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Waist Circumference and the Relation to Aerobic Exercise and Perception of Illness in Adults with Type 2 Diabetes Mellitus

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Bailey J. Huebner

Eastern Illinois University, 2019

Abstract

The purpose of this study was to observe the relationship between waist circumference (WC), amount of aerobic exercise performed weekly and overall Health Belief Model (HBM) score in adults with diagnosed type 2 diabetes mellitus (T2DM). Members from a local Midwest adult fitness program ($n = 5$) who had been diagnosed T2DM participated in this study. Participants ranged in age from 70 to 80 years with an average age of 74 years. Four of the participants were female and one participant was male. The questions included in this study were 1.) in those with diagnosed T2DM, was a low overall HBM score correlated with a high WC? and 2.) was there a relationship between the overall HBM score and whether individuals with diagnosed T2DM met American College of Sports Medicine's (ACSM's) guidelines for aerobic exercise? WC measurements were taken by the primary researcher and the type and amount of aerobic exercise participants completed was documented as part of the demographic survey. Participants' perception of illness was analyzed using a version of the Health Belief Model, adapted from Gutierrez and Long (2011). Analysis of the data was done by first calculating Cronbach's alpha to assess internal reliability of the HBM used. Both a Pearson's Correlation Coefficient r and a p-value were then calculated to test the first hypothesis, yielding values of $r = 0.09$ and $p = 0.89$, respectively. These results both showed a non-significant relationship between WC measurement and the overall HBM score in this sample of adults with diagnosed T2DM. Similarly, the second hypothesis was assessed by both a Pearson's Correlation Coefficient r and a p-value, yielding values of $r = 0.36$ and $p = 0.55$, respectively. These results showed a non-significant relationship between the overall HBM score and whether participants met ACSM's guidelines for

aerobic exercise. Overall, the results of this study did not support either hypothesis, indicating no observed relationship between WC measurements and overall HBM score or between overall HBM score and whether individuals met ACSM's guidelines for aerobic exercise. It is recommended that future studies use a larger population in order to obtain a larger sample size, hopefully yielding more significant results. Additionally, it is recommended that future studies sample from multiple facilities and more diverse populations in order to increase the variation in age range and duration of diagnosis among participants.

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CHAPTER I

INTRODUCTION

Diabetes mellitus is prevalent across the country and the number of people who are diagnosed may continue to rise in the future. As of 2015, about 30.3 million adults in the United States have diabetes, totaling 9.4% of the population (Centers for Disease Control and Prevention, 2017). Furthermore, as of 2016, about 21.0 million adults in the United States have type 2 diabetes, totalling 8.65% of the population, and 1.3 million adults have type 1 diabetes, making up about 0.55% of the population (National Center for Health Statistics, 2017). Additionally, "diabetes, with its associated side effects, remains the seventh leading cause of mortality in the U.S. (Chaudhury et al., 2017, p. 2). There are different types of diabetes, including type I diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM). Both forms of diabetes mellitus have a relationship with insulin, either by lack of insulin in the body or the inability of the body to utilize insulin (Piemonte, 2019). Insulin is a hormone produced by the pancreas and is essential for many processes throughout the body, as it regulates the amount of glucose that is in the blood, ensuring a normal level (<120mg/dL) is maintained. By aiding in the uptake of glucose into cells to be used for energy, insulin works to stimulate transporter proteins to deliver energy to tissues to be used for their metabolic functions (Tokarz et al., 2017). If insulin is not used properly by the body, or is not recognized by necessary tissues, the amount of glucose in the blood will start to accumulate, eventually causing damage to internal organs. Blood vessels throughout the body are small and fragile, and normal hemoglobin cells are able to pass through without resistance. However, when excess blood glucose begins to build up as a result of insulin resistance, the glucose molecules attach to these hemoglobin cells and cause them to have difficulty passing through the small blood vessels (Glycemic Targets, 2016). These elevated levels of blood glucose ultimately lead to diabetes and the complications that are associated with the disease (Glycemic Targets, 2016).

Type 1 diabetes mellitus, also known as insulin-dependent diabetes, is an autoimmune condition wherein the immune system of the body attacks beta cells in the pancreas, thereby causing the pancreas to significantly reduce or even stop insulin production (CDC, 2018). Patients with T1DM must inject insulin via either a pump or pen/syringe and must also check their blood glucose levels daily to make sure there is adequate insulin available to control blood glucose. The site of injection should be rotated, as skin under each site could become stiff or lumpy from excess fat accumulation if used as the only site over time. When choosing where to inject insulin, four common areas are the abdomen, posterior of the upper arms, thighs and buttocks, as these sites usually have the largest layers of subcutaneous fat for quicker absorption. A decent layer of subcutaneous fat is required so as not to inject insulin directly into muscle tissue, as this could quickly lead to low blood glucose (hypoglycemia) (How to inject insulin, n.d.). If glucose levels are abnormal, insulin must be adjusted in order to maintain optimal levels, which will aid in preventing damage to their blood vessels from buildup of glucose molecules on the hemoglobin cells (CDC, 2018).

Type 2 diabetes mellitus, the more common form, is not an autoimmune condition, but a condition that alters how insulin is used in the body. The body may have trouble utilizing insulin correctly, or at all, and therefore, the regulation of blood glucose is inhibited. Initially the body may not realize that insulin is not being utilized, and the pancreas will begin to oversecrete insulin because it continues to sense high blood glucose levels. However, the pancreas cannot continuously create a surplus of insulin, and over time it will eventually stop making insulin all together. Therefore, blood glucose levels are not controlled which usually results in high quantities of glucose in the blood, called hyperglycemia (Riebe et al, 2017). When blood glucose is not controlled with insulin, negative effects can occur throughout the rest of body as a result of the excess glucose molecules attaching to hemoglobin cells in the blood. This causes the blood cells that were once small and agile to become larger and harder, causing damage to blood vessel walls as they pass through (Glycemic Targets, 2016). This occurs throughout the whole body and can eventually cause damage to the eyes (retinopathy), kidneys (diabetic nephropathy), nervous system (neuropathy) and heart (coronary artery disease - CAD) (Facts About Type 2, n.d.). Other major complications that can occur if T2DM is not treated properly include "renal failure, atherosclerotic cardiovascular disease (ASCVD), non-traumatic lower limb amputation, blindness, and death" (Chaudhury et al, 2017, p. 10).

Insulin resistance has many effects on the body and especially on those tissues that utilize it most frequently, such as muscle and adipose tissue. Muscle tissue accounts for approximately 60-80% of the body's uptake of glucose via insulin, while adipose tissue accounts for approximately 10% of the uptake of glucose via insulin (Wilcox, 2005; DeFronzo, 2009). When tissues in the muscle, which are insulin dependent via glucose transporter 4 protein (GLUT4), are not adequately supplied with glucose as a result of insulin impairment, they cannot carry out their proper function of muscle contraction or activity (Wilcox, 2005; DeFronzo, 2009). Adipose tissue is also insulin dependent via GLUT4 and takes up glucose when insulin is present and stimulated. The effects of insulin resistance on adipose tissue are similar to those on muscle tissue, but instead lead to increased accumulation of triglycerides in the blood. Triglycerides are a very common type of fat stored in adipose cells throughout the body that can be used as energy at a later time. This type of fat typically comes from foods, such as oils and butters (Triglycerides, 2018). An increase in this kind of fat can lead to many comorbidities, including CAD, increased risk for stroke, or diabetes (High Blood Triglycerides, n.d.) The adipose cells in individuals with diabetes and insulin resistance have improper functioning of GLUT4, where it is not translocated properly and therefore cannot function to aid insulin in glucose uptake.

T1DM and T2DM can be diagnosed by a blood sample, looking at random blood glucose (RBG), fasting blood glucose (FBG), oral glucose tolerance (OGT) or glycated hemoglobin A1c (HbA1c) tests, with the following values indicating disease: RBG > 200 mg/dL, FBS > 126 mg/dL, OGT > 200 mg/dL (after 2 hours), and HbA1c > 6.5% (American Diabetes Association [ADA], 2016). RBG simply tests the amount of blood glucose that is circulating in the body at any time of the day. This is a simple way to check glucose levels for individuals who have diabetes and allows them to determine what needs to be done to regulate it, especially if insulin injections are required, as in T1DM (ADA, 2016). FBG is typically tested in the morning immediately after waking up, before any foods or liquids are ingested. This will show the trend of blood glucose levels overnight and can indicate if glucose levels drop too low while an individual is sleeping (ADA, 2016). For patients with diabetes, taking insulin with dinner and going to bed soon after can cause a drop in blood glucose overnight, as the insulin can continue working for five to six hours after a meal. Hypoglycemia may also occur if one is physically active and/or exercises prior to going to bed, as this decreases blood glucose already (Avoiding Nighttime Lows, n.d.). If blood glucose drops too low overnight, individuals may experience symptoms including sweating, headaches or shaking, and eventually the brain will start to be affected. Individuals may start to become confused or have impairments in their speech or concentration. When blood glucose remains low for an extended period of time, serious complications can arise, including seizures, coma, or in rare cases, death (Hypoglycemia, n.d.). OGT is used to screen individuals for T2DM by using a glucose drink to observe how the body responds to glucose after eating or drinking (ADA, 2016). Blood is drawn before and after ingesting the drink to observe changes in glucose levels from a fasted state to a postprandial state (ADA, 2016). This will indicate any progression towards diabetes or if the blood glucose test already indicates diagnosis of diabetes (ADA, 2016). An HbAIC test is similar to an RBG test but instead measures the average blood glucose levels in the body over a period of time, usually about three months. This can be very useful in that it allows healthcare providers and their patients to see trends of blood glucose control over that time, indicating if changes to insulin or medications are necessary to regulate glucose. (ADA, 2016).

The above tests are extremely reliable at diagnosing diabetes. There are, however, anthropometric tests that can assess an individual's diabetes severity. These tests are essential in evaluating the disease risk, for both diagnosis and future complications, based on body composition (Fauziana et al, 2016). Waist circumference (WC) is an anthropometric test that can analyze the relative risk of developing cardiac and metabolic diseases. When discussing the best way to measure fat, Després (2012) suggested that measurement of WC is more closely associated with visceral adiposity amounts, making it a strong predictor of risk for obesity-related diseases, such as diabetes. "Measuring WC helps screen for possible health risks that come with overweight and obesity" (Dalvand et al., 2015, p. 1). In a study by Janssen et al (2004), it was observed through statistical analysis that WC alone was a better predictor of health risk from obesity than body mass index (BMI) alone. Similarly, WC has shown to be an important addition to BMI, making it a strong predictor of diabetes risk, and could be used independently to assess abdominal adiposity related to diabetes (Feller et al., 2010; Lee et al., 2017). BMI has a predictive ability for both morbidity and mortality but has not been shown to be completely reliable on its own as the sole measure of health-related risk from obesity (Janssen et al, 2004). BMI has been shown to predict central fat, including subcutaneous fat but does not differentiate between lean muscle mass or fat mass (Dalvand et al., 2015; Cerhan et al, 2015). It has long been combined with WC to get a better understanding of the risk that comes with having both a high BMI and a high WC (Janssen et al, 2004; Feller et al., 2010; Lee et al., 2017). Those individuals who have high WC values, no matter which BMI category they fall into, have a larger risk for developing health-related issues than those individuals who have normal WC values (Janssen et al, 2004; Feller et al., 2010; Lee et al., 2017). As WC is one of the most practical ways in which to assess abdominal and central adiposity, it can be used in clinical settings to evaluate risk of development of cardiovascular or metabolic diseases, as central adiposity is a primary variable in diagnosis of metabolic disease (Bray, 2004; O'Donovan et al., 2009).

