The main effect of time was significant, $F(1, 19) = 23.334, p < .001$ with a
large effect size (partial $\eta^2 = .551$) and adequate power (.996), indicating a significant
change in overcoming barriers from pretest to posttest. The interaction effect was also
significant, $F(1, 19) = 24.001, p < .001$, with a large effect size (partial $\eta^2 = .558$) and
adequate power (.996), suggesting that the change in overcoming barriers from pretest to
posttest was dependent upon the intervention group. Lastly, the main effect of the
intervention was also significant, $F(1, 19) = 7.027, p = .016$ with a large effect size
(partial $\eta^2 = .270$) and moderate power (.711), suggesting significant differences in
overcoming barriers between the intervention and control groups.
Cohen’s $d$ effect size calculations for overcoming barriers showed similar results for the completer analysis. There was a large effect of the intervention on overcoming barriers from pretest to posttest (2.25). There were also small differences in the control group from pretest to posttest (.02). Finally, there was a large difference in overcoming barriers between the intervention and control group at posttest (1.85). This implies that the intervention group had meaningfully higher levels of overcoming barriers from pretest to posttest when compared to the control group.

Table 4. 43 Tests of Time, Interaction, and Group Effects for Completer Analysis of Overcoming Barriers

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III SS</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta$^2$</th>
<th>Observed Power$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>8.77</td>
<td>1</td>
<td>8.77</td>
<td>23.334</td>
<td>&lt; .001</td>
<td>0.551</td>
<td>0.996</td>
</tr>
<tr>
<td>Time * Group</td>
<td>9.02</td>
<td>1</td>
<td>9.02</td>
<td>24.001</td>
<td>&lt; .001</td>
<td>0.558</td>
<td>0.996</td>
</tr>
</tbody>
</table>

Test of Between-Subject Effects

| Group            | 4.426       | 1  | 4.426       | 7.027 | 0.016 | 0.27            | 0.711              |

*Note. Measure: Overcoming Barriers a Computed using alpha =.05

Additional Analysis: Regression

Due to the significant impact of the intervention on number of steps per day, an additional regression analysis was conducted in order to evaluate the extent to which the dimensions of self-regulation predicted posttest number of steps in the intervention group. First, there was a significant correlation between self-monitoring and posttest number of steps per day ($r = .747, p = .007$). There were no other statistically significant correlations between dimensions of self-monitoring and number of steps per day. The linear combination of self-regulation, self-monitoring, goal setting, time management, overcoming barriers, self-reward, and social support explained 32% and 39% of the...
variance in number of steps per day for the completer and intention-to-treat analyses, respectively. However, the regression models were not statistically significant for either the completer (F= 1.706, p = .354) nor intention-to-treat analysis (F = 2.174, p = .206). Therefore, we cannot conclude that the $R^2$ value was significantly different from 0, or that dimensions of self-regulation significantly explained posttest number of steps per day. When examining the regression coefficients, none of the dimensions of self-regulation contributed to the model for the completer analysis, and only self-monitoring contributed to the model for the intention-to-treat analysis (t = 2.577, p = .05). Therefore, we can conclude that although the number of steps in the intervention group did improve from pretest to posttest, self-monitoring was the only self-regulation dimension that contributed to the posttest number of steps.
Chapter 5

Discussion

The primary purpose of this study was to evaluate the effect of a brief, 4-week behavioral intervention on MVPA among 23 overweight and obese adults with type 2 diabetes. A secondary purpose was to evaluate the effect of a behavioral intervention on dimensions of self-regulation.

Regular physical activity is at the forefront of type 2 diabetes management, as sufficient levels of physical activity alone can significantly improve glycemic control and insulin resistance (Colberg et al, 2010). Unfortunately, a majority of adults with type 2 diabetes do not engage in regular physical activity (Nelson, Rieber, & Boyko, 2002). Previous physical activity interventions have demonstrated the need for future interventions focused on objective physical activity measurement as well as documented change in theoretical variables. Targeting theoretical constructs from Social Cognitive Theory may play an important role in stimulating a positive and lasting behavior change. Therefore, the current intervention sought to build upon previous research by gathering data to determine the effect of an SCT-based behavioral intervention to improve upon MVPA and the rate of use of self-regulatory strategies among a sample of overweight and obese adults with type 2 diabetes.
Conclusions

Effect of Intervention on Self-Regulation

This study hypothesized that the 4-week behavioral intervention would stimulate increases in self-regulation, self-monitoring, goal setting, time management, overcoming barriers, self-reward, and social support in the intervention group beyond those in the control group.

First, the results supported the hypothesis that the intervention would stimulate positive changes in self-regulation. Specifically, the behavioral intervention used exercise plans and exercise logs (Appendix D) in order to help the intervention group better regulate their physical activity. At baseline, levels of self-regulation were not significantly different in the intervention and control groups. The main effects of group, time and interaction were all significant. In other words, from pretest to posttest, the intervention group significantly improved their levels of perceived self-regulation. Additionally, the significant group by time interaction suggests the change in self-regulation in the intervention group over time was dependent upon the intervention itself. Inspection of effect sizes demonstrated a large change in self-regulation in the intervention group over time (3.15), suggesting that the behavioral intervention had a meaningful impact on self-regulation. Also, while the control group did improve their levels of self-regulation, the change was not significant, and the effect size was low (.28). Finally, the large difference in self-regulation between the intervention and control groups at posttest (2.43), suggest that the intervention was successful in improving upon the use of self-regulatory strategies among individuals in the intervention group, but not in the control group.
The results also supported the hypothesis that the intervention would produce positive changes in self-monitoring. At baseline, levels of self-monitoring were not significantly different in the intervention and control groups. Similar to self-regulation, individuals in the intervention group were asked to write down their daily activity over the course of three weeks. Consequently, by keeping track of their daily activity, the intervention group increased their levels of self-monitoring from baseline to 4-week posttest. The main effects of group, time and interaction were all significant. In other words, from pretest to posttest, the intervention group significantly improved their levels of exercise self-monitoring. Additionally, the significant group by time interaction suggests the change in self-monitoring in the intervention group over time was dependent upon the intervention itself. Inspection of effect sizes revealed that large improvements in self-monitoring over time in the intervention group (4.63) were superior to changes in the control group following the behavioral intervention (.16). Furthermore, the large effect size for the difference in self-monitoring between the intervention and control group at posttest (3.75) suggests that the use of activity logs enabled the intervention group to better monitor their activity and therefore improve their levels of self-monitoring beyond that of the control group.

The data supported the hypothesis that the behavioral intervention would have a positive impact on goal setting. At baseline, there were no significant differences in goal setting between the intervention and control group. At posttest, the main effect of time and interaction were significant, suggesting that increases in goal setting from pretest to posttest were only in intervention group. The main effect of the intervention was statistically inclusive as a result of low power. Low power suggests that the study may
have been too small to detect any differences that may have occurred between the intervention and control groups. However, there was a large effect size for the change in goal setting overtime in the intervention group (3.17), suggesting that the behavioral intervention had a stimulated a meaningful improvement in goal setting. Additionally, the difference in goal setting between the two groups at posttest, were large (1.68), suggesting that the improvement in goal setting across time in the intervention group was superior to changes in the control group. This was support by the small effect size for changes in the control group over time (.44). As a result, the results from this study suggest that the behavioral intervention had a meaningful and positive impact on goal setting.

The data supported the hypothesis that the behavioral intervention would have a positive impact on social support. At baseline, there were no differences in perceived social support between the intervention and control groups. The main effects on group, time and interaction were all significant. This suggests that, from pretest to posttest, the intervention group significantly improved their levels of social support beyond that of the control group. Inspection of effect sizes revealed a large change in social support in the intervention group over time (1.29). This suggests that the intervention promoted social support for exercise among individuals in the intervention group. The large differences between the intervention and control group at posttest (1.33) suggest that the intervention group had higher levels of social support for exercise following the intervention than the control group. Additionally, the change in social support for the control group was not practically significant (.10). This suggests that the intervention had a meaningful impact on improving social support over time in the intervention group, but not the control
group, and we can conclude that the behavioral intervention had a meaningful and positive impact on social support for physical activity.

The results also supported the hypothesis that the intervention would positively impact self-reward. At baseline, there were no differences in self-reward between the intervention and control groups. The main effect of time, the main effect of the intervention, and the interaction were significant. This suggests that there was a positive change in self-reward from pretest to posttest, and this change was dependent upon the intervention group. In other words, the positive changes in self-reward from pretest to posttest occurred in the intervention group, but not the control group. Further inspection of Cohen’s $d$ effect sizes support large changes in self-reward from pretest to posttest in the intervention group (1.98), suggesting that the behavioral intervention meaningfully stimulated positive changes in self-reward. Small changes in the control group over time (.31) suggest that while the control group did increase their levels of self-reward, this improvement was not of practical importance. Additionally, there was a large effect size for the difference in self-reward between the intervention and control groups at posttest (1.45), suggesting that the improvement in self-reward as a result of the intervention was greater in the intervention group than the control group. Therefore, the behavioral intervention successfully improved levels of self-reward for physical activity in this sample.

The data also supported the hypothesis that the intervention would positively impact time management. There were no observed differences in time management between the intervention and control groups at baseline. The main effect of time, the main effect of the intervention, and the interaction were significant. The main effect of
time suggests improvements in time management in both groups. However, the interaction effect suggests that this change was dependent upon the intervention group, as positive changes in time management from pretest to posttest occurred in the intervention group, but not the control group. Inspection of Cohen’s $d$ effect sizes reveal large changes in time management from pretest to posttest in the intervention group (4.41), suggesting that the behavioral intervention meaningfully stimulated positive changes in time management. Small changes in the control group over time (.46) suggest that while the control group did increase their levels of time management, this improvement was not of practical importance. Additionally, there was a large effect size for the difference in time management between the intervention and control groups at posttest (2.35), suggesting that the improvement in time management as a result of the intervention was greater in the intervention group than the control group. Therefore, the behavioral intervention successfully improved levels of time management for physical activity.

The final dimension of self-regulation analyzed in this study was overcoming barriers. The results of this study supported the hypothesis that the behavioral intervention would positively impact overcoming barriers. There were no significant differences in overcoming barriers between the intervention and control groups at baseline. Results demonstrated significant main effects of time, intervention, and interaction. The main effect of time suggests that the intervention had a significant impact on overcoming barriers from pretest to posttest. The interaction effect suggests that the improvements in overcoming barriers were dependent upon the intervention group, and that the intervention stimulated positive changes in overcoming barriers. Similarly, large effect sizes suggested a meaningful change in time management in the intervention group
over time (2.25), suggesting that the intervention positively stimulated changes in overcoming barriers. Higher levels of overcoming barriers in the intervention versus control group following the intervention (1.85) allow us to conclude that the behavioral intervention had a meaningful and positive impact on overcoming barriers to physical activity.

Overall, the results of this study supported the hypothesis that the behavioral intervention would positively impact dimensions of self-regulation. The behavioral intervention used exercise plans and exercise logs to promote the use of self-regulation for physical activity among individuals in the intervention group. Specifically, the exercise plans had individuals setting weekly goals for their physical activity by systematically planning dimensions of their daily activity, including the time of day, type of activity, location of activity, duration of activity, number of steps, and with whom they would exercise with. Subsequently, participants then logged their actual weekly physical activity behavior, including day of activity, type of activity, location of activity, time of day, duration of activity, intensity, number of steps, with whom they exercise, and level of enjoyment. These procedures were heavily focused on self-regulation, self-monitoring, goal setting, time management, and overcoming barriers. However, there was also an increase in social support, self-reward. Participants met one-on-on with researchers in order to fill in and review completed exercise plans and logs. This allowed for in depth discussions about successful or unsuccessful strategies that worked for each participant. For example, anecdotal evidence demonstrated that some participants were more likely to engage in activity when they were using their pedometers to track their steps, whereas other individuals relied on being active with members of their family, friends, or pets.
These discussions may have stimulated increases in other dimensions of self-regulation beyond those laid out by the exercise plans and logs. As a result of all of these behavioral intervention components, levels of self-regulation, self-monitoring, goal setting, time management, overcoming barriers, self-reward, and social support all increased in the intervention group from pretest to posttest. Therefore, we can conclude that the behavioral intervention enhanced participants’ frequency of using self-regulation strategies for physical activity participation.

**Effect of Intervention on Physical Activity**

This study hypothesized that the 4-week behavioral intervention would stimulate increases in dimensions of MVPA, including minutes of MVPA per week, minutes of MVPA per day, caloric expenditure per day, sedentary time per day, and steps per day, over time in the intervention group but not the control group.

The hypothesis that the total minutes of MVPA per week would improve in the intervention group was not supported by the results of this study. At baseline, there were no differences in minutes of MVPA per week between the intervention and control groups. There was a main effect of time, with both the intervention and control groups decreasing their minutes of MVPA per week from pretest to posttest. While the main effect of the intervention and interaction effect were not significant, low power suggests the sample size was too small to detect true differences in minutes of MVPA per week between the groups over time. However, the effect sizes for changes in the intervention (.22) and control (.39) groups over time suggest that the decrease in minutes of MVPA per week in both groups was not practically important. Therefore, although both groups
decreased their minutes of MVPA per week, this decrease was very small. Additionally, baseline values for both groups suggest that the individuals were meeting physical activity guidelines prior to the start of the intervention. As a result, a ceiling effect may have resulted in the inability of MVPA minutes per week to increase beyond baseline. Finally, there were moderate differences in total minutes of MVPA at posttest between the intervention and control group at posttest (d = .64). This suggests that individuals who did complete the behavioral intervention were participating in higher levels of MVPA per week at posttest than members of the control group. However, the small effect sizes from pretest to posttest suggest that the intervention overall failed to impact minutes of MVPA per week.

The data also failed to support the hypothesis that minutes of MVPA per day would improve over time as a result of the behavioral intervention. There were no differences in minutes of MVPA per day between groups at baseline. There was a main effect of time, with both the intervention and control groups decreasing their minutes of MVPA per day from pretest to posttest. While the main effect of the intervention and interaction effect were not significant, low power suggests the sample size was too small to detect true differences in minutes of MVPA per day between the groups over time. Inspection of effect sizes demonstrates small decreases in minutes of MVPA per day from pretest to posttest in both the intervention (.23) and control (.41) groups. This suggests that although both groups decreased the minutes of MVPA per day, this change was not of practical importance. Similar to MVPA per week, as both groups were meeting physical activity recommendations at baseline, the effect of the ceiling may have result in the little change in MVPA per day over time. There was also a medium effect size between the
intervention and control groups at posttest (.64), suggesting that intervention group was engaging in more minutes of MVPA per day at posttest compared to the control group. However, we cannot support this research hypothesis, as the intervention did not appear to have a meaningful impact on improving minutes of MVPA per day.

The data supported the hypothesis that the intervention would have a positive impact on number of steps per day over time. There were no differences in number of steps per day between the two groups at baseline. The main effect of time and the interaction effect were significant. The main intervention effect was statistically inconclusive, as low observed power increases the likelihood that a true difference was no detected. Upon inspection of Cohen’s $d$ effect sizes, the intervention had a moderate impact on increasing the number of steps in the intervention group over time (.57), suggesting a meaningful improvement in number of steps per day from pretest to posttest. Additionally, the control group did not demonstrated meaningful improvements in number of steps per day over time (.08). There was also a large difference in number of steps between the intervention and control group at posttest (.77), suggesting that the intervention group was taking a greater amount steps when compared to the control group at posttest. Therefore, we can conclude that the behavioral intervention had a positive impact on the number of steps per day. Additionally, results from a secondary regression analysis suggested the improvements in number of steps per day in the intervention group could be partially explained by increases in self-monitoring. However, no other dimensions of self-regulation were related to posttest number of steps per day. This suggests that changes in the remaining dimensions of self-regulation may not have contributed to a change in number of steps per day.
The data also failed to support the hypothesis that caloric expenditure would improve over time as a result of the behavioral intervention. There were no differences in daily caloric expenditure between groups at baseline. There was a main effect of time, with both the intervention and control groups decreasing their daily caloric expenditure from pretest to posttest. While the main effect of the intervention and interaction effect were not significant, low power suggests the sample size was too small to detect true differences in daily caloric expenditure between the groups over time. However, inspection of effect sizes demonstrates small decreases in caloric expenditure per day from pretest to posttest in both the intervention (.30) and control (.52) groups. This suggests that the small decrease in daily caloric expenditure over time was not practically important in either group. Additionally, there was little difference in caloric expenditure between the intervention and control groups following the intervention (.26). This suggests that the intervention group did not expend more calories per day than the control group following the intervention. Therefore, we can conclude that the intervention did not appear to have a meaningful impact on improving caloric expenditure per day.