When individuals who are overweight or obese do not control their weight, the compounding effects can lead to development of T2DM (Stanford and Goodyear, 2014).

With progression of weight gain and increased obesity, tissues and cells in the body become increasingly resistant to insulin, which may lead to improper glucose uptake, leading to the development of T2DM (Stanford and Goodyear, 2014). The pancreas may no longer be able to keep up with production of insulin and could stop eventually (Stanford and Goodyear, 2014). Those persons who have metabolic comorbidities, like insulin resistance, are shown to have greater body fat accumulation in their abdomen, referred to as abdominal visceral adipose tissue (Després, 2012). This type of obesity and fat accumulation has been shown to be strongly correlated with multiple "metabolic abnormalities including insulin resistance, hyperinsulinemia, glucose intolerance and type 2 diabetes mellitus" (Després, 2012, p. 1303)

Diabetes mellitus can be treated in a variety of ways, including pharmacologically and with lifestyle changes, such as diet and exercise. While all paths seem to have a positive effect on the treatment of the disease, there may be side effects to the medications used, such as vitamin deficiencies, neuropathy, anemia, pancreatitis, nausea, vomiting, or allergic reactions at the injection site. These are seen primarily in those persons with T2DM and may cause them to discontinue use because they do not want these adverse effects (Thent et al., 2013; Chaudhury et al., 2017). However, individuals with T1DM cannot discontinue use of their medications, as their bodies do not create insulin, hence the name "insulin-dependent diabetes" (Medication, n.d.).

Another form of treatment for diabetes is exercise. Exercise has been heavily researched as a viable treatment option for patients with diabetes, especially patients with T2DM, whose disease usually presents itself in adulthood (Thent et al., 2013). Aerobic exercise, such as swimming, biking, walking, etc., has been shown to have a profound positive effect on T2DM management (Colberg et al., 2010). Including higher intensity aerobic exercise has led to more improvements in blood glucose control, FBG and triglyceride levels, while also aiding in the prevention of buildup of fatty plaque and other materials throughout vessels, decreasing the risk of developing cardiovascular complications from diabetes (Thent et al., 2013). Non-contraindicated individuals diagnosed with diabetes mellitus, either type 1 or type 2, should be encouraged by their healthcare provider to participate in more frequent daily activity and more structured exercise routines to improve any complications or comorbidities from diabetes. "According to the U.S. Department of Health and Human Services, adults ≥ 18 years of age should do a minimum of 150 min/week of moderate intensity exercise or 75 min/week of vigorous physical activity spread over at least 3 days/week" (Chaudhury et al., 2017, p. 3). This amount of exercise has been shown to decrease morbidity and mortality in those individuals with diabetes mellitus (Riebe et al., 2017).

Exercise causes a physiological change to the way blood glucose is used or excreted by the body. When muscle tissue contracts, the ability of insulin to properly perform its job of bringing blood glucose into the cells is enhanced. This can be caused by multiple factors, including increased delivery of glucose to the cells and increased permeability of the cell membrane to glucose (Rose & Richter, 2005; Colberg et al., 2010). During higher intensity exercise, perfusion of blood into muscle tissue elevates, leading to increases in glucose uptake into that tissue for energy (Rose & Richter, 2005; Colberg et al., 2010). More glucose is then used by the skeletal muscle tissues for energy during contraction, resulting in lower overall blood glucose levels (Thent et al., 2013). Lifestyle modifications, such as aerobic exercise, are a cost-effective way for individuals with T2DM to manage their disease. Previous studies have shown that the risk for development of diabetes decreased by about 58% in three years in people who incorporated lifestyle modifications into their weight management routines (Chaudhury et al., 2017; Yang et al., 2019). Aerobic exercise can be performed at any time, without the need for a gym or exercise equipment, and with no side effects such as those that can be seen with pharmacological treatment. Along with the added cardiovascular and metabolic benefits seen with aerobic exercise, such as increased oxygen consumption and reduction of metabolic risk factors, aerobic exercise has also been shown to improve blood pressure, levels of blood glucose, body weight, mortality and overall quality of life (Stanford and Goodyear, 2014).

Alongside the physical assessment of risk, there is also a psychological aspect to understanding diabetes management. Individuals may view their disease severity, self-efficacy to control their disease, and the potential self-care options differently and this can be a determining factor into whether they take initiative to care for and manage the disease, or if they allow their disease to negatively affect their health and well-being. This can be evaluated by assessing perception of disease, including their beliefs about management and control of the disease (Harvey and Lawson, 2009). It has been observed that individuals with diabetes take better care of themselves, either via diet, exercise or medication adherence, if they have self-efficacy that the treatment being performed is helping relieve symptoms or prevent further complications and comorbidities (Strauss et al., 2015).

The Health Belief Model (HBM) is a behavioral model that has been used as a way for researchers and healthcare professionals to assess a patient's perception of the severity of an illness, ability to control the illness and potential benefits and barriers to performing self-care methods. "Health Belief Model (HBM)...is one of the most effective models of health education which mainly focuses on disease prevention" (Dehghani-Tafti et al, 2015, p. 34). Therefore, it can be used in a research setting to understand how individuals feel about their disease, how the disease is affected by their perceived control of it, and how individuals may act towards the management of that disease.

Dehgani-Tafti and colleagues (2015) assessed the factors that may influence self-care behaviors performed by patients with diabetes based on a behavioral model similar to the one used for the current study. In their model, they assessed perceived benefits, perceived barriers, perceived severity and susceptibility, perceived self-efficacy, social support, and self-care behaviors. It was concluded that patients with diabetes who believed they were more susceptible to developing complications from diabetes had higher levels of self-care behaviors regardless of what barriers they perceived they had towards performing those self-care behaviors (Dehgani-Tafti et al., 2015). In this way, implementing the HBM into the evaluation of individuals with diabetes may help health and exercise professionals structure a program based around the thoughts of the patient, potentially aiding in better management and self-control of the disease.

Statement of the Problem

The purpose of this study was to observe the relationship between waist circumference (WC), amount of aerobic exercise performed weekly and overall Health Belief Model (HBM) score in adults with diagnosed type 2 diabetes mellitus (T2DM). WC measurements are increasing in adults as years progress and "the individual perception of obesity as a health risk is vital to prevent development of obesity among the normal weight in the future" (Visscher et al., 2017, p. 55). When WC increases, so does abdominal adiposity, leading to increased metabolic risk factors (Visscher et al., 2017). A better understanding of how individuals with T2DM perceive their disease may aid in more optimal program development for the exercise professional, which may motivate individuals to perform more self-management activities and promote overall control of diabetes. Assessing whether the HBM overall score is correlated with the amount of aerobic exercise that individuals perform and whether or not they are meeting ACSM's guidelines for the recommended amount of aerobic exercise needs to be further researched, as perception of illness can be a predictor of performance of self-care behaviors such as exercise (Harvey and Lawson, 2009). This may help exercise professionals increase the desire of individuals to make such lifestyle changes that will positively affect not just the disease itself, but also the perception individuals have on their ability to manage their disease. It has been observed that in obese individuals who were actively looking for ways to improve their condition, perceived health status was a stronger personal assessor of their quality of life than their body weight (Visscher et al., 2017). While it may seem as though patients with diabetes should know how obesity and weight affect their disease, those who are obese often underestimate their actual body weight and overweight persons seem to nullify their weight status as affecting their disease (Visscher et al., 2017). A greater understanding of the connection between health risk status (measured by WC), patients' performance of self-care behaviors that could improve their condition (measured by ACSM guidelines for aerobic exercise) and patients' perceptions of how their disease affects them (measured by HBM) is needed in order to better treat these patients.

Research Questions

1. In those with diagnosed type 2 diabetes mellitus, was a low overall HBM score correlated with high WC? (M 100-120 cm, W 90-110 cm)
2. Was there a relationship between the overall HBM score and whether individuals with diagnosed T2DM met ACSM guidelines for aerobic exercise?

Hypotheses

1. It was hypothesized that a lower HBM score would be shown in those persons who had high WC measurements.
2. It was hypothesized that persons who met aerobic exercise recommendations based on ACSM guidelines had a higher overall HBM score.

Rationale

Diabetes is a worldwide issue that has been studied in great depth. Waist circumference is used to evaluate abdominal obesity and therefore can aid in prediction of risk for obesity-related diseases, such as T2DM (Després, 2012). It has been shown to be effective at predicting abdominal obesity and the related risk of disease even without measuring body mass index, making it one of the most common anthropometric measurements of obesity (Measuring Obesity, 2016). The correlation of WC to diabetes has been studied multiple times, as abdominal obesity is highly linked to increased incidence of T2DM (Adegbija et al., 2015; Dalvand et al., 2015; Zhang et al., 2008).

Healthcare professionals likely have a strong influence on their patient's abilities to learn about disease management. When initially diagnosed with diabetes, it is important that the practitioner-patient communication be clear and straightforward, as this important step may guide patients to begin self-management early on (Parry et al., 2004). Depending on the quality of communication and care patients received from their primary provider, patients may view their diagnosis as approachable and may therefore begin adapting their lifestyle to their condition. On the other hand, they may view it as hopeless and be unsure if treatment will be beneficial or detrimental (Parry et al., 2004; Manski-Nankervis et al., 2014). By providing information regarding self-care behaviors, such as exercise and physical activity, and ways to prevent concurrent symptoms of diabetes, patients are more likely to succeed in their abilities to treat their disease outside of the provider's office (Parry et al., 2004; Manski-Nankervis et al., 2014). This is an important aspect of disease management, as the physician or healthcare provider will not always be present to supervise individuals' behaviors.

Aerobic exercise has been shown to be therapeutic for patients with diabetes, aiding in improved use of insulin, increased secretion of insulin, reductions in high glucose levels, along with the added prevention of progression of T2DM and development of comorbid conditions (Holloszy, 2005; Yang et al., 2019, Zhang et al., 2008). Individuals who have incorporated aerobic exercise into their lifestyles and have participated in long-term exercise can have significant increases in the transporter proteins, GLUT-4 proteins, that bring glucose from the blood into the tissues and muscle cells that use it for energy (Hussey et al., 2012). Additionally, physical activity and exercise are very important factors in weight loss and management of insulin resistance and diabetes, however many people do not partake in the recommended amounts of aerobic exercise, with only 53.3% of adults in the U.S. over 18 years of age meeting guidelines (FastStats, n.d.).

In order for individuals to be motivated to begin practicing behaviors of self-care such as aerobic exercise, barriers towards exercise must first be explicitly understood. Perception of disease is a predominant factor in predicting behavior changes towards management of a disease, such as diabetes. Kugbey et al. (2017) found that patients who thought their diabetes was threatening practiced less self-care behaviors than those who had a lesser perception of threat from their illness. If individuals obtained a high score on the illness perception questionnaire used, they were indicated to perceive their illness as threatening, meaning they felt it was a fatal and dangerous illness that would negatively affect their health and survival. Conversely, those patients who showed high levels of knowledge of diabetes self-care behaviors engaged in more of those behaviors as a result (Kugbey et al., 2017). Participants who had a more threatening view of their diabetes may have felt that there was no benefit to partaking in self-care behaviors, as they had a fatalistic view of how diabetes would affect them, regardless of the management strategy (Kugbey et al., 2017). Participants in a study conducted by Abubakari et al. (2011) showed an association between perception of severe consequence of diabetes and low adherence to exercise as self-management, with additional low exercise adherence also associated with participants who worried more frequently about diabetes and its effects on them.