Finally, the data did not support the hypothesis that the intervention would improve sedentary time per day. There were no differences in sedentary time per day between groups at baseline. The main effect of time, main effect of the intervention, and the interaction effect were not significant. However, low power suggests the sample size was too small to detect true differences in sedentary time per day between the groups over time. Further inspection of effect sizes demonstrates small increases in sedentary time per day from pretest to posttest in both the intervention (.39) and control (.47) groups. This suggests that the small increase in sedentary time per day in both groups was no
practically important. Additionally, there was little difference in sedentary time per day between the intervention and control groups following the intervention (.35). This suggests that the intervention group did participate in less sedentary time per day than the control group following the intervention. Therefore, we can conclude that the intervention did not appear to have a meaningful impact on reducing sedentary time per day.

We hypothesized that the 4-week behavioral intervention would increase MVPA, in minutes of MVPA per week, minutes of MVPA per day, number of steps per day, caloric expenditure per day, and sedentary time per day, over time in the intervention group but not the control group. The results failed to support the hypotheses for all dimensions of physical activity except for number of steps per day. Total minutes of MVPA per week, minutes of MVPA per day, and caloric expenditure decreased in both the intervention and control groups over time. Individuals in both groups also increased their time spent being sedentary per day. The individuals in the intervention group increased their daily number of steps over time whereas the control group did not improve their number of steps. The behavioral intervention promoted all types of physical activity. That is, individuals were able to select the mode of activity they most preferred. However, individuals were given a pedometer to track their number of steps. Additionally, anecdotal evidence supports that most individuals were incorporating walking as their primary form of physical activity. As a result, the findings of this study suggest that intervention served to enhance walking behavior through number of steps per day, but did little to improve other dimensions of physical activity.
Discussion

Results from this study suggest that the 4-week behavioral intervention had little impact on physical activity behavior, but succeeded in positively impacting dimensions of self-regulation.

Self-Regulation

The positive impact on self-regulation has important implications for type 2 diabetes research. First, previous research in type 2 diabetes management has emphasized the importance of self-regulation. However, diet and glucose are often the focus of self-management training. This study supported the notion that we can improve the use of self-regulatory behavioral strategies specifically for physical activity in a sample of adults with type 2 diabetes. Additionally, the use of exercise plans and logs in this study primarily focused on self-monitoring, goal setting, and time management. However, all dimensions of self-regulation improved. This suggests that targeting different dimensions of self-regulation may contribute to the auxiliary development of other dimensions (i.e. self-reward, social support). As physical activity plays such an important role in disease management, and self-regulation has proven to be an important technique in this population, evidence that a brief behavioral intervention can stimulate positive changes in self-regulation for physical activity has important implications for health promotion programs. For, researchers can use this information in order to develop interventions that target a positive change in self-regulation in order to ideally stimulate a positive change in behavior.
Physical Activity

The insignificant results of the intervention on dimensions of MVPA were unexpected. First, pretest MVPA values for both groups suggested they were meeting the guidelines for physical activity prior to the intervention (Colberg et al, 2010). Two possible explanations could lie in the selection and reactivity of the participants. We recruited volunteers, who were feeling highly motivated to adopt physical activity into their lifestyles. Additionally, a majority of the participants were recruited from ResearchMatch.org. This website is home to research volunteers whom (1) are more likely to participate in research studies and (2) may have already been active prior to the study. However, the recruitment materials were tailored toward inactive individuals, and we asked participants about their current behavior prior to the intervention. When asked how many days per week they typically exercise, 12 of the 23 of the participants said “0”, and the remaining 11 reported exercising 3 days per week or less, for 20 to 40 minutes. When asked how many days they exercised during the previous week, 15 of the 23 participants said “0”, one participants said “3”, and the remaining seven reported 1 or 2 days. Finally, 21 of the 23 participants reported being in the preparation or contemplation stage of the Transtheoretical Model, which are defined as either not currently exercising, but thinking about exercising in the next 6 months, or exercising some, but not meeting the guidelines for physical activity. Therefore, according to these self-reported activity levels, individuals in this study were generally not regularly active prior to the intervention. As a result, reactivity appears to be a more likely explanation for the high baseline MVPA levels. As stated above, individuals in this study were motivated to exercise and change their behavior. Also, during their first session, participants were
informed that the BodyMedia would be monitoring dimensions of their physical activity for the subsequent week. As a result, participants may have reacted to the novelty of wearing the BodyMedia Armband, and made more of an effort to engage in activity, beyond that of their reported “typical” week. Consequently, the high levels of reactivity among participants resulted in inflated baseline values for MVPA that reached the threshold for meeting physical activity guidelines.

As a result of this reactivity, a ceiling effect may further explain the low impact of the intervention on behavior. Individuals in the intervention group who adhered to the study procedures decreased their minutes of MVPA per day from 52.45 minutes to 50.44 minutes; a practically insignificant decrease according to Cohen’s $d$ effect size calculations. These values suggest that this group was meeting MVPA guidelines both before and after the intervention, and that the pretest reactivity was potentially sufficient to get individuals to reach the ceiling in terms of minutes of MVPA. However, the control group’s minutes of MVPA per day decreased from 44.09 minutes to 26.64 minutes, suggesting that at the end of study, these individuals were no longer meeting the recommendations for physical activity. Therefore, although the intervention did not appear to have a large effect on dimensions of MVPA over time, the intervention may have enabled the intervention group to maintain adequate levels of MVPA, beyond that of the control group.

Another possible explanation for the limited impact on MVPA could lie in the strengths and weaknesses of the BodyMedia Armbands. First, using the BodyMedia Armbands to measure physical activity helped to fill a gap that exists in much of the physical activity research for adults with type 2 diabetes. For, the BodyMedia has a low
rate of error (±3%) in terms of recording MVPA time, suggesting that this device is a valid measure of daily physical activity (Berntsen et al., 2010). Previous research has used self-report questionnaires as a physical activity measurement tool among adults with type 2 diabetes (Heiss & Petosa, 2014). Self-report measures are limited by objective factors such as participant recall and varying interpretation of questions (Welk, 2002). The advantage to using the BodyMedia Armbands in this study was that we were able to obtain an objective measure of MVPA in a sample of overweight and obese adults with type 2 diabetes. Additionally, the BodyMedia measures different dimensions of activity, such as caloric expenditure and number of steps, giving us a more thorough picture of an individual’s behavior. Finally, the consumer-friendly nature of the BodyMedia helped researchers provide the participants with a detailed description of their behavior. Anecdotal evidence demonstrates that participants were both interested and excited about the BodyMedia Armbands, and felt as though they were receiving very useful information. The utility of the BodyMedia both as an accurate research tool as well as a consumer device may have important implications for using these armbands in the future.

However, a weakness of this device is its inability to distinguish bouts of physical activity. Instead, it accumulates all counts of physical activity throughout the entire day. For example, an individual who accrued 60 minutes on a single day may have done so in an accumulation of 30, 2-minute bouts. Therefore, while this individual was moderately active for an hour per day, they were not meeting the physical activity recommendations due to bouts being less than 10 minutes in length (Thompson, 2010). Therefore, while there was very little change in total minute of MVPA from pretest to posttest, there is a possibility that individuals adjusted their individual physical activity bouts to exceed 10
minutes in order to accumulate very similar total volumes of MVPA per day and MVPA per week. Also, research suggests that sedentary time has been independently associated with cardiovascular disease markers (Healy, Matthews, Dunstan, Winkler, & Owen, 2011). Therefore, regardless of the duration of each individual physical bout, individuals in the intervention group may have been able to receive the protective effects of activity by engaging in a total of 50-60 minutes of physical activity per day, regardless of the bout length.

An additional concern of the BodyMedia is its ability to detect moderate physical activity. The armband records sedentary time as well as moderate-to-vigorous physical activity, but does not count light activity. For example, although individuals in the intervention group appeared to increase their number of steps per day via walking, their walking behavior may have not been of at least moderate intensity. Therefore, the BodyMedia Armband may not have registered their increase in number of steps as a simultaneous increase in minutes of MVPA per day or minutes of MVPA per week. Interestingly, this finding was similar to previous research in the ADAPT trial. The ADAPT trial found that at 12-month follow-up, the only variable that was positively impact by a telephone counseling physical activity intervention was number of steps per day; moderate-to-vigorous physical did not significantly change (Plotnikoff, Karunamuni, Courneya, Sigal, Johnson, & Johnson, 2013). Therefore, although this study did have a positive impact on walking behavior in a sample of adults with type 2 diabetes, this walking behavior may not have been of sufficient intensity to improve MVPA per week, MVPA per day, or daily caloric expenditure.
A final explanation for the limited effect on MVPA could be that the length of the intervention only allowed a positive change in behavioral strategies, but not actual behavior. First, this study is novel in that it was able to detect a measurable change in SCT variables as a result of a brief, behavioral intervention. For example, the First Step Program targeted social support, goal setting, and self-regulation in their physical activity program that positively impacted walking behavior in a small sample of adults with type 2 diabetes (Tudor-Locke, Myers, Bell, Stewart, Harris, & Rodger, 2002). However, the First Step Program failed to measure any SCT variables, leaving researchers unable to determine if changes in said variables contributed to the change in behavior.