The HBM is one of the most commonly used behavioral theories that evaluates the intentions of individuals to pursue health behaviors based on their perceptions (Orji et al., 2012). When the HBM was originally created, its primary goal was to assess the perception of illness and evaluate why individuals did not pursue healthy behavior changes to prevent future health complications (Orji et al., 2012). Now it can be used as a tool to help newly diagnosed patients or persons who have had a long diagnosis understand what may be holding them back from performing self-care behaviors. As cited by Harvey and Lawson (2009), the way individuals view the effectiveness of a particular treatment on diabetes is strongly related to their adherence to self-management behaviors, such as exercise (as cited in Harvey and Lawson, 2009, p. 7).

Limitations of the Study

Firstly, this study was performed using a convenience sample and therefore was limited by the number of members from a local Midwest adult fitness program who had diagnosed T2DM or who wanted to participate in the study. However, the immediate accessibility of the primary researcher to the population mentioned above made this an ideal study group. Additionally, because of the use of a convenience sample, age range in the participant population was also limited. Lastly, participants have been diagnosed with T2DM at different times, making this a limiting factor and excluding it as a variable in this study.

Timing of diagnosis and duration of disease may impact the perception that an individual has towards diabetes and how it affects them. For individuals who are first diagnosed with diabetes, it is important that the healthcare provider delivering the diagnosis be clear and upfront about the specific diagnosis and the future treatment of disease (Parry et al., 2004; Manski-Nankervis et al., 2014). In a study conducted by Parry et al. (2004), newly diagnosed patients who were sent from their primary provider to a diabetes specialist perceived their disease to be a priority and that they would receive the education and treatment they needed to control their newly diagnosed diabetes. On the other hand, those patients who perceived their diabetes diagnosis as a potentially serious condition and who had to wait for an appointment to see a specialist were more concerned about their diagnosis (Parry et al., 2004; Manski-Nankervis et al., 2014).

CHAPTER II

LITERATURE REVIEW

Assessment of Risk

There are many body composition assessments that can be performed in order to identify an individual's risk of disease. These include body mass index (BMI), percent body fat by skinfolds, waist-to-hip ratio (WHR), waist circumference (WC), and a variety of other, more intensive tests. All assessments have benefits and drawbacks when looking at predicting risk of disease, and all are slightly varied in their analysis of body composition.

Body Mass Index

Body mass index simply uses a ratio of weight, in kilograms, to height, in meters squared. This ratio is then categorized as underweight, normal, overweight or obese. While this is a very easy tool for assessing potential risk for disease based on weight, it only gives a vague estimate of risk, as it does not consider age, gender, muscle mass or body fat percentage (CDC, n.d.). It has been shown, however, to be highly associated with risk for development of diabetes or prevalence of diabetes (Lee et al., 2017; Pham et al., 2014). BMI has been studied to be more useful and a better overall predictor of disease risk when combined with various other anthropometric measurements, such as those listed above (Janssen et al., 2004).

Waist Circumference

Similar to BMI, waist circumference can be an important assessment to measure the risk of developing metabolic diseases, such as diabetes. It is commonly used as the best measure of body fat distribution in a clinical setting and has been shown to be positively correlated with all-cause mortality (Cerhan et al., 2014). As concluded by Janiszewski, Jansen and Ross (2007), participants were more likely to have diabetes if they had a high WC as compared to those participants who had a lower WC. Even those participants who had moderate to high WC measurements had a higher predictive incidence of diabetes than others in the study. WC can also be directly linked to obesity, as there have been studies showing a positive relationship between WC and prevalence of obesity (Dalvand et al., 2015; Zhang et al., 2008). Because WC is used to assess total adipose tissue and visceral adipose tissue in the abdominal area, it can be used as a predictor of disease risk, including risk for development of diabetes (Dalvand et al., 2015). An excess amount of this visceral adipose tissue in the abdominal area can cause many issues, including insulin resistance, hyperinsulinemia, glucose intolerance, and T2DM, among many other complications (Després, 2012). Therefore, it could be indicated that WC could be a strong indicator of diabetes disease risk in patients who have high measurements, as excess amounts of total abdominal adipose tissue can be seen to be highly predictive of increased risk for T2DM (Després, 2012). WC may therefore be a good first step in assessing those persons who are highly obese or on the higher end of the obesity index, leading to further investigation into their overall health and risk of disease, (Janssen et al., 2004).

BMI vs WC

While both BMI and WC have been studied separately as ways to measure risk for obesity-related disease, they have also been studied together to observe the reliability and effectiveness of these two body composition measurements combined (National Institutes of Health, 2000; Chinedu et al., 2013). It has been suggested that combining

WC with BMI has a greater predictive capability for health-related risk than BMI does alone (Janssen et al, 2004). Because BMI assesses morbidity and mortality from obesity and WC assesses abdominal obesity, they have been used in conjunction to increase reliability of risk measurement (Janssen et al, 2004; Feller et al., 2010). However, BMI and WC have independent relationships in their predictiveness of health-related obesity comorbidities (Feller et al., 2010).

When WC is used in addition to BMI, it is shown to expand the variability of risk that can be predicted from this combined measurement, but the opposite situation cannot necessarily be proven true. For example, when WC is measured, and BMI is added as a second variable, the BMI value does not necessarily increase the predicted risk observed (Janssen et al, 2004). As a result of their study, Janssen et al (2004) concluded that WC alone was itself a better predictor of obesity-related health risk than was BMI and WC combined, stating that "overweight and obese persons have a health risk that is comparable to that of normal weight persons with the same WC value" (p. 381).

Even though these measurements of body composition can be easily performed for assessment of potential health risk, there are few facilities that implement them on a regular basis. As a result of a study done in Australia, only 22% and only 5% of patients at general healthcare facilities had BMI or WC measurements taken, respectively (Lee et al., 2017). This indicates that either healthcare providers are not educated on the importance of these measurements as predictors of risk or they are simply not taking enough time with each patient to fully assess all parameters of disease prevention (Lee et al., 2017).

WC can be beneficial when used alongside other anthropometric measurements of diabetes risk, however, it can be shown to be equally reliable independently as well, making it a simple measure in a clinical setting (Janssen et al., 2004; Feller et al., 2010; Bray, 2004).

Self-management of Diabetes

There are many ways to manage diabetes and individuals with diabetes mellitus should routinely visit their primary physician and various diabetes specialists to discuss these management strategies. The main self-management strategies include pharmacological intervention, diet and physical activity/exercise, all designed to control glucose and hopefully decrease severity of complications from diabetes (Chatterjee & Davies, 2015).

In 1926, it was understood that there were no other treatments for diabetes outside of a proper diet and use of insulin, as no other medications had been found to affect diabetes or its symptoms at that time (Chatterjee & Davies, 2015). Since then, there have been great strides in the management and treatment of both types of diabetes.

The pharmacologic treatment of diabetes has evolved from solely utilizing insulin as the main treatment for both T1DM and T2DM to understanding the mechanisms that cause each type and how medication can be therapeutic for treatment for each individual. There are eight mechanisms that are shown to lead to hyperglycemia in individuals with diabetes. They include: "reduced insulin secretion from pancreatic β cells, increased glucagon secretion from pancreatic α cells, increased hepatic glucose production, neurotransmitter dysfunction and insulin resistance in the brain, increased lypolysis, increased renal glucose reabsorption, reduced incretin effect in the small intestine and reduced glucose uptake in peripheral tissues (skeletal muscle, liver, adipose tissue)" (Chatterjee & Davies, 2015, p. 613). All of the above, in one way or another, affect blood glucose levels and can have detrimental effects on the body, especially in an individual with T2DM. The main goal when developing medication treatment for diabetes was to act upon one or more of these mechanisms (Chatterjee & Davies, 2015). Insulin is currently the best and most effective treatment for individuals with T1DM and can be administered with multiple injections or with the use of an insulin pump, which gives a continuous supply of insulin when needed (Chatterjee & Davies, 2015).

Even though medication can aid in controlling diabetes complications, exercise, regardless of the amount of weight loss a person may achieve, has been shown to lower HbA1C values, leading to decreases in overall blood glucose and improvements in glucose control in patients with diabetes (Chaudhury et al., 2017). As endorsed by the U.S. Department of Health and Human Services, exercise is recommended to be performed regularly (minimum 150 min/week of moderate intensity exercise or 75 min/week of vigorous physical activity spread over at least three days/week) and is considered fundamental to the prevention and management of diabetes, both for individuals who have diabetes or who have prediabetes (Chaudhury et al., 2017).

Aerobic Exercise and Diabetes

All forms of activity are good for the body and for those individuals with T2DM, exercise can be especially beneficial (Colberg et al., 2010). The benefits associated with regular exercise include, but are not limited to, improvement in blood glucose levels, decreased insulin resistance, increased insulin secretion, and numerous positive effects on cardiovascular functioning (Yang et al., 2019). Alongside these benefits is the overall benefit of weight management, with many forms of exercise leading to weight loss if performed as recommended and for a consistent time period. This benefit can lead individuals with T2DM to better overall health and the comorbidities associated with T2DM may be diminished or even eliminated because of weight loss (Yang et al., 2019).

T2DM is characterized by defects in the ability of organs to properly utilize insulin, also known as insulin resistance, leading to increases in blood glucose. One of the mechanisms by which this occurs is a decrease in expression of the glucose transporter 4 (GLUT4) protein, which has the responsibility of sending glucose molecules towards the surface of the cell to be used by skeletal muscle for energy. (Yang et al., 2019). Skeletal muscle, being the largest muscular system in the human body, accounts for about one third of the total energy metabolism performed at rest and can account for up to 90% of the energy metabolism performed during exercise (Lee & Song, 2018). The GLUT4 protein can be triggered to action by insulin, so when insulin is not able to be used properly as a result of diabetes, the protein will not be able to do its job, therefore resulting in the accumulation of blood glucose.

Exercise has been shown to counteract this effect and can actually enhance the effects of the GLUT4 protein, thereby increasing the regulation of glucose (Stanford & Goodyear, 2014). Exercise decreases insulin resistance and therefore allows insulin to be utilized more readily by the muscle tissues. These two combined factors allow the GLUT4 protein to be able to function properly and draw glucose towards insulin, which transports the glucose to tissues for use. Exercise has also been shown to increase insulin sensitivity, which is mediated by the proper translocation of more GLUT4 to the cell surface, particularly in muscle cells (Holloszy, 2005). With the addition of physical activity amounting to about 150 minutes per week, progression or even development of T2DM can be hindered and can be just as or more effective than programs that alter diet alone (Colberg et al., 2010).

Another way that exercise can improve the effects and diminish the risk of development of T2DM is through the modification of mitochondria in skeletal muscle cells. Mitochondria are considered the powerhouse of cells and supply energy to tissues. Their main responsibility is to oxidize glucose- and fat-derived metabolites to create adenosine triphosphate (ATP), which is used as an energy source throughout the body (Lee & Song, 2018). When mitochondria are defective, they are not able to utilize glucose properly, leading to decreases in energy availability to produce ATP in adequate quantities (Lee & Song, 2018). Skeletal muscle is the primary tissue that utilizes glucose and is therefore the main tissue affected by mitochondrial dysfunction and insulin resistance. When exercise is implemented, mitochondria content increases, and the skeletal muscle undergoes changes to its structure leading to increases in insulin sensitivity and glucose uptake by the muscle (Stanford & Goodyear, 2014). Stanford and Goodyear (2014) observed that both moderate-intensity exercise and endurance exercise training are shown to have beneficial effects on individuals with T2DM, in the way their bodies utilize insulin and in how the organs and organelles are better able to carry out their proper functions.

ACSM Guidelines for Aerobic Exercise

The American College of Sports Medicine (ACSM) is an organization that works to evaluate and identify the standards that are used for exercise professionals. Based on scientifically based standards, this guideline is used in the professional world to guide professionals who prescribe exercise programs and who perform exercise testing for all populations (Riebe et al., 2017). According to the ACSM's guidelines, individuals with diabetes should participate in the following recommended guidelines for aerobic exercise: frequency of three to seven days each week, with the intensity at moderate to vigorous levels with ratings of perceived exertion between 11 to 17 on a scale of 6 to 20 for at least 150 minutes each week (moderate intensity) or at least 75 minutes each week (vigorous intensity), focusing on prolonged, rhythmic activities using large muscle groups (e.g. walking, cycling, swimming) (Riebe et al., 2017). Additionally, for individuals to be classified as being current exercisers, they must "have a history of performing planned, structured physical activity of at least moderate intensity for at least 30 minutes on three or more days per week during the past three months (Riebe et al., 2017, p. 28).

Even though many individuals understand the health benefits of physical activity and exercise, there is still only half of the U.S. population (51.6%) that partake in any of these activities, and on a global level, just over half (68.9%) of adults are physically active (Riebe et al., 2017). Globally, among individuals with diabetes, those who engaged in any sort of exercise self-management was estimated to be approximately 40%, while in the U.S., only 28.2% of individuals with diabetes participated in the recommended amount of physical activity (Hamasaki, 2016).

Cognitive-Behavioral Strategies

There are many theories and models that create strategies for the promotion of healthy lifestyle behaviors in persons with disease and are "focused on changing how an individual thinks about themselves, their behaviors, and surrounding circumstances and how to modify their lifestyle" (Artinian et al., 2010, p. 424). One of the main components of these behavioral strategies is the influence of self-efficacy, or the confidence an individual has towards performing the actions to make behavioral changes (Riebe et al., 2017). Efforts to improve an individual's self-efficacy by promoting confidence during interventions can lead to more success in behavior changes (Artinian et al., 2010). Individuals generally continue participation in healthy behaviors, such as exercise, when they have had positive, successful experiences with that behavior and find that this increases their confidence that they can perform that behavior (Riebe et al., 2017). In a study conducted by Leone and Ward (2013), obese and non-obese women were compared in their perception of exercise benefits and barriers. It was found that the group of obese women had lower overall self-efficacy scores than did the group of non-obese women. This was thought to be mediated by the finding that obese women were found to have a slightly more significant relationship with the barrier "I am uncomfortable with how I look while exercising or wearing exercise clothing" (Leone & Ward, 2013, p. 6). Obese women were also more likely to state that they did not enjoy exercising and that they only exercised when they were looking to lose weight. They were also more likely to state that their weight affected their ability to exercise when compared to the non-obese women (Leone & Ward, 2013). According to their results, Leone and Ward (2013) determined that although exercise was seen as a way for these women to lose weight, the obese women who had previously experienced no success with exercise and weight loss were shown to be far less motivated to continue. As exercise has been shown to reduce the risk of development of type 2 diabetes, it should be the intention of all health interventions to understand the barriers individuals have towards exercise and educate individuals about the benefits exercise may have, especially in regards to reducing the development of disease (Leone & Ward, 2013; Colberg et al., 2010; Hamasaki, 2016).

Perception of Illness

Individual perception of illness may be an influencing factor towards participation in self-care behaviors (Harvey and Lawson, 2009). In order to understand the reasons behind pursuing or not pursuing a self-care regimen, it is important to assess how individuals perceive their illness in terms of severity and how confident they are at controlling their disease on their own or with guided treatment. This can be done using many models of assessment, including the Health Belief Model, Brief Illness Perception Questionnaire, or the Theory of Planned Behavior, just to name a few. For this study, only the Health Belief Model was used in the assessment of the proposed questions.

The Health Belief Model (HBM) is used to assess why individuals do not pursue activities related to self-care when they have an illness, such as diabetes. By assessing certain variables related to engaging in self-care behaviors, researchers can establish long-term and short-term interventions that will assist the patient in performing self-management acts. The six constructs that are assessed in the HBM include: perceived susceptibility, perceived severity, perceived benefit, perceived barrier, cues to action, and self-efficacy (Orji et al., 2012). This model of assessing perception has been changed and altered in many different studies to best evaluate the population of interest (Orji et al., 2012; Kharrazi et al., 2009; Gutierrez and Long, 2011). The primary intention of this model was to "improve public health by understanding why individuals do not take preventive measures to health promotion" (Orji et al., 2012, para. 7). Originally, the HBM consisted of the first four constructs (susceptibility, severity, benefit, and barrier).

Together, perceived susceptibility and perceived severity assess the perceived threat that individuals feel development of a disease is to them. Perceived benefit and perceived barrier collectively evaluate the behavior an individual may take in order to prevent or slow complications from a disease. It was not until years later that cues to action and self-efficacy were added and they were seen to add tremendous validity to this method of behavioral analysis (Orji et al., 2012).

Perceived benefit refers to individuals' belief that partaking in a healthy behavior, such as exercising, will be influential in preventing a disease, such as diabetes or diabetes related comorbities. In this way, individuals will adopt those healthy behaviors out of the belief that doing so will better their quality of life and prevent the threatening conditions (Orji et al., 2012).

Perceived barrier, on the other hand, assesses whether individuals with a condition believe that the potential barriers to adopting healthy behaviors outweigh the benefits they may accumulate from doing that act. For example, if individuals with diabetes believe that, although exercise may improve their condition and prevent future comorbities, it is too expensive to join a gym and they would not have time to go as often as recommended, they are far less likely to partake in that healthy behavior, even though they know the benefits it may have on their condition (Orji et al., 2012).

Perceived susceptibility assesses whether individuals feel that they are likely to develop a disease if they participate or do not participate in a certain act (Orji et al., 2012). Therefore, if individuals believe they are more likely to develop diabetes because they are being inactive, they are more likely to increase physical activity and exercise to negate that likelihood of developing diabetes. It has been studied that those who perceive their susceptibility to be higher will be more likely to participate in behaviors that will decrease their perceived risk. (Orji et al., 2012). This perception for how likely a person feels they are to develop a disease has been shown to be predictive of many positive behavioral changes, including an increase in the amount of exercise performed (Orji et al., 2012).

Perceived severity assesses if individuals, who may think they are susceptible to a certain disease, believe the negative outcomes from developing that disease are strong enough to push them to take action. For example, if someone feels as though being inactive makes them more susceptible to developing diabetes and also feels that the negative consequences from developing diabetes would have a severe impact on them, they are more likely to start being more physically active and engage in exercise to postpone development of diabetes (Orji et al., 2012).

Alongside the aforementioned primary constructs, there are two additional constructs that have been added to the HBM that contribute to its overall prediction of perception of illness severity that are also used in the current study (Orji et al., 2012; Gutierrez and Long, 2011).

Cues to action is an additional variable that consists of perceived locus of control, either from internal sources, external sources, or from chance. It observes how external factors, such as other individuals, or internal factors, such as bad body image, affect individuals' change in behavior, either towards or against something beneficial. It also observes whether control is affected solely by chance (Orji et al., 2012). In the case of this study, perceived locus of control from chance observes a patient's ideas about whether they will have control of their disease or if they will inevitably have complications from their disease, no matter what self-care behaviors they participate in.

Lastly, self-efficacy adds the element of belief that individuals can or cannot perform the behavior they wish to, such as beginning to exercise for health. When individuals believe that they can do a task, they are more likely to do that task; whereas if they do not believe they can do it, they are less likely to do that task for the shear fact that they do not believe they can (Orji et al., 2012; Rivera et al., 2018). This can be related to exercise – if individuals do not feel that they can routinely participate in exercise because of barriers they perceive to be blocking them, they will not likely exercise and may then have negative consequences related to their disease.

In summary, there are many ways to assess risk of development of diabetes in individuals, including BMI and WC measurements. Aerobic exercise has been shown to have positive impacts on patients with diabetes and can decrease the detrimental effects diabetes has on the body (Hamasaki, 2016; Thent et al., 2013; Yang et al., 2019). In conjunction with determination of risk is the evaluation of psychological effects of diabetes, including the perception individuals have toward diabetes and how this may influence their behaviors associated with it. Assessing how measurement of risk is related to perception of illness and the behaviors individuals take toward overcoming any illness complications may be useful in educating and motivating adults with T2DM to perform self-management strategies to decrease complications from diabetes (Kugbey et al., 2017).

CHAPTER III

METHODOLOGY

This chapter describes the ways in which this study was performed, including the population that was used and how data was collected and analyzed. The purpose of this study was to observe the relationship between waist circumference (WC), amount of aerobic exercise performed weekly and overall Health Belief Model (HBM) score in adults with diagnosed type 2 diabetes mellitus (T2DM). The main questions for this study were:

- In those diagnosed with type 2 diabetes mellitus, was a low overall HBM score correlated with high WC (M 100-120 cm, W 90-110 cm)?
- Was there a relationship between the overall HBM score and whether individuals with diagnosed type 2 diabetes mellitus met ACSM's guidelines for aerobic exercise?

Subjects

Participants were recruited from a local adult fitness program in the Midwest. Individuals in this program who had T2DM were first identified by reviewing health history charts of all members in the program, looking for medical history that stated the diagnosis of T2DM. Members were either approached during adult fitness open exercise hours by the primary researcher or were called by the primary researcher and asked if they were interested in participating in the study.

Measures

Data was collected by the primary researcher between May 2019 and June 2019. Informed consent was obtained from each participant prior to the collection of data.

Participation was completely voluntary. Included on the informed consent was the summary of the purpose of the study, the procedures to be performed, information regarding potential risks or discomforts and also potential benefits from participating, a statement regarding participation and opportunity to withdrawal at any time and contact information of the study investigators (Appendix A). Demographic information, including age, gender and information regarding the type and duration of aerobic exercise performed weekly, was also collected from each subject (Appendix B). Waist circumference measurements, information regarding the type and duration of aerobic exercise performed each week and the HBM questionnaire were all collected by the primary researcher.

Waist Circumference

Waist circumference was measured by the primary researcher to ensure the most recent and accurate numbers were used for this study, along with ensuring the same method of measurement was used. Waist circumference was taken around the smallest circumference of the waist, between the xiphoid process and the umbilicus (Riebe et al., 2017). Measurements were taken with a Gulick II measuring tape (model number 67020). This measuring device had a non-stretch, retractable fiberglass tape. The start of the measuring tape was placed at the smallest point on the right side of the waist of each participant and wrapped around the waist parallel to the floor. Participants were asked to place their feet together and their arms at the sides of their body. They were then asked to take one normal inhalation and normally exhale immediately before recording of the waist measurement by the investigator. Exactly four ounces of tension were applied by pulling the tension device at the end of the measuring tape to show one red bead and align the silver disk with the edge of the black tube (Appendix F). Exact measurement of the WC was determined by aligning the zero line of the tape with the associated tape graduation mark. Measurements were recorded in centimeters to the nearest tenth. Each WC measurement was ranked for risk using the ACSM Guidelines risk criteria for WC in adults (Riebe et al., 2017) (Appendix E).

ACSM Aerobic Exercise

Aerobic exercise was assessed using the standard recommended guidelines from the American College of Sports Medicine (ACSM) that constitute an individuals' classification as currently exercising. "As designated, participants classified as current exercisers should have a history of performing planned, structured physical activity of at least moderate intensity for at least 30 minutes on three days or more per week during the past three months." (Riebe et al., 2017, p. 28). This was evaluated by a yes or no question on the demographic survey given to all participants on the day of data collection (Appendix B). Participants were also asked to self-report the type and quantity of aerobic exercise they performed each week, if any, and the duration of each aerobic exercise session for further clarification.