Additionally, previous researchers in type 2 diabetes exercise interventions have primarily focused on self-efficacy to change physical activity behavior (Allen, 2004). The current study presents preliminary evidence that a SCT- behavioral intervention can positively change other SCT-based constructs among adults with type 2 diabetes, such as self-regulation, self-monitoring, time management, goal setting, and social support. However, even with the evidence that a brief, SCT-based behavioral intervention positively impacted dimensions of self-regulation, a 4-week intervention may not have been long enough to produce meaningful behavior changes. For example, the Transtheoretical Model suggests that 6 months is needed in order to making a lasting change in behavior (Marshall & Biddle, 2001). Additionally, the review of the literature on physical activity interventions for adults with type 2 diabetes, in Chapter 2, revealed a minimum length of 8 weeks to change behavior (Tudor-Locke et al., 2002). Therefore, although this study showed great promise for a brief, SCT-based behavioral intervention
to positively impact self-regulatory strategies, longer study duration may have been necessary to detect changes in behavior.

**Limitations**

A major limitation to this study is low power, particularly for physical activity variables. Having low power increases the likelihood of making a Type II Error, and therefore prevents the researcher of making sounds statistical conclusions (Vincent, 2005). Additionally, low power suggests the possibility that a true difference in physical activity across time between the intervention and control groups was not detected. Therefore, the effect of the intervention on physical activity should focus more on effect sizes. However, inspection of Cohen’s $d$ effect sizes still suggest a small effect of the intervention on MVPA per week, MVPA per day, caloric expenditure per day, and sedentary time per day, and a medium effect of the intervention on number of steps per day. The intervention, however, did have a large effect on all dimensions of self-regulation. When focus is placed on effect sizes, this intervention seemed to have a practical and important impact on self-regulation, but not on levels of MVPA. Therefore, these results should be viewed as preliminary, and future studies should focus on obtaining a sample size that achieves optimal power in order to detect the true effect of a physical activity behavioral intervention on SCT-variables as well as physical activity behavior.

Another limitation to this study is generalizability, and many threats to external validity were not controlled. First, individuals in this study were not randomly selected from the population of overweight and obese adults with type 2 diabetes. As a result of
this non-probability sample, results from this study should not be generalized beyond this sample. However, Chapter 3 describes this study in full detail including the exact individuals involved, the environment, the variables measured, and all intervention procedures. Therefore, researchers in the future could replicate this study in order to determine the ability of this behavioral intervention to generalize to other samples of overweight and obese adults with type 2 diabetes. This study also recruited volunteers for participation. Additionally, pretest values for physical activity suggest that this sample may have already been engaging in sufficient levels of physical activity. Recruiting subjects with high motivation to be physically active may have resulted in high reactivity for physical activity behavior, creating a ceiling effect for physical activity, and limiting the ability of the behavioral intervention to create a meaningful change in behavior.

Finally, the Hawthorne Effect was not controlled for in this study. The Hawthorne effect occurs when individuals are aware that they are part of a research study. Therefore, their reaction and attitudes may impact the generalizability. This was not controlled for in this study, and individuals in the intervention group may have acted differently because they knew they were part of a study. This may have resulted in physical activity levels that were inflated due to reactivity, and therefore limits the generalizability to future uses of this intervention in non-research settings.

As stated above, another limitation to this study is study duration. This study was a 4-week experimental design. Four weeks is a relatively short time to change behavior, and the preliminary results from this study suggest that there was potentially not enough time for this study to have a meaningful impact on physical activity behavior. However, this study did have a meaningful impact on self-regulatory strategies, and longer study
duration may have enabled the change in self-regulation to stimulate a change in
behavior. Additionally, the study did have a moderate impact on walking behavior, as
individuals in the intervention group increased their number of steps by almost 2000 in a
4-week period. Continuing this trend for a longer duration could individuals in the
behavioral intervention to reach the recommended amount of 8,000-10,000 steps per day.

A final limitation to this study is the time of year in which it took place. The
intervention took place from February to April. That time of year, particularly February
and March tends to have poorer weather compared to other months of the year. Given
that a majority of the individuals were focusing on walking behavior, poor weather may
have hindered their ability to walk outside and meaningfully change their behavior.

**Recommendations for Future Research**

A major concern in this current study was the potential reactivity among study
participants as baseline, producing adequate levels of physical activity prior to the
intervention. This ceiling effect therefore limited the ability of the intervention to have
any additional impact on behavior. Therefore, we recommend that future researchers
focus on reducing the reactivity and novelty effect of wearing a physical activity monitor,
such as the BodyMedia Armband. For example, allowing individuals to wear the device
for a longer period of time (i.e. 1-to-2 weeks) prior to the actual baseline measurement
may give participants the ability to acclimate to the device. Additionally, allowing
enough time for the novelty of the device to wear off may be crucial to ensuring that
participants are not making additional efforts to be physically active, and engaging in a
true ‘typical’ week in terms of MVPA behavior. Focusing on reducing reactivity and the
potential for a ceiling effect is essential for researchers to understand (1) the true baseline values of their sample and (2) the true impact of the intervention on physical activity behavior. In addition, future research should emphasize obtaining adequate power. An adequately powered study allows researchers to be confident in their ability to detect a true difference or change in behavior. Therefore, the results of this study should be viewed as preliminary, and future research should focus on an experimental design that recruits the acceptable amount of subjects to achieve optimal power across all variables.

Although power and reactivity were cause for concern, the positive results from this study can still be used to direct future research endeavors. First, this study produced a meaningful change in self-regulation variables, including self-monitoring, goal setting, overcoming barriers, time management, self-reward, and social support. Second, this study was novel in that it focused on self-regulation and self-monitoring specifically for exercise among adults with type 2 diabetes. Previous research has supported the notion that effective self-management training is key for adults with type 2 diabetes (Norris, Engelgau, & Narayan, 2001). However, studies often examine exercise and physical activity as only one piece of a self-care regimen (Allen, 2004). Preliminary results from this study provide evidence that self-regulatory strategies for physical activity can be targeted and improved in a sample of overweight and obese adults with type 2 diabetes. Specifically, this intervention used weekly exercise plans and logs as techniques for increasing the use of self-regulatory strategies. Future researchers may adopt these strategies into physical activity promotion programs in order to continue to produce meaningful changes in SCT-based variables. Another suggestion could be using the BodyMedia Armbands as a means to self-regulate behavior. Although this study did not
document acceptability or satisfaction with the armbands, anecdotal evidence supports that individuals in this study felt comfortable wearing the armbands, and enjoyed receiving the feedback given to them by the Online Activity Manager. Additionally, the reactive effect of the armbands suggests the individuals felt more motivated to exercise as a result of wearing a physical activity monitor. While feasibility issues resulted in individuals only being able to receive feedback from researchers during their weekly sessions, BodyMedia Armbands do have the potential to provide individuals with immediate feedback through Bluetooth and USB capabilities (BodyMedia, Inc., 2014). In other words, individuals could continuously check their phone or computer in order to regulate their daily minutes of MVPA, caloric expenditure, and steps per day. Therefore, future research endeavors may focus on understanding the feasibility of using these devices as both a measurement tool and a self-regulation strategy in order to improve physical activity behavior. Additionally, given that this current study failed to promote a large change in physical activity, it is important for future research to further explore the ability of improvements in SCT variables, specifically self-regulation for physical activity, to stimulate a positive and lasting behavior change.

Finally, this study only produced a moderate impact on number of steps per day, supporting the notion that a behavioral intervention can positively impact number of steps per day. Additionally, self-monitoring was positively associated with the posttest number of steps per day. First, this suggests that the change in steps per day may have been aided by the improvement in self-monitoring. However, none of the remaining dimensions of self-regulation were associated with number of steps. Therefore, future research needs to determine the extent to which changing dimensions of self-regulation can predict and
stimulate positive changes in behavior. Additionally, there is also evidence to suggest that changes in walking behavior may not be of sufficient intensity to produce meaningful changes in MVPA. For, changes in walking behavior in this study, as well as previous research in the ADAPT trail, did not coincide with changes in minutes of MVPA. Therefore, future research needs to focus on engaging participants in walking behavior that is of at least moderate intensity in order to ensure that participants are meeting the minimum recommendations for physical activity as well as receiving the health benefits of MVPA for adults with type 2 diabetes.