Health Belief Model

The Health Belief Model is widely used to assess patient perception of illness, particularly "why individuals fail to undertake preventive health measures" (Orji et al., 2012, p. 2). It has been used for many different disease populations, including diabetes and cardiac rehabilitation (Riebe et al., 2017; Jones et al., 2015; Scarinci et al., 2012). The main constructs assessed using the HBM are perceived benefit, perceived barrier, perceived susceptibility, perceived severity, cues to action (perceived locus of control internal, external, and chance), and self-efficacy. This tool is easy to use in any population and provides a simple way of analyzing perception of health and behaviors towards health risk. While the four major constructs of the HBM, benefits, barriers, susceptibility, and severity, are important foundations for predicting whether a person will pursue healthy behaviors or not, these are not the only variables that influence behavior change (Orji et al., 2012). Additionally, the constructs cues to action and self-efficacy add tremendous validity to this method of behavioral analysis, evaluating whether attitude toward change in behavior is influenced by outside or inside factors or by chance, and whether individuals believe they are able to perform the behavior (Orji et al., 2012). The HBM questionnaire used by Gutierrez and Long (2011) separated cues to action into three separate constructs (perceived locus of control external, internal, chance), which was also done in the current study. They further confirmed the reliability of the constructs of perceived locus of control internal and external and diabetes self-efficacy, observing Cronbach alphas that were similar to previous research in populations with diabetes. Additionally, the construct of perceived diabetes control was used in this current study to observe an overall perception of how participants feel they are managing their disease. For the current study, a total of nine constructs were used to evaluate perception of illness in adults with type 2 diabetes mellitus.

The HBM survey used for this study (Appendix C) was adapted from the survey used in a study by Gutierrez and Long (2011) (Appendix D) which evaluated the validity and reliability of previously created HBM scales on veterans with diabetes and serious mental illness. Gutierrez and Long (2011) found that the HBM scales were both reliable and valid in prediction of diabetes specific perceptions of illness. For the purposes of this study, the following modifications were made: the construct "perceived side effects" was excluded as it did not influence or add supporting data to the research questions for this study; in the first three constructs used ("perceived benefits, perceived general barriers, perceived susceptibility"), the phrase "diabetes medication" was replaced with aerobic exercise, as this was related to the research questions of this study.

The following Likert scales were used to evaluate each of the nine constructs and their individual statements: perceived benefits consisted of four items scored from 1 "strongly disagree" to 5 "strongly agree"; perceived general barriers consisted of five items scored from 1 "strongly disagree" to 5 "strongly agree"; perceived susceptibility consisted of two items scored from 1 "very unlikely" to 5 "very likely"; perceived severity consisted of two items scored from 1 "not at all severe" to 5 "extremely severe"; self-efficacy consisted of four items scored from 1 "not at all true" to 7 "very true"; locus of control consisted of six items scored from 1 "disagree" to 6 "agree"; perceived diabetes control consisted of one item scored from 1 "not very well" to 5 "very well".

Scoring of the HBM questionnaire for the purpose of this study was done using the numerical ratings of each item, as listed above, with overall higher ratings signifying a positive attitude towards performing healthy behaviors. A Cronbach's alpha was calculated to determine the internal reliability of the questionnaire for the purpose of assessing participants' perception of diabetes. The frequency of answers for each question was evaluated, including the percentage of participants from the total who answered for each question. Individual scores, means, standard deviations, and percentages of each construct were then calculated.

CHAPTER IV

RESULTS

This study was approved by the Institutional Review Board of Eastern Illinois University prior to contacting participants and the subsequent collection of data. The purpose of this study was to observe the relationship between waist circumference (WC), amount of aerobic exercise performed weekly and overall Health Belief Model (HBM) score in adults with diagnosed type 2 diabetes mellitus (T2DM).

Subject Characteristics

A total of 11 members from a local Midwest adult fitness exercise program were identified as being diagnosed with T2DM. Of those identified, five members voluntarily participated in this study for an overall response rate of 45%. Participants' ages ranged from 70 to 80 years, with an average age of 74 years. Of these five participants, four were female and one was male.

Waist circumference was assessed in this study. Table 1 shows the WC measurements of each participant and the associated risk according to the American College of Sports Medicine's (ACSM's) guidelines (Riebe et al., 2017). All participants in this study were classified as either high (M 100-120 cm, W 90-110 cm) or very high (M >120cm, W >110 cm) risk. The average WC of the participants was calculated to be 103.9 cm.

Table 1

Waist Circumference Measurements of Participants and Associated Risk According to the ACSM's Guidelines

Participant	WC Measurement (cm)	Risk
P1 (W)	103.5	High
P2 (W)	94.0	High
P3 (W)	116.0	Very high
P4 (W)	91.0	High
P5 (M)	115.0	High

Note. P = participant; W = women; M = men

Of the participants (*n*=5) three met the recommended guidelines for being physically active, completing aerobic activity on at least three days each week for a minimum of 30 minutes each session over at least the last three months. The remaining two participants did not partake in any aerobic exercise on a regular basis that would qualify them as being physically active according to the ACSM's guidelines. Table 2 shows the distribution of subjects who met ACSM's recommendations for physical activity (30 min/3d/wk/3 mo) and the type of aerobic exercise they routinely completed to meet that recommendation.

Table 2

Type and Duration of Aerobic Exercise Performed Weekly (If Any) For Each Participant

Participant	Meets ACSM's Recommendation	Type
P1	No	N/A
P2	Yes	Walking (60min/sess. x 5 d/wk)
P3	Yes	Walking/trail hiking (30min/sess. x 4d/wk)
P4	Yes	Walking (30 min/sess. x 3d/wk) Jazzercise (60 min/sess. x 2d/wk)
P5	No	N/A

Note. P = participant, sess = session of exercise, wk = week, d = days

The HBM was used to assess participants' perception of their diabetes. Participants completed a questionnaire consisting of nine constructs, each with their own subset of questions. Internal reliability of the questionnaire used was assessed by calculating Cronbach's alpha using an excel spreadsheet, with a Cronbach's alpha of greater than 0.7 being considered as adequate for internal reliability of the questionnaire (Bujang et al., 2018). The total calculated Cronbach's alpha for the HBM questionnaire used was calculated to be 0.86, indicating that the given questionnaire accurately measured perception of illness in adults with T2DM. Seven of the nine individual constructs had internal reliability with a Cronbach's alpha greater than 0.7 with calculated alphas ranging from -0.30 to 0.96 (Table 3). The third construct, perceived susceptibility, did not show good internal reliability, with a Cronbach's alpha of -0.30. The ninth construct, perceived diabetes control, only had one question, making a Cronbach's alpha incalculable. Table 4 shows the distribution of each construct on the given HBM, including the number of participants who answered for each option and the percentage of the total who answered for each option. Higher scores on the Likert scale were related to a positive attitude towards performing healthy behaviors.

Table 3

Internal Reliability for Diabetes Health Belief Model Constructs

Construct	Cronbach α
C1	0.75*
C2	0.86*
C3	-0.30
C4	0.96*
C5	0.86*
C6	0.96*
C7	0.93*
C8	0.75*
C9	N/A

Note. C = construct; * = good internal reliability

Table 4

Frequency Distribution of Health Belief Model Constructs Among Participants (n = 5)

Likert scale	1	2	3	4	5	6	7
Construct questions	n/%	n/%	n/%	n/%	n/%	n/%	n/%
C1a	0/0	0/0	0/0	2/40	3/60	NA	NA
C1b	0/0	0/0	1/20	2/40	2/40	NA	NA
C1c	0/0	0/0	1/20	1/20	3/60	NA	NA
C1d	0/0	0/0	2/40	0/0	3/60	NA	NA
C2a	4/80	0/0	1/20	0/0	0/0	NA	NA
C2b	4/80	0/0	0/0	1/20	0/0	NA	NA
C2c	3/60	1/20	1/20	0/0	0/0	NA	NA
C2d	3/60	0/0	2/40	0/0	0/0	NA	NA
C2e	2/40	1/20	0/0	0/0	2/40	NA	NA
C3a	0/0	3/60	2/40	0/0	0/0	NA	NA
C3b	2/40	1/20	1/20	0/0	1/20	NA	NA
C4a	1/20	1/20	2/40	0/0	1/20	NA	NA
C4b	0/0	2/40	1/20	1/20	1/20	NA	NA
C5a	0/0	0/0	0/0	1/20	0/0	1/20	3/60
C5b	0/0	0/0	0/0	1/20	0/0	1/20	3/60
C5c	0/0	0/0	0/0	0/0	0/0	0/0	5/100
C5d	0/0	0/0	0/0	1/20	0/0	1/20	3/60
C6a	0/0	0/0	1/20	0/0	0/0	4/80	NA
C6b	0/0	0/0	1/20	0/0	1/20	3/60	NA

C6c	0/0	0/0	1/20	1/20	0/0	3/60	NA
C6d	0/0	0/0	0/0	1/20	0/0	4/80	NA
C6e	0/0	0/0	0/0	0/0	1/20	4/80	NA
C6f	0/0	0/0	0/0	1/20	1/20	3/60	NA
C7a	2/40	1/20	0/0	0/0	0/0	2/40	NA
C7b	3/60	0/0	0/0	0/0	0/0	2/40	NA
C7c	1/20	0/0	0/0	0/0	1/20	3/60	NA
C7d	2/40	0/0	0/0	0/0	1/20	2/40	NA
C7e	3/60	0/0	0/0	0/0	0/0	2/40	NA
C7f	0/0	0/0	0/0	1/20	0/0	4/80	NA
C8a	3/60	0/0	1/20	1/20	0/0	0/0	NA
C8b	3/60	1/20	1/20	0/0	0/0	0/0	NA
C8c	3/60	0/0	0/0	0/0	0/0	2/40	NA
C8d	2/40	0/0	1/20	0/0	1/20	1/20	NA
C8e	4/80	0/0	0/0	1/20	0/0	0/0	NA
C8f	2/40	0/0	0/0	1/20	0/0	2/40	NA
C9a	0/0	0/0	1/20	1/20	3/60	NA	NA

Note. n = number of participants; C = construct

Among the nine constructs, the highest scores were seen in diabetes self-efficacy (C5), with the average score being 91.43% of the total possible score, while the lowest scores were seen in perceived general barriers (C2), with the average score being 36.80% of the total possible score. Higher scores were related to a positive attitude towards performing healthy behaviors. Table 5 shows the individual scores, means, standard deviations (SD), and mean percentages from the total score possible in each construct of the HBM.

Table 5

Individual Scores, Means, Standard Deviations, and Percentages of Health Belief Model Constructs

Construct	Possible score range	Individual scores	Mean	SD	Percentage of score
Perceived benefits	4-20	P1: 14 P2: 16 P3: 20 P4: 20 P5: 17	17.40	2.61	87.00%
Perceived general barriers	5-25	P1: 15 P2: 5 P3: 6 P4: 5 P5: 15	9.20	5.31	36.80%
Perceived susceptibility	2-10	P1: 4 P2: 3 P3: 6 P4: 4 P5: 7	4.80	1.64	48.00%
Perceived severity	2-10	P1: 10 P2: 7 P3: 6 P4: 3 P5: 4	6.00	2.74	60.00%
Diabetes self-efficacy	4-28	P1: 19 P2: 26 P3: 27 P4:28 P5: 28	25.60	3.78	91.43%

Perceived locus of control internal	6-36	P1: 22 P2: 36 P3: 32 P4: 36 P5: 36	32.40	6.07	90.00%
Perceived locus of control external	6-36	P1: 21 P2: 9 P3: 15 P4: 36 P5: 36	23.40	12.26	65.00%
Perceived locus of control chance	6-36	P1: 21 P2: 6 P3: 7 P4: 23 P5: 18	15.00	7.97	41.67%
Perceived diabetes control	1-5	P1: 3 P2: 5 P3: 4 P4: 5 P5: 5	4.40	0.89	88.00%

Note. P = participant

Higher scores on the HBM indicated a positive attitude towards performing healthy behaviors. Therefore, a score above 50% of the total possible score indicated progressive attitude toward healthful behavior. Table 6 shows the overall HBM scores for each participant and the associated percentage of the total possible score of the HBM questionnaire used. All participants achieved over 50% (103 points) of the total (206 points), with the lowest score being 54.85% of the total possible score.

Table 6

Overall Health Belief Model Scores for Each Participant and Associated Percentage of Total Possible Score of Health Belief Model

Participant	Overall HBM Score (points)	Percentage of Total Possible Score
P1	129	62.62%
P2	113	54.85%
P3	123	59.71%
P4	160	77.67%
P5	166	80.58%

Note. P = participant

The Relationship Between WC Measurement and Overall HBM Score

It was examined whether, in those adults with diagnosed T2DM, a low overall HBM score correlated with high WC (M 100-120 cm, W 90-110 cm). All participants were classified as either high risk or very high risk for WC measurements and all participants achieved over 50% (103 point) of the total possible HBM score (206 points). The lowest WC measurement was associated with the second highest overall HBM score, the second lowest WC measurement was associated with the lowest overall HBM score and the highest WC measurement was associated with the second lowest overall HBM score. A Pearson's Correlation Coefficient r was calculated using an excel spreadsheet, analyzing if the relationship between WC and overall HBM score occurred by chance or if it really exists in the population. The alpha level set for statistical significance was 0.05, as is used for most educational research. For this data, the degrees of freedom (df) were calculated to be three and the r-value was calculated to be 0.09. This value was evaluated for statistical significance by being compared with the value on a critical value table at the intersection of $p = 0.05$ and $df = 3$, which found a value of 0.878.

Additionally, a p-value was calculated from this Pearson Correlation Coefficient using an excel spreadsheet, yielding a p-value of 0.89, with the comparable alpha set at $p = 0.05$ for statistical significance. Table 7 shows the WC measurement with the associated overall HBM score for each participant. Figure 1 depicts the relationship between WC measurements and overall HBM score.

Table 7

Waist Circumference Measurement and Associated Overall Health Belief Model Score For Each Participant

Participant	WC measurement (cm)	Overall HBM score (points)
P1	103.5	129
P2	94.0	113
P3	116.0	123
P4	91.0	160
P5	115.0	166

Note. P = participant, ($p = 0.89$, $r(3) = 0.09$)

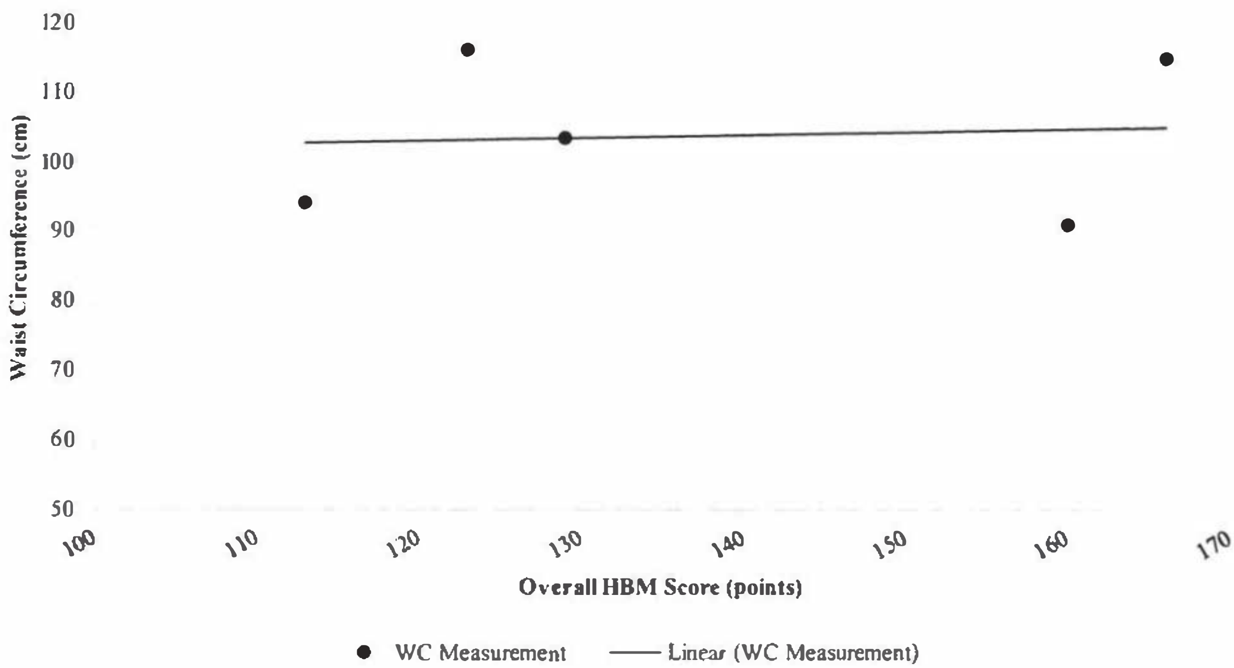

Figure 1. Waist circumference measurement and associated overall Health Belief Model score for each participant

The Relationship Between Overall HBM Score and Meeting of the ACSM's Guidelines Recommendations

It was also examined whether there was a relationship between the overall HBM score and whether an adult with diagnosed T2DM met ACSM's guidelines for physical activity by completing regular aerobic exercise. Table 8 shows the overall HBM score for each participant and whether they met the ACSM's guidelines. For the purposes of statistical analysis, the variable "no" was given a numerical value of 1 and the variable "yes" was given a numerical value of 0. A Pearson's Correlation Coefficient r was calculated using an excel spreadsheet, analyzing if the relationship between WC and participants meeting of ACSM's guidelines for aerobic exercise occurred by chance or if it really existed in the population. The alpha level set for statistical significance was 0.05, as is used for most educational research. Again, the degrees of freedom (df) were calculated to be three and the r-value was calculated to be 0.36. This value was evaluated for statistical significance by again being compared with the value on a critical value table at the intersection of $p = 0.05$ and $df = 3$, which was found to be 0.878. Similar to the first hypothesis, a p-value was calculated from this Pearson Correlation Coefficient using an excel spreadsheet, yielding a p-value of 0.55, with the comparable alpha set at $p = 0.05$ for statistical significance. Those participants who did not meet the ACSM's guidelines (n=2) had the highest and third highest overall HBM scores, respectively. Figure 2 shows a depiction of the relationship between overall HBM scores and participants' meeting of the ACSM's guidelines.

Table 8

Overall Health Belief Model Score and Meeting of the ACSM's Guidelines For Each Participant

Participant	Overall HBM Score (points)	Meets ACSM Guidelines
P1	129	No (1)
P2	113	Yes (0)
P3	123	Yes (0)
P4	160	Yes (0)
P5	166	No (1)

Note. P = participant

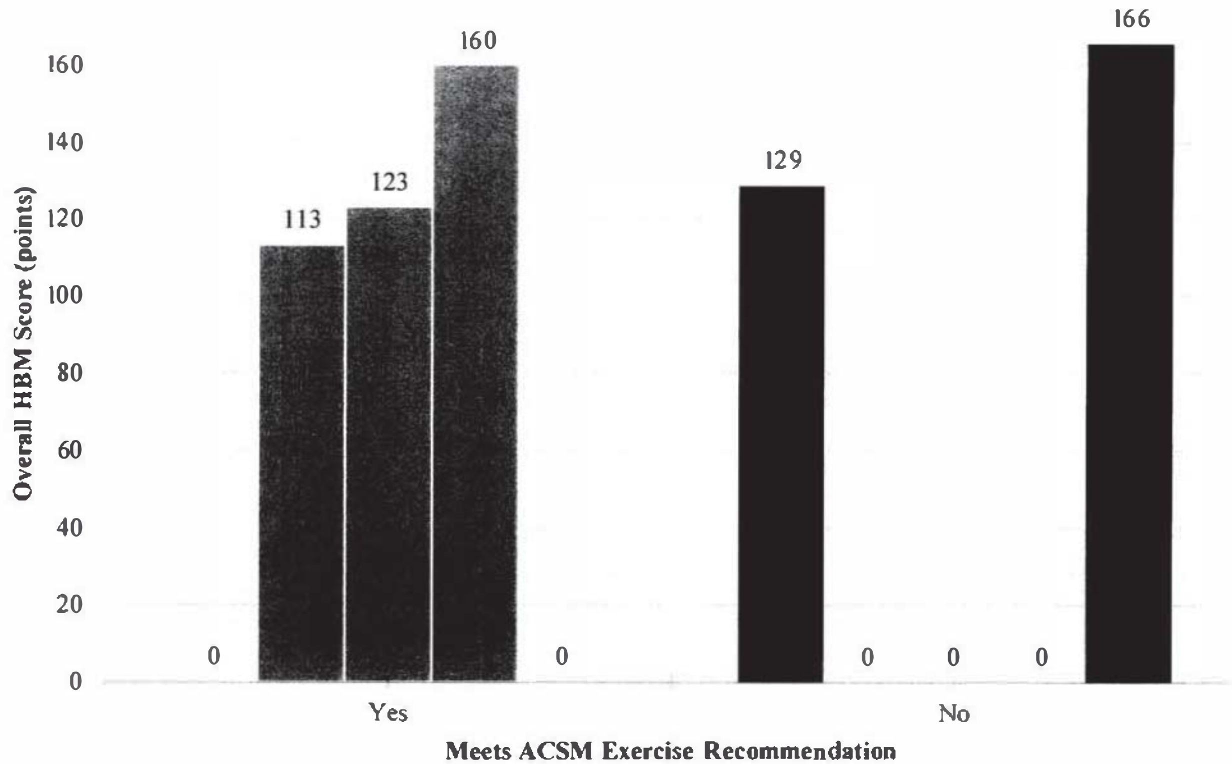

Figure 2. Overall Health Belief Model score and meeting of the ACSM's guidelines for each participant

CHAPTER V

DISCUSSION

The purpose of this study was to observe the relationship between waist circumference (WC), amount of aerobic exercise performed weekly and overall Health Belief Model (HBM) score in adults with diagnosed type 2 diabetes mellitus (T2DM). A total of five members from a local Midwest adult fitness exercise program voluntarily participated in this study.

Hypothesis One

The relationship between WC measurement and the overall HBM score was analyzed for the first hypothesis of this study. It was hypothesized that a lower overall HBM score would be shown in those persons who had high WC measurements. This hypothesis was rejected, however, as it was shown that there was no statistical significance in the relationship between WC and overall HBM score.