Summary

In summary, this study provided preliminary evidence to support that a 4-week behavioral intervention can have a meaningful effect on dimensions of self-regulation among a sample of overweight and obese adults with type 2 diabetes. Additionally, this study supported that a behavioral intervention can have a moderate impact on number of steps per day over a 4-week period. The moderate relationship between self-monitoring and posttest number of steps per day also suggests that the change in self-monitoring may have aided in the stimulation of improved walking behavior. However, this study did not have a meaningful impact on minutes of MVPA per day, minutes of MVPA per week, caloric expenditure, or sedentary time. Given the importance of regular physical activity for adults with type 2 diabetes, it is important for physical activity programs to prioritize positively changing behavior in this population. Therefore, given the observed effect sizes and meaningful changes in SCT variables, an optimally powered subsequent study should focus on reducing pretest ceiling effects on physical activity behavior, while
reproducing said changes in self-regulation, and focusing on their ability to stimulate meaningful changes in physical activity behavior in order to having a lasting effect on type 2 diabetes management.
References


Appendix A

Demographic Questionnaire

The following statements ask you to identify some basic information about yourself.

1. Age: ______ (years)
2. What is your sex/gender?
   ______ Male ______ Female ______ Transgender ______ Other
3. Highest Level of Education:
   _____ Some High School _____ High School Diploma
   _____ Some College _____ College Degree
   _____ Graduate Degree _____ Professional Degree
4. Marital Status:
   _____ Single (Never married) _____ Married/partnered
   _____ Separated _____ Divorced _____ Widowed
5. Ethnic Background:
   _____ Hispanic or Latino
   _____ Not Hispanic or Latino
6. Race (Please select one category):
   _____ White
   _____ Black or African American
   _____ American Indian or Alaskan Native
   _____ Native Hawaiian or other Pacific Islander
   _____ Asian
   _____ Multi-Racial
   _____ Other
7. Height (without shoes): ______ feet ______ inches
8. **Weight:** _____ lbs.

9. **How many days did you exercise last week?**
   - ___ 0  ___ 4
   - ___ 1  ___ 5
   - ___ 2  ___ 6
   - ___ 3  ___ 7

10. **How many days per week do you typically exercise?**
    - ___ 0  ___ 4
    - ___ 1  ___ 5
    - ___ 2  ___ 6
    - ___ 3  ___ 7

11. **On these days, for how many minutes on average do you exercise?**
    - ___ 0-10 minutes  ___ 10-20 minutes
    - ___ 20-40 minutes  ___ 40-60 minutes
    - ___ Greater than 60 minutes  ___ I do not engage in exercise

12. **What is your typical mode of exercise (select all that apply)?**
    - ___ Walking  ___ Jogging or Running
    - ___ Bicycling  ___ Swimming
    - ___ Weight Lifting  ___ Pilates, Yoga, or Tai Chi
    - ___ Elliptical  ___ Fitness Classes (i.e. Aerobics, Zumba, BodyPump)
    - ___ Sports Games (i.e. tennis, basketball, volleyball)
    - ___ I do not engage in exercise

    Other (fill in type(s)): ________________________________
Appendix B

Participant Instructions for Wearing the BodyMedia Armband

Wear on the back of your left upper arm (triceps). Be sure that your upper left arm and the Armband are clean, dry, and free of oil or lotion. Beginning tomorrow, wear the armband on the same side and location during all waking hours each day for 7 consecutive days.

a. The silver sensors on the underside should be in contact with your skin
b. The BodyMedia logo should face upward

2. Put the armband on while dressing in the morning and do not remove it until undressing at night for bed. This includes wearing the device during exercise or while engaging in other activities.

3. After you have put the armband on, the sensor will automatically turn on and begin collecting data within 10 minutes. Activation is indicated by a series of audio tones. There is no power button on the armband.

4. The BodyMedia Armband sensor is vulnerable to being dropped or submerged in water. It cannot be worn in a shower or pool. Care should be taken to cover it with a jacket or other protective clothing while active in the rain. Make sure the device is removed before clothing is laundered. At bedtime, or during other extended periods of non-use, the BodyMedia armband should be stored in a safe location where it will not be damaged by water or falling to the floor, or accessible to young children or pets.

5. Clean the armband sensor after sweating or when it becomes noticeably moist. Use a cloth or towel moistened with mild soap and water to wipe the side of the sensor that touches the skin. Remove any excess soap and dry with a cloth or towel completely before wearing.
6. The BodyMedia Armband should be returned to the PAES research staff at the end of the seven-day wear period. Since the life of the battery is short, the device should be returned promptly following the seventh day. Questions about the device should be directed to Valerie Heiss, at 412-478-8584 or Heiss.22@osu.edu
Appendix C

Exercise Guidelines for Adults with Type 2 Diabetes

<table>
<thead>
<tr>
<th>Benefits of Exercise</th>
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<tbody>
<tr>
<td>Helps your body use insulin</td>
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<tr>
<td>Helps control blood sugar</td>
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<tr>
<td>Lowsers blood pressure</td>
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<tr>
<td>Strengthens bones</td>
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<tr>
<td>Lowsers cholesterol levels</td>
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<tr>
<td>Lowsers risk of having a heart attack or stroke</td>
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<td>Lowsers stress levels</td>
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### Recommendations for Exercise Participation

<table>
<thead>
<tr>
<th>Aerobic Exercise Training</th>
<th>Frequency</th>
<th>Intensity</th>
<th>Duration</th>
<th>Mode</th>
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<tbody>
<tr>
<td>At least 3 days per week</td>
<td>At least at moderate intensity 40-60% of aerobic capacity</td>
<td>At least 150 minutes per week. Can be accumulated in bouts of at least 10 minutes</td>
<td>Strive for 8,000-10,000 steps per day</td>
<td>Any form of aerobic exercise that uses large muscle groups and causes a sustained increase in heart rate. Examples: Brisk walking, water aerobics, bicycling</td>
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</table>

<table>
<thead>
<tr>
<th>Resistance Exercise Training</th>
<th>Frequency</th>
<th>Intensity</th>
<th>Duration</th>
<th>Mode</th>
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</thead>
<tbody>
<tr>
<td>At least 2 days per week</td>
<td>Can be moderate (50% of 1-repetition max) or vigorous (75%-85% of 1-repetition max)</td>
<td>Include 5-10 exercises involving major muscle groups 10-15 repetitions 3-4 sets</td>
<td>Resistance machines and free weights (i.e. dumbbells)</td>
<td>Heavier weights may be needed for optimization of blood glucose control</td>
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## Appendix D

### Exercise Plan and Exercise Log

### Exercise Plan

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>Time of Day</th>
<th>Duration</th>
<th>Intensity (0-10)</th>
<th>Number of Steps</th>
<th>With Whom?</th>
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<tbody>
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<td>Monday</td>
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### Actual Exercise

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>Time of Day</th>
<th>Duration</th>
<th>Intensity (0-10)</th>
<th>Number of Steps</th>
<th>With Whom?</th>
<th>Enjoyment (0-10)</th>
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<tbody>
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Appendix E

Participant Instructions for Completing the Exercise Plan

• Let’s fill out an exercise chart in order to plan out your exercise out for the week

1. Decide what days of the week you will exercise
   a. Recommendations state at least 3 days per week
   b. Think about your weekly schedule.
   c. What days work best for you?

2. Decide the type of exercise you will do
   b. Try to think of something that you enjoy
   c. Decide on an exercise that you are likely to do

3. Decide on the location of your exercise
   a. Where will you exercise?
   b. Do you have access to a gym? Shopping mall? Outside?
   c. If you plan on exercising outside, do you have a back-up plan for bad weather?

4. Decide on the time of day for your exercise
   a. Make sure that it fits with your daily schedule
   b. What time of day works best?
   c. What time of day do you feel most energized?

5. Decide on the duration of your exercise
   a. It is recommended that you exercise for 20 to 60 minutes
   b. This can be accumulated in 10 minute bouts

6. Decide on the intensity of your exercise
   a. Choose on a scale from 0-10. This is your Rating of Perceived Exertion (RPE)
   b. Your exercise should be at least moderate intensity. This means at least a 3 on the 0 to 10 scale

7. Set a goal for your number of steps per day
   a. You will have a pedometer to use to record your
number of steps
b. The recommendation is **10,000 steps per day**

8. Decide *with whom* you will be exercising
   a. Are you more likely to exercise if you have support from friends or family
   b. *Note: You do not need to exercise with anyone if you wish to exercise alone*

- Now that you’ve made all of these decisions—Fill in your plan for the week! **For each day that you are going to exercise, fill in the type, location, time of day, duration, intensity (0-10), number of steps, and exercise buddy.**

- Then, during the week, complete the “Actual Exercise: Weekly Activity Log”. Track your exercise everyday and see how closely you stuck to your plan!
Appendix F

Behavioral Intervention Researcher Handbook

Valerie Heiss: Dissertation

Guidelines for Researchers

**Intervention Protocol**

- **Informed Consent, PAR-Q, Stages of Change**
  a. Before beginning *any* of the procedures, the individual needs to sign the informed consent
  b. Have individual read the informed consent carefully
  c. Also have them complete the PAR-Q and Stages of Change Questionnaire
    i. **NOTE**: If someone answers “YES” to any of the PAR-Q questions and/or if they are in the Maintenance Stage of the TTM then they *cannot be included in the study*
  d. **If someone does not meet the criteria, they still receive a pedometer**

- **Cancelled or Missed Visits: Participants**
  o Email participant IMMEDIATELY
  o Tell participant that they need to reschedule their visit *within 7 days* of their originally scheduled visit

- **Cancelled or Missed Visits: Researchers**
  o If YOU need to cancel a visit, first contact the other two researchers to fill in
    *Heiss.22@osu.edu*
    *Schaub.7@osu.edu*
    *Laurent.23@osu.edu*
  o If they can’t, work with the participant to reschedule their visit *within 7 days* of the originally scheduled appointment

- **Complete vs. Incomplete Data**
  o *BodyMedia: Experimental and Control Group*
    - Must meet the following criteria to be considered “COMPLETE”
      - During the seven days of measurement, participants must have worn the BodyMedia for *at least four days*
      - One the days in which the BodyMedia was worn, participants must have worn the device for *at least eight hours.*
    - If “INCOMPLETE”
      * Allow participant to wear device for one more week
      * Must be completed for the next week
You CANNOT combine weeks (i.e. 2 days week 1 + 2 days week 2 = 4 days)

- If, after two attempts, a participant still fails to wear the BodyMedia for at least eight hours on at least four days, then they will be dismissed from the study.

Planned and Actual Exercise Logs: Experimental Group Only

- During visit #3, participant will give you 3 exercise logs. You will have done plan #1 together (during visit #2), 2 actual, 1 planned
- In order for these to be “COMPLETE”, 2 of the 3 logs must meet the following criteria:
  - Participants must have planned or logged their exercise for at least 3 of the 7 days*
    - *Note: Even if an individual writes phrases such as “nothing” or “rest day” to indicate no exercise, this still demonstrates completeness.
    - Although a participant didn’t exercise, they still took note and tracked their behavior
  - Participants must have at least 4 of the 8 columns completed.
    - Specifically, participants need to have completed type, duration, intensity, and steps (focus on the ones that are more important)
  - The above criteria must be met for at least two of the three logs.
- If “INCOMPLETE”
  - Participants will be dismissed from the study and will not receive incentive

VISIT #1
Researcher Script
Experimental Group AND Control Group
Once Someone Meets the Criteria and Signs the Informed Consent (See Intervention Protocol):

- Introduction
  - e. Welcome to the program!
  - f. My name is _____ and I will be your advisor for the next 4 weeks
  - g. Over the course of the next 4 weeks you will be asked to return to this building 3 more times
    - i. One week from now, three weeks from now, and four weeks from now
    - ii. During this first week, and during the last week, you will be asked to wear a BodyMedia Armband

- Review Benefits of Participation
  - h. Experimental Group
    - i. You are going to receive detailed information about your lifestyle habits over the course of the next few weeks
You will get detailed information regarding your activity behavior including caloric expenditure, minutes of activity, and number of steps.

Next week, we will be talking about your activity and coming up with an exercise plan for yourself.

- **You will receive a pedometer and exercise log to help you with your activity.**

It is the hope that this program helps you to become a regular exerciser.

All of this is designed to help you develop a personal, practical approach to regular activity to contribute to diabetes management.

**Control Group**

- **You are going to receive detailed information about your lifestyle habits over the course of the next few weeks.**

- **You will get detailed information regarding your activity behavior including caloric expenditure, minutes of activity, and number of steps.**

- **At the conclusion of the program, you will also receive the recommendations for physical activity and a pedometer, and we will be able to talk about way to potentially change your behavior.**

- **It is important for us first to look at your behavior over the course of two weeks in order to get a more detailed picture of your lifestyle.**

- **All of this is designed to help you develop a personal, practical approach to regular activity to contribute to diabetes management.**

**Clarify Incentive**

- **As you know, you will receive a total of $40 for completing this study.**

- **You will receive $20 next week, after the first BodyMedia Measurement and then $20 during the final visit, after the second BodyMedia Measurement.**

- **It is really important to follow the steps, and we are here to help you follow them.**

- **If you aren’t completing the steps you will be asked to leave the study and you will not receive your incentive.**

**Body Media Introduction**

- **For this first week, we are asking that you wear a Body Media Armband.**

- **This is a device that will track your physical activity for the next 7 days.**

- **You will wear the device on your arm. The sensors will measure your things like your skin temperature and sweat rate.**

- **It will record factors such as your number of steps, minutes of physical activity, and caloric expenditure.**

- **This will allow us to give you an accurate estimate of your daily activity and how many calories you expend.**

- **We will discuss these results one week from now.**

- **Over the next week, I want you to engage in a typical week of physical activity.**

**Set-Up Online Activity Manager**

- **The online activity manager is a BodyMedia software package that allows data from the armband to be downloaded.**
p. This software will break down your activity and show us what you did during the week
q. Next week, when you return, we will download your data to this software
r. In order for the device to analyze your personal activity data, I need some personal information (Found under “Settings”→ “User Profile” on Online Activity Manager)
   i. Height, weight, age, gender, number of hours per sleep, what time participant goes to bed, general activity level
s. This information helps the device to collect the most accurate data possible in terms of your activity
t. Do you have any questions so far?

• Show the participant how to wear BodyMedia
  u. First demonstrate how to wear it
  v. Help them put on the BodyMedia
  w. Talk them through the directions (below)
x. Once you have demonstrated/talked them through the directions, proceed to #7

• Give Participant “Participant Instructions for Wearing the BodyMedia Armband” Handout

  y. Wear on the back of your left upper arm (triceps). Be sure that your upper left arm and the Armband are clean, dry, and free of oil or lotion.
  z. Beginning tomorrow, wear the armband on the same side and location during all waking hours each day for 7 consecutive days.
  aa. The silver sensors on the underside should be in contact with your skin
     i. The BodyMedia logo should face upward
  bb. Put the armband on while dressing in the morning and do not remove it until undressing at night for bed. This includes wearing the device during exercise or while engaging in other activities.
  cc. After you have put the armband on, the sensor will automatically turn on and begin collecting data within 10 minutes. Activation is indicated by a series of audio tones. There is no power button on the armband.
  dd. The BodyMedia Armband sensor is vulnerable to being dropped or submerged in water. It cannot be worn in a shower or pool. Care should be taken to cover it with a jacket or other protective clothing while active in the rain. Make sure the device is removed before clothing is laundered. At bedtime, or during other extended periods of non-use, the BodyMedia armband should be stored in a safe location where it will not be damaged by water or falling to the floor, or accessible to young children or pets
  ee. Clean the armband sensor after sweating or when it becomes noticeably moist. Use a cloth or towel moistened with mild soap and water to wipe the side of the sensor that touches the skin. Remove any excess soap and dry with a cloth or towel completely before wearing.