The results of this study suggested that, for this sample group of five participants, there was no significant relationship between WC measurement and overall HBM score. Participants were either classified as high risk (n=4) or very high risk (n=1) based on their WC measurements and the risk criteria for WC in adults described by the ACSM's guidelines (Riebe et al., 2017) (Appendix F). The lowest overall HBM score was found to be 113 points out of a total possible score of 206 points. This score belonged to the participant who had the second lowest WC measurement (94.0 cm). This relationship supports the rejection of the proposed hypothesis, as the lowest overall HBM score was not correlated with the highest WC measurement. Conversely, the highest overall HBM score was found to be 166 points and belonged to the participant with the second highest

WC measurement (115.0 cm). Again, this relationship points to the rejection of this hypothesis and supports the idea that individuals may perceive their illness at varying levels of threat, regardless of anthropometric measurements and the associated risk they know to come from higher body composition measurements. All participants likely have varying durations of time since their initial diagnosis, which may have affected the way in which they rated the constructs of the HBM. The participant who achieved the highest overall HBM score (166 points) had the second highest WC measurement, which was a surprising finding, as the second highest overall HBM score (160 points) was achieved by the participant who had the lowest WC measurement, indicating that both of these participants had a positive attitude towards performing healthy behaviors related to their disease, as both were enrolled in a fitness program. The latter was the result that was expected; those who had high HBM scores would have low WC measurements, but this was not supported in the current study. While their HBM scores both indicate a positive attitude toward behavior change, they vary in how they perceive the steps necessary to taking that healthy behavior change. These two participants had similar scores in each construct of the HBM except in the perceived general barriers construct, in which the participant with the lowest WC measurement had the lowest barriers score (5 points), while the participant with the second highest WC measurement had one of the highest barriers scores (15 points) (Table 5). General barriers included time, family, normal daily activity, and motivation. This indicated that participant four, who had the lowest barriers score, did not feel that they had barriers preventing them from performing aerobic exercise, whereas participant five, who had the highest barriers score, did feel they had barriers to performing aerobic exercise. There may be many reasons why this occurred, and it is difficult to decipher these reasons with only five participants. This may have been caused by the fact that individuals perceive their illnesses to affect them differently and with different levels of severity. Individuals have different feelings of control when deciding whether or not to perform actions of self-care. In the construct of perceived general barriers, these two individuals answered oppositely to the statement "I don't feel motivated to perform aerobic exercise regularly", with the participant having the lowest WC measurement giving it a score of 1, indicating strongly disagree, while the participant with the second highest WC measurement gave it a score of 5, indicating strongly agree. This result is not surprising, as those individuals who do not partake in self-care, such as exercise, are predicted to have higher body composition measurements and an increase in accumulation of abdominal fat, both subcutaneous and visceral (Kim et al., 2019). In contrast, the participant with the highest WC measurement (116 cm) scored the second lowest overall HBM score of 123 points, which does support the proposed hypothesis, that low HBM scores would be related to high WC measurements. It may be more significantly supported if there were more participants in the current study so a stronger relationship may have been identified.

Correlation statistics are used to observe the strength of a relationship using data collected from study populations. The strength of the relationship between variables is indicated by numerical values. When interpreting the correlation coefficient of this data set, it was shown that with five subjects and an r-value of 0.09, there was not a statistically significant relationship between WC measurement and overall HBM score in adults with diagnosed T2DM. The calculated r-value was considerably smaller than the value found at the intersection of $p = 0.05$ and degrees of freedom (df) = 3 on a critical value table for Pearson's Correlation Coefficients ($r(3) = 0.09$, $p > 0.05$). This indicated that we cannot be 95% confident that a relationship exists and that the hypothesis, that a lower overall HBM score would be shown in those persons who had high WC measurements, is rejected. Figure 1 potentially showed a slight positive linear relationship between these variables, but the data points themselves were not clustered along the trendline, indicating that there was no relationship between the data points. This was further strengthened by the r-value of 0.09, with an r-value of 0.00 indicating no relationship (Siegle, 2015).

When interpreting the p-value (0.89) of this data set, it was inferred that there was no statistical significance between the two variables in question, as this value was much larger than the associated alpha p-value of 0.05, which was set to indicate statistical significance. These analyses aid to reject the proposed hypothesis, indicating, at least for the observed population, that there was no relationship between WC measurement and the overall HBM score for adults with diagnosed T2DM.

Comparing the individual construct scores for the two participants who had the lowest WC measurements, 91 cm and 94 cm respectively, six of the nine constructs were similar. Both participants scored similarly in the following constructs: perceived benefits, perceived barriers, perceived susceptibility, perceived self-efficacy, perceived locus of control internal, and perceived diabetes control. These two participants scored oppositely in the constructs perceived severity, perceived locus of control external and perceived locus of control chance. From this, it was shown that participant four did not perceive their diabetes to be a severe health problem and did not perceive the complications that may arise from diabetes to be severe in terms of their health, while participant two felt more strongly about their perception of these statements, with a more extreme perception of the degree of severity of diabetes. Participant four also agreed that external factors, such as family members and healthcare providers, had a strong influence on their ability to control their diabetes, where participant two felt the opposite. They also had opposite perceptions of chance being a factor in the control of their disease, with participant four perceiving chance to possibly play a role in the control of their diabetes. These comparisons show that even though individuals may have similar body composition measurements that could elude to good control of diabetes, they may have opposite perceptions of how diabetes affects them and how they are able to control their disease.

Hypothesis Two

The relationship between overall HBM score and meeting of the American College of Sports Medicine's (ACSM's) guidelines for aerobic exercise was analyzed in order to assess hypothesis two. It was hypothesized that persons who met aerobic exercise recommendations based on the ACSM's guidelines had a higher HBM total score. Again, this hypothesis was not supported by the results of this study, finding that there was no statistical significance in the relationship between overall HBM score and whether a participant met the ACSM's guidelines for aerobic exercise.

Participants in this study all achieved over 50% (103 points) of the total (206 points) possible points on the HBM questionnaire, indicating varying levels of positive attitudes toward performing healthy behaviors. Of the total participants (n=5), three met the aerobic exercise recommendations set by the ACSM's guidelines and the remaining two participants did not. To reiterate the recommendations, "participants classified as current exercisers should have a history of performing planned, structured physical activity of at least moderate intensity for at least 30 minutes on three days or more per week during the past three months." (Riebe et al., 2017, p. 35). Participant one and participant five did not meet the ACSM's guidelines for aerobic exercise and showed the third highest and highest overall HBM scores, respectively. Seeing as the highest overall HBM score did not belong to a participant who met the ACSM's guidelines for aerobic exercise, this data supports the rejection of the present hypothesis. It was, however, observed that the second highest overall HBM score was associated with a participant who does meet the ACSM's guidelines for aerobic exercise, supporting this hypothesis, but without the strength of significance. Participant one and participant five scored similarly in all constructs of the HBM except perceived severity, indicating that participant one perceives diabetes to be a severe health problem and the complications that may arise from diabetes are extremely severe. Participant five had a lesser perception of the severity of diabetes and the complications that may arise from diabetes.

When analyzing the correlation coefficient of this data set, it was shown that with five subjects and an r-value of 0.36, there was not a statistically significant relationship between overall HBM score and whether participants met the ACSM's guidelines for aerobic exercise ($r(3) = 0.36$, $p > 0.05$). The calculated r-value was considerably smaller than the value found at the intersection of $p = 0.05$ and $df = 3$ on a critical value table for Pearson's Correlation Coefficients. This indicated that we cannot be 95% confident that a relationship exists and the hypothesis, that persons who met aerobic exercise recommendations based on the ACSM's guidelines had a higher HBM total score, was rejected. When interpreting the p-value (0.55) of this data set, it was inferred that there was no statistical significance between these two variables, as again this value was much larger than the associated alpha p-value of 0.05 for statistical significance. By rejecting the proposed hypothesis, it was stated, at least for the observed population, that there was no relationship between the overall HBM score and whether individuals met the ACSM's guidelines for aerobic exercise in adults with diagnosed T2DM.

It has been studied that individuals who have a more positive perception of their disease overall can also have poor self-care behaviors and feel they have poor control over their disease, despite having fewer complications from their disease compared to other individuals with less positive perceptions (Rivera et al., 2018). This was explained by the possibility that these individuals' diseases were less severe overall compared to other patients and therefore they did not feel they needed to partake in self-care behaviors to combat complications from their disease (Rivera et al., 2018). It was also shown that those individuals who scored the highest on positive perception of disease also had the highest adherence to self-care, which was not found to be true in this study (Rivera et al., 2018). However, these individuals were shown to have more hospitalizations than groups with more negative perceptions and self-care acts, leading the researchers to question if these individuals had a misperception of how detrimental their disease really was or how capable they were at controlling it (Rivera et al., 2018). This could be proposed as a reason why the participant in the current study who had the highest overall HBM score was not also partaking in the recommended amounts of aerobic exercise as proposed by the ACSM's guidelines. This participant achieved the highest score possible (28 points) on the self-efficacy construct of the HBM, as well as the highest scores possible in both the internal and external perceived locus of control constructs, scoring 36 points in each, respectively. This may explain why this participant does not feel the need to partake in aerobic exercise as a means of self-care towards diabetes. If an individual believes that they are already able to control their disease without having to manage it with high levels of self-care, they may choose not to partake in those behaviors (Rivera et al., 2018).

This understanding of a patient's perception of their illness can help guide healthcare providers and exercise professionals to create strategies that enable patients to feel more in control of their disease and possibly help them understand why partaking in self-care behaviors, even if they do not perceive them to be beneficial, can lead to better overall health in patients with chronic diseases, such as T2DM (Rivera et al., 2018).

Limitations

There were several limitations in the current study that may have affected the strength of the results, leading to the lack of statistical significance found. The largest limitation was the quantity of members of the local Midwest adult fitness program who were diagnosed with T2DM. A total of 11 members were identified as being diagnosed with T2DM and the response rate of those members was only 45%. This may have been due in part to the fact that individuals had to be physically present to have their WC measurements taken and to complete the HBM questionnaire in order to participate in the study. If members had not regularly been participating in the adult fitness exercise program, they may have been deterred to participate in the current study because of the prospect of finding out negative results. Members may also have had other reasons behind not participating, including being out of town or being unable to meet with the primary researcher during the week due to work.

Another limitation may have been the subjective interpretation each individual had in regard to the HBM questionnaire and its constructs. Because each question on the

HBM was scored on a Likert scale, participants had more freedom to make subjective choices for each question, as opposed to using a questionnaire that only had yes/no answer choices. Likert scales are usually used to "ask respondents about their attitudes, perceptions or evaluations" of something (Dawes, 2012). Respondents choose an answer from a variety of choices, usually in the form of verbal statements or numbers. In the case of the current study, number answers were used for the participants to choose from, indicating their subjective level of agreement with the question asked on the HBM. Because of this type of scale, participants had to determine for themselves how to respond and this determination was likely variable for each participant, potentially leading to lack of statistical significance.

Participants in this study were currently enrolled in an exercise program, leading to the idea that they had the intention of performing positive healthy behaviors towards the management of their diabetes. Additionally, participants self-reported the type and duration of aerobic exercise they performed, which gave the primary researcher no true way of knowing if the participants were honestly recording their exercise. This may have affected both the outcome of the demographic survey but also the ranking of the constructs of the HBM. If participants ranked statements according to what they believed to be the correct answer, even if they did not accurately report the aerobic exercise they performed, this may have been a limiting factor as to the non-significant results of this study.

Future Studies

It is recommended that any future studies observing relationships like those analyzed in the current study attempt to observe a larger quantity of participants. It may also be beneficial to sample from multiple facilities, thereby including the potential for a larger range of ages and more participants of each gender, along with a variety of exercise programs. Additionally, including participants who have the same duration since diagnosis of T2DM may also be beneficial, as timing of diagnosis and duration of disease may impact the perception that an individual has towards diabetes and how it affects them. Lastly, it may be beneficial to observe different groups of participants, including a group of newly diagnosed participants who meet the ACSM's guidelines for aerobic exercise versus a group of newly diagnosed participants who do not have a history of regular aerobic exercise. This may provide further information related to how exercise history may affect an individual's perception of their disease.

In future studies, the use of a different or secondary health belief model may also be beneficial, as this may enhance the strength of any findings. The Theory of Planned Behavior (TPB) has been used to observe perceived control in populations with diabetes and could be used in a study like this one in order to examine self-care behavior intentions in this population (Akbar et al., 2015). It was concluded that the TPB observed a wide range of intention and behavior in diabetic patients, eluding to the use of the TPB in specific populations to target those specific behaviors that lead to change (Akbar et al., 2015). This may be a secondary model used in a study like this one to pinpoint certain behaviors after a general understanding of perception of illness is observed. In this way, individuals' perceived control may be increased, leading to a greater desire to add healthy behaviors, such as exercise, into the self-management of their diabetes.