• Administer Self-Regulation Questionnaire
To finish this visit, please complete this questionnaire. It should take you about 5-10 minutes

- **Set-Up Next Meeting**
  - gg. Your next visit will be 1 week from today in this same room
    - i. Please bring back the BodyMedia Armband
  - hh. During the next visit
    - i. **Experimental Group**
      1. During the next visit, we will download your BodyMedia information to the Activity Manager
      2. This will allow us to look at the number of calories you burn everyday, how much activity you do everyday, and how many steps you take everyday
      3. You will be give a printout of this information to keep
      4. We will also talk about the recommendations for physical activity and see how you compare
      5. We will also be setting goals for your activity. You will be creating an activity plan to help you increase your activity over the next few weeks
      6. This will give you a personal plan for your exercise that can help you with managing your type 2 diabetes
    - ii. **Control Group**
      1. During the next visit, we will download your BodyMedia information to the Activity Manager
      2. This will allow us to look at the number of calories you burn everyday, how much activity you do everyday, and how many steps you take everyday
      3. You will be give a printout of this information to keep
      ii. We need the Armband to download the information to the Activity Manager
    - jj. Can we set up a time that works best for you?
      - i. Note: If they can’t meet on the *exact* same day, try and schedule a visit within 48 hours of their visit #1 appointment time
    - kk. In the event that you need to reschedule or cancel, I need you to contact me as soon as you can
    - ll. Next week, you will receive you first $20 installment once you return the BodyMedia device

**VISIT #2**

**Researcher Script**

**Experimental Group**

1. **BodyMedia Data Download**
   - a. Let’s download your BodyMedia data from the past week onto the Online Activity Manager
   - b. I am going to print off a summary sheet so that we can go over this together
2. **Review BodyMedia Summary Sheet**
   a. Let’s review this summary sheet in terms of what you did over the course of the past week
      i. Note: This is simply a review of what they did, going through the sheet section by section. Basically reading the summary sheet
   b. Average minutes of physical activity per day
   c. Average number of steps per day
   d. Calorie balance by day
      i. Daily average
   e. Physical activity by day
      i. Target minutes vs. actual minutes
      ii. Moderate and vigorous activity
   f. Number of steps by day

3. **Review ACSM/ADA Recommendations**
   a. Ok, now that we have looked at what you did, let’s talk about the recommendations for physical activity
   b. Give participant “Exerci_se Guidelines for Adults with Type 2 Diabetes”
   c. These are the recommendations for both aerobic and resistance training from the American College of Sports Medicine and the American Diabetes Association
      i. At least 3 days per week
      ii. At least a moderate intensity
      iii. At least 150 minutes per week
         1. 30 minutes per day
         2. 8,000-10,000 steps
   d. *NOTE: Feel free to compare the recommendations to their actual activity if you feel that will help them

4. **Introduce Exercise Intervention**
   a. Now that we have observed your activity over the past week and the recommendations for exercise, let’s start a plan to get you to meet the minimum recommendations for physical activity
   b. Over the course of the next 3 weeks, you are going to write a weekly plan for your exercise
   c. Then, you are going to log your actual activity for a week
   d. You are also going to be given a pedometer to use so that you can monitor the number of steps you take each day
   e. So, at the conclusion of this program you will have 3 exercise plans and 3 exercise activity logs
   f. Let’s start by planning your first week together

5. **Complete Exercise Plan**
a. Give participant “Exercise Log” (TWO Copies) and “Participant Instructions for Completing the Exercise Plan”

b. Handout **pedometer**
   i. Pedometer directions:
      1. This is a pedometer for you to keep
      2. It counts the number of steps you take every day
      3. Clip it to your clothing around your hip, and wear it so the screen faces forward
      4. The screen displays the number of steps you have taken, and you can reset it and the beginning of each day

c. Ok, let’s go through the directions and exercise plan together
   i. Decide what **days of the week** you will exercise
      1. Recommendations state at least 3 days per week
      2. Think about your weekly schedule.
      3. What days work best for you?
   ii. Decide the **type** of exercise you will do
      2. Try to think of something that you enjoy
      3. Decide on an exercise that you are likely to do
   iii. Decide on the **location** of your exercise
      1. Where will you exercise?
      2. Do you have access to a gym? Shopping mall? Outside?
      3. If you plan on exercising outside, do you have a back-up plan for bad weather?
   iv. Decide on the **time of day** for your exercise
      1. Make sure that it fits with your daily schedule
      2. What time of day works best?
      3. What time of day do you feel most energized?
   v. Decide on the **duration** of your exercise
      1. It is recommended that you exercise for 20 to 60 minutes
      2. This can be accumulated in 10 minute bouts
   vi. Decide on the **intensity** of your exercise
      1. Choose on a scale from 0-10. This is your Rating of Perceived Exertion (RPE)
      2. Your exercise should be at least moderate intensity. This means at least a 3 on the 0 to 10 scale
   vii. Set a goal for your **number of steps per day**
      1. You will have a pedometer to use to record your number of steps
      2. The recommendation is 8,000-10,000 steps per day
   viii. Decide **with whom*** you will be exercising
      1. Are you more likely to exercise if you have support from friends or family
      2. *Note: You do not need to exercise with anyone if you wish to exercise alone
ix. Now that you’ve made all of these decisions—Fill in your plan for the week! For each day that you are going to exercise, fill in the type, location, time of day, duration, intensity (0-10), number of steps, and exercise buddy.

6. Discuss Actual Exercise Log
   a. Now that you have a plan, I want you to try and stick to this plan over the course of the next week
   b. Over the next week, track your exercise everyday and see how close you stick to your plan
      i. Even if you don’t engage in activity, RECORD THAT
         1. You can write words like “NOTHING” or “REST DAY”
   c. The main goal is that you are writing in the log and recording your activity

7. Discuss Second Exercise Plan
   a. One week from today, I want you to complete a second exercise plan on your own
      i. See how well you stuck to the first plan. Do you need to create a new plan?
   b. Follow the directions we gave you to complete the plan
   c. Then, track your actual exercise for the following week
   d. We will meet again two weeks from today to discuss your logs and your exercise
   e. This means, that when we meet again, you need to bring me TWO exercise plans and TWO actual exercise logs
   f. I will be sending you an email reminder to encourage you to complete these logs over the next two weeks

8. Stress Completeness
   a. In order to remain in the study, it is important that you complete all of the logs you have received today
   b. When you come back in two weeks, we will first check the logs for completeness
   c. This means, that, even if you have a day where you do not exercise, please indicate that on your log
      i. It’s ok to write words such as “NOTHING” or “REST DAY”
   d. If you fail to complete these logs, then you will not be eligible to finish the study and you will not receive your incentive.

9. Set-Up Next Meeting
   a. Your next visit will be 2 weeks from today in this same room
   b. When you return in two weeks, it is important for you to bring your competed exercise plans and activity logs
   c. During the next visit, you and I will talk about your logs and discuss what worked best for you. We will be able to talk about what you learned from your exercise logs and how well you followed your plan.
      i. We will then create a final plan together for the last week of the program
   d. Can we set up a time that works best for you?
      i. Note: If they can’t meet on the exact same day, try and schedule a visit within 48 hours of their visit #1 appointment time
   e. Incentives
i. Give individual $20 as long as they have completed all of the steps and returned the BodyMedia

VISIT #2
Researcher Script
Control Group

1. BodyMedia Data Download
   a. Let’s download your BodyMedia data from the past week onto the Online Activity Manager
   b. I am going to print off a summary sheet so that you can have one to keep
      i. Note: Print TWO—keep one for yourself in the participant folder

2. Give Participant Summary Sheet
   a. This summary sheet gives you some information about your activity over the course of the past week
   b. When you return here in two weeks, I am going to ask you to wear the BodyMedia one more time

3. Review BodyMedia Summary Sheet
   a. Let’s review this summary sheet in terms of what you did over the course of the past week
      i. Note: This is simply a review of what they did, going through the sheet section by section. Basically reading the summary sheet
   b. Average minutes of physical activity per day
   c. Average number of steps per day
   d. Calorie balance by day
      i. Daily average
   e. Physical activity by day
      i. Target minutes vs. actual minutes
      ii. Moderate and vigorous activity
   f. Number of steps by day
   g. Do NOT discuss whether they have met the guidelines for physical activity
   h. Do NOT encourage participant to increase their physical activity levels
   i. In the event that someone asks questions about their behavior
      i. In order to have a more comprehensive description of your behavior, we will again measure you in two weeks. After this, we will be giving you more information about the guidelines for physical activity and will be happy to answer any questions you have about your behavior.
      ii. You can answer questions about what they did (i.e. clarify something), but be careful about comparing it to recommendations or encouraging them

4. Set-Up Next Meeting
   a. Your next visit will be 2 weeks from today in this same room
b. During this visit, we will give you this same BodyMedia again to wear for one more week.

c. It is important for us to get two weeks of your behavior. We want to really understand your lifestyle before we discuss your results and the recommendations for activity.

d. At the end of the program, we will have a comprehensive picture of your lifestyle and then we will be able to talk about your exercise activity in terms of the recommendations.

e. Can we set up a time that works best for you?
   i. Note: If they can’t meet on the exact same day, try and schedule a visit within 48 hours of their visit #1 appointment time.

f. Incentives
   i. Give participant $20 as long as they have completed all of the steps and returned the BodyMedia device.

VISIT #3
Researcher Script
Experimental Group

1. Review Actual Exercise Log From Week 1
   a. Let’s review the logs that you completed over the past two weeks.
   b. Tell me about your exercise log during the first week.*
   c. What were the main things that you learned about exercise and you during the past two weeks?
   d. Did you follow the plan that we made together?
      i. Why or Why not?