Conclusions

The following conclusions were found from the current study: 1) no significant relationship was found between WC measurement and perception of diabetes using the overall HBM scores in adults with diagnosed T2DM; 2) no significant relationship was found between overall HBM scores and participant meeting of ACSM guidelines for aerobic exercise in adults with diagnosed T2DM.

Individuals with diabetes may perceive their disease to affect them differently and have different perceptions of their control over their diabetes. Even though the current study used a small convenience sample, it could be beneficial to perform a similar study with a larger sample size in order to determine any true significance. As the diagnosis of diabetes continues to increase, it is important for healthcare providers and exercise professionals to understand the perception individuals have towards lifestyle modifications as management of diabetes, as this can be an effective way to help patients with T2DM (Parry et al., 2004; Rivera et al., 2018). Continued education from healthcare providers and exercise professionals on the benefits of exercise for patient's with diabetes is important as it may influence patients to take steps to performing aerobic exercise regularly (Delamater, 2006).

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APPENDIX A – Consent to Participate in Research

APPENDIX A

CONSENT TO PARTICIPATE IN RESEARCH

Waist Circumference and the Relation to Exercise and Illness Perception in Adults with Type 2 Diabetes Mellitus

You are invited to participate in a research study conducted by Bailey Huebner and Dr. Stacey Ruholl from the Department of Kinesiology, Sport, and Recreation at Eastern Illinois University.
Your participation in this study is entirely voluntary. Please ask questions about anything you do not understand before deciding whether or not to participate.

You have been asked to participate in this study because you have Type 2 Diabetes Mellitus and participate in a structured exercise program.

PURPOSE OF THE STUDY

The purpose of this study is to see what relationship exists between waist circumference in adults with diabetes and if this relationship correlates with perception of illness and amount of aerobic exercise performed.

PROCEDURES

If you volunteer to participate in this study, you will be asked to:

1. Complete a demographic survey related to pertinent information needed for the study, including gender, age, and exercise history.
2. Have your current waist circumference measured in the confines of the EIU Adult Fitness Office.
3. Complete a questionnaire (Health Belief Model Questionnaire) related to perception of illness.

This should take no longer than 20 minutes on one day, with all data collected in the EIU Adult Fitness Office in room 1011 Lantz Arena.

Your name or personal identifiers will not be released to the public or used in the final write up of data.

POTENTIAL RISKS AND DISCOMFORTS

No foreseeable risk or discomforts accompany participation in this study. There are no foreseeable psychological, social, legal, or financial risk or harms associated with participation in this study. If you do not wish to have waist circumference measurements taken by a student, you are welcome to withdraw from the study.

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

From the analysis of this research, you may have a better understanding of how diabetes affects you and what may be done to better improve overall health.

By researching the correlations between body measurements and exercise history, ways in which exercise physiologists can help clients decrease their risk for both morbidity and mortality from disease may be identified.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Data will be collected without names or identifiers related to participants. Data will be stored in a binder only accessible to the principle investigator and the faculty sponsor assisting in the study. If any subjects formally withdraw from the study, their data will be shredded. When research is complete, all questionnaire papers and informed consent papers will be kept in a binder by the principle investigator for approximately three years.
The subject's information or biospecimens collected as part of the research even if identifiers are removed, will not be used or distributed for future research.

PARTICIPATION AND WITHDRAWAL

Participation in this research study is voluntary and not a requirement or a condition for being the recipient of benefits or services from Eastern Illinois University or any other organization sponsoring the research project. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind or loss of benefits or services to which you are otherwise entitled.
There is no penalty if you withdraw from the study and you will not lose any benefits to which you are otherwise entitled.
You may also refuse to answer any questions you do not want to answer.

IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about this research, please contact:

Bailey Huebner
bjhuebner@eiu.edu

Dr. Stacey Ruholl
slruholl@eiu.edu

RIGHTS OF RESEARCH SUBJECTS

If you have any questions or concerns about the treatment of human participants in this study, you may call or write:

Institutional Review Board
Eastern Illinois University
600 Lincoln Ave.
Charleston, IL 61920
Telephone: (217) 581-8576
E-mail: eiuirb@www.eiu.edu

You will be given the opportunity to discuss any questions about your rights as a research subject with a member of the IRB. The IRB is an independent committee composed of members of the University community, as well as lay members of the community not connected with EIU. The IRB has reviewed and approved this study.

I voluntarily agree to participate in this study. I understand that I am free to withdraw my consent and discontinue my participation at any time. I have been given a copy of this form.

____
Printed Name of Participant

____ ____________________

Signature of Participant Date

I, the undersigned, have defined and fully explained the investigation to the above subject.

Signature of Investigator Date

APPENDIX B - Demographic Information

APPENDIX B

Demographic Information

Please complete the following demographic survey:

Gender

1. M
2. F
3. Prefer not to say

Age - include date of birth (mm/dd/yyyy)

Exercise History

4. Have you participated in aerobic exercise 3d/wk, for 30 minutes each session, for at least the last 3 months? Y/N

5. What type of aerobic exercise do you partake in. List all. (Aerobic exercise = running, jogging, swimming…)

APPENDIX C – Health Belief Model (modified from Gutierrez and Long, 2012)

APPENDIX C

Perceived Benefits (1 "strongly disagree" to 5 "strongly agree"):

a. Performing aerobic exercise will help prevent diseases (complications) related to diabetes.

b. Performing aerobic exercise will help me control my diabetes.

c. Performing aerobic exercise will help me feel better.

d. Performing aerobic exercise will help me live longer.

Perceived General Barriers (1 "strongly disagree" to 5 "strongly agree"):

a. I have difficulty remembering when to perform aerobic exercise.

b. Family problems make it difficult for me to perform aerobic exercise regularly.

c. I would have to change too many habits to perform aerobic exercise regularly.

d. Performing aerobic exercise interferes with my normal daily activities.

e. I don't feel motivated to perform aerobic exercise regularly.

Perceived Susceptibility (1 "very unlikely" to 5 "very likely"):

a. How likely will you be to develop the complications of diabetes or have complications worsen?

b. How likely are you to have a shortened life expectancy?

Perceived Severity (1 "not at all severe" to 5 "extremely severe"):

a. To what extent do you consider diabetes to be a severe health problem?

b. To what extent do you consider complications arising from diabetes to be severe health problems?

Diabetes Self Efficacy (1 "not at all true" to 7 "very true"):

a. I feel confident in my ability to manage my diabetes.

b. I feel capable of handling my diabetes now.

c. I am able to do my own routine diabetes care now.

d. I am able to meet the challenges of controlling my diabetes.

Perceived Locus of Control Internal (1 "disagree" to 6 "agree"):

a. If I take care of myself, I can minimize diabetic complications.

b. The main thing which affects whether I will develop diabetic complications is what I do for myself.

c. If I avoid diabetic complications, it's because of my efforts.

d. If my diabetes goes out of control, it is my own behavior which determines how soon I get back in control again.

e. If I take the right actions, I can keep my diabetes in control.

f. The main thing which affects my diabetes control is what I do for myself.

Perceived Locus of Control External (1 "disagree" to 6 "agree"):

a. Having regular contact with other individuals who have diabetes is the best way for me to avoid developing diabetic complications.

b. My family has a lot to do with whether or not I will develop diabetic complications.

c. If I am able to avoid diabetic complications it's because other individuals (for example doctor, nurses, family, friends) have been taking good care of me.

d. When I am able to keep my diabetes in control it's because other individuals (for example doctor, nurses, family, friends) have been taking good care of me.

e. My family has a lot to do with my diabetes being in control or out of control.

f. Having regular contact with my doctor is the best way for me to keep my diabetes in control.

Perceived Locus of Control Chance (1 "disagree" to 6 "agree"):

a. Avoiding diabetic complications is largely a matter of good fortune.

b. No matter what I do, I'll probably develop diabetic complications.

c. If it's meant to be, my diabetes will stay in control.

d. When my diabetes goes out of control, it's usually by accident.

e. No matter what I do, my diabetes is likely to go out of control.

f. Most things that affect my diabetes happen by accident.

Perceived Diabetes Control (1 "not very well" to 5 "very well"):

a. How well do you think you are managing to control your diabetes?

APPENDIX D – Health Belief Model (Gutierrez and Long, 2012)

APPENDIX D

Perceived Benefits:

a. Sticking to my diabetes medication will help prevent diseases (complications) related to diabetes.

b. Sticking to my diabetes medication will help me control my diabetes.

c. Sticking to my diabetes medication will help me feel better.

d. Sticking to my diabetes medication will help me live longer.

Perceived Side Effects:

a. Diabetes medications cause annoying side effects.

b. I sometimes worry about the long term effects of my diabetes medication.

Perceived General Barriers:

a. I have difficulty remembering when to takes my diabetes medication.

b. Family problems make it difficult for me to take my diabetes medication regularly.

c. I would have to change too many habits to take my diabetes medication regularly.

d. Taking my diabetes medication interferes with my normal daily activities.

e. I don't feel motivated to take my diabetes medication regularly.

Perceived Susceptibility:

a. How likely will you be to develop the complications of diabetes or have complications worsen?

b. How likely are you to have a shortened life expectancy?

Perceived Severity:

a. To what extent do you consider diabetes to be a severe health problem?

b. To what extent do you consider complications arising from diabetes to be severe health problems?

Diabetes Self Efficacy:

a. I feel confident in my ability to manage my diabetes.

b. I feel capable of handling my diabetes now.

c. I am able to do my own routine diabetes care now.

d. I am able to meet the challenges of controlling my diabetes.

Perceived Locus of Control Internal:

a. If I take care of myself, I can minimize diabetic complications.

b. The main thing which affects whether I will develop diabetic complications is what I do for myself.

a. If I avoid diabetic complications, it's because of my efforts.

b. If my diabetes goes out of control, it is my own behavior which determines how soon I get back in control again.

a. If I take the right actions, I can keep my diabetes in control.

b. The main thing which affects my diabetes control is what I do for myself.

Perceived Locus of Control External:

a. Having regular contact with other individuals who have diabetes is the best way for me to avoid developing diabetic complications.

b. My family has a lot to do with whether or not I will develop diabetic complications.

c. If I am able to avoid diabetic complications it's because other individuals (for example doctor, nurses, family, friends) have been taking good care of me.

d. When I am able to keep my diabetes in control it's because other individuals (for example doctor, nurses, family, friends) have been taking good care of me.

e. My family has a lot to do with my diabetes being in control or out of control.

f. Having regular contact with my doctor is the best way for me to keep my diabetes in control.

Perceived Locus of Control Chance:

a. Avoiding diabetic complications is largely a matter of good fortune.

b. No matter what I do, I'll probably develop diabetic complications.

c. If it's meant to be, my diabetes will stay in control.

d. When my diabetes goes out of control, it's usually by accident.

e. No matter what I do, my diabetes is likely to go out of control.

f. Most things that affect my diabetes happen by accident.

Perceived Diabetes Control:

a. How well do you think you are managing to control your diabetes?

APPENDIX E - ACSM Risk Criteria for Waist Circumference in Adults

APPENDIX E

Risk Criteria for Waist Circumference in Adults

	Waist Circumference cm (in)	
Risk Category	Women	Men
Very low	<70 cm (<27.5 in)	<80 cm (31.5 in)
Low	70-89 (27.5-35.0)	80-99 (31.5-39.0)
High	90-110 (35.5-43.0)	100-120 (39.5-47.0)
Very high	>110 (>43.5)	>120 (>47.0)

Note. from ACSM Guidelines for Exercise Testing and Prescription, Tenth Edition (Riebe et al., 2017, p. 73)

APPENDIX F - Pictures of Gulick II Measuring Tape and Tension Device

APPENDIX F