2. Review Week 2 Exercise Plan
   a. Tell me about the plan that you made by yourself. *
      i. Were you able follow the directions?
      ii. Were there any differences between the plan we made together and the plan you made on your own?
         1. If you made changes, why?
         2. If you did not make changes, why not?
   b. Tell me about your decisions in terms of the days, type, location, time of day, etc.

3. Review Week 2 Actual Exercise Log
   a. Tell me about the exercise log that you completed during the second week*
   b. Did you stick to your plan and meet your goals?
      i. Why or why not?
      ii. If YES → What do you think helped your stick with your plan?
      iii. If NO → What factors made it hard for you to stick with your plan?

*NOTE: Let them tell you/explain these logs to you. You want to give them a chance to talk through their behavior.
4. **Complete Exercise Plan**
   a. Now we are going to make one more plan for next week.
   b. You learned some key things about your exercise preferences and challenges
   c. Let’s use what you learned to make a new plan
   d. We are going to plan your exercise together, and then you are going to log your activity for one more week
   e. We are going to go through the same exercise plan and directions together
      i. Decide what *days of the week* you will exercise
         1. Recommendations state at least 3 days per week
         2. Think about your weekly schedule.
         3. What days work best for you?
      ii. Decide the *type* of exercise you will do
         2. Try to think of something that you enjoy
         3. Decide on an exercise that you are likely to do
      iii. Decide on the *location* of your exercise
         1. Where will you exercise?
         2. Do you have access to a gym?
         3. If you plan on exercising outside, do you have a back-up plan for bad weather?
      iv. Decide on the *time of day* for your exercise
         1. Make sure that it fits with your daily schedule
         2. What time of day works best?
         3. What time of day do you feel most energized?
      v. Decide on the *duration* of your exercise
         1. It is recommended that you exercise for 20 to 60 minutes
         2. This can be accumulated in 10 minute bouts
      vi. Decide on the *intensity* of your exercise
         1. Choose on a scale from 0-10. This is your Rating of Perceived Exertion (RPE)
         2. Your exercise should be at least moderate intensity. This means at least a 3 on the 0 to 10 scale
      vii. Set a goal for your *number of steps per day*
         1. You will have a pedometer to use to record your number of steps
         2. The recommendation is 8,000-10,000 steps per day
      viii. Decide *with whom* you will be exercising
         1. Are you more likely to exercise if you have support from friends or family
         2. *Note: You do not need to exercise with anyone if you wish to exercise alone
      ix. Now that you’ve made all of these decisions—Fill in your plan for the week!
         For each day that you are going to exercise, fill in the type, location, time of day, duration, intensity (0-10), number of steps, and exercise buddy.

5. **Discuss Actual Exercise Log**
a. Now that you have a plan, I want you to try and stick to this plan over the course of the next week
b. Over the next week, track your exercise everyday and see how close you stick to your plan
   i. Even if you don’t engage in activity, RECORD THAT
      1. You can write words like “NOTHING” or “REST DAY”
c. The main goal is that you are writing in the log and recording your activity

6. Redistribute BodyMedia
   a. For one more week, we are asking that you wear a Body Media Armband
   b. You will be wearing the same device that you did during week 1
   c. Reiterate [“Participant Instructions for Wearing the BodyMedia Armband”]
   d. Over the next week, I want you to try and engage in the recommended levels of physical activity, according to the plan that you made

7. Set-Up Next Final Meeting
   a. Your next visit will be 1 week from today in this same room
      i. Please bring back the BodyMedia and your completed activity log
   b. Next week will serve as your final meeting for this study
   c. We will talk about your improvements over the past few weeks and see how your exercise now compares to your exercise at the start of the program
   d. Can we set up a time that works best for you?
      i. Note: If they can’t meet on the exact same day, try and schedule a visit within 48 hours of their visit #1 appointment time

VISIT #3
Researcher Script
Control Group

1. Body Media Introduction
   a. For one more week, we are asking that you wear a Body Media Armband
   b. This is a device that will track your physical activity for the next 7 days
      i. It will record factors such as your number of steps, minutes of physical activity, and caloric expenditure
   c. You will be wearing the same device that you did during week 1
   d. Over the next week, I want you to try and engage a typical week in terms of your physical activity
   e. Reiterate [“Participant Instructions for Wearing the BodyMedia Armband”]
   f. In the event that someone asks questions about their behavior
      i. In order to have a more comprehensive description of your behavior, we will talk during our visit next week
      ii. We will be giving you more information about the guidelines for physical activity and will be happy to answer any questions you have about your behavior.
2. **Set-Up Next Meeting**
   a. Your next visit will be 1 week from today in this same room
      i. Please bring back the BodyMedia Armband
   b. **Discuss benefits of final meeting**
      i. During the final meeting, we will compare your two BodyMedia measurements in order to see how your behavior compared over the two weeks
      ii. We will also talk about the current recommendations for exercise and see how you compare
      iii. Then, we will be giving you a pedometer in order to help you keep track of your activity and help you in the future
   c. Next week will serve as your final meeting for this study
   d. Can we set up a time that works best for you?
      i. Note: If they can’t meet on the *exact* same day, try and schedule a visit within 48 hours of their visit #1 appointment time

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**VISIT #4**

**Researcher Script**

**Experimental Group**

1. **Review Week 3 Actual Exercise Log**
   a. Tell me about the exercise log that you completed during the last week
   b. Did you stick to your plan and meet your goals?
      i. Why or why not?
      ii. If YES → What do you think helped your stick with your plan?
      iii. If NO → What factors made it hard for you to stick with your plan?

2. **BodyMedia Data Download**
   a. Let’s download your BodyMedia data from the past week onto the Online Activity Manager
   b. I am going to print off a summary sheet so that we can go over this together
      i. Note: Print TWO—keep one for yourself in the participant folder

3. **Review BodyMedia Summary Sheet**
   a. Let’s review this summary sheet in terms of what you did over the course of the past week
      i. Note: This is simply a review of what they did, going through the sheet section by section. Basically reading the summary sheet
   b. Average minutes of physical activity per day
   c. Average number of steps per day
   d. Calorie balance by day
      i. Daily average
   e. Physical activity by day
      i. Target minutes vs. actual minutes
      ii. Moderate and vigorous activity

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19.

4. **Administer Self-Regulation Questionnaire**
   a. Please complete this questionnaire again
   b. It will take you about 5-10 minutes

5. **General Wrap-up and Encouragement**
   a. This concludes this intervention program
   b. We encourage you to continue your exercise behavior and strive to meet the recommendations for physical activity
   c. You have learned skills over the past 3-4 weeks that you can use in your exercise. We hope that these skills, and this pedometer, will help you to maintain any increases that you’ve experienced in your activity
   d. **Incentives**
      i. Pay participant second installment of incentive: $20
      ii. Give pedometer to keep

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**VISIT #4**

**Researcher Script**

**Control Group**

1. **BodyMedia Data Download**
   a. Let’s download your BodyMedia data from the past week onto the Online Activity Manager
   b. I am going to print off a summary sheet so that we can go over this together
      i. Note: Print TWO—keep one for yourself in the participant folder

2. **Administer Self-Regulation Questionnaire**
   a. Please complete this questionnaire again
   b. It will take you about 5-10 minutes

3. **Review BodyMedia Summary Sheet**
   a. Let’s review this summary sheet in terms of what you did over the course of the past week
      i. Note: This is simply a review of what they did, going through the sheet section by section. Basically reading the summary sheet
   b. Average minutes of physical activity per day
   c. Average number of steps per day
   d. Calorie balance by day
      i. Daily average
   e. Physical activity by day
      i. Target minutes vs. actual minutes
      ii. Moderate and vigorous activity
   f. Number of steps by day
4. **Review ACSM/ADA Recommendations**
   a. Ok, now that we have looked at what you did, let’s talk about the recommendations for physical activity
   b. Give participant “**Exercise Guidelines for Adults with Type 2 Diabetes**”
   c. These are the recommendations for both aerobic and resistance training from the American College of Sports Medicine and the American Diabetes Association
      i. At least 3 days per week
      ii. At least a moderate intensity
      iii. At least 150 minutes per week/30 minutes per day

5. **Wrap-Up**
   a. This concludes this intervention program
   b. We encourage you to continue your exercise behavior and strive to meet the recommendations for physical activity
   c. **Incentives**
      i. Pay participant $20 and give pedometer to keep
         1. **Pedometer Directions:**
            a. It counts the number of steps you take every day
            b. Clip it to your clothing around your hip, and wear it so the screen faces forward
            c. The screen displays the number of steps you have taken, and you can reset it and the beginning of each day
         2. If you want to increase your physical activity, a pedometer may be a way to help you to do so. This will track your number of steps everyday. Your goal should be to reach somewhere between 5,000 and 10,000 steps