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Physical Activity, Healthcare Use, and Medication Use In Diabetes Patients

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Abstract

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MS, The Chicago School of Professional Psychology, 2013

Dissertation Submitted in Partial Fulfillment

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Abstract

There may be connections between physical activity, diabetes, healthcare use, and medication use. However, scholars have not defined the nature of the relationship among those variables. The purpose of this cross-sectional, correlational research study was to examine physical activity, healthcare use, and medication use. The integrated theory of health behavior change guided this study. Data for the study were taken from the 2013-2016 National Health and Nutrition Examination Survey's conducted by the Centers for Disease Control and Prevention as a means for monitoring and providing information on health statistics for people in the United States. MANOVA and logistic regression were conducted to assess the relationships between physical activity, healthcare use, and medication use among 235 diabetes patients over a 12-month period. The findings revealed a lack of a significant difference between physical activity as a function of health care utilization on patients with Type 2 diabetes. In addition, physical activity, age, race, and gender do not predict the type of medication use. This study may help patients increase healthy living habits resulting in better medical implications while managing their diabetic condition. Also, patients and health organizations can incur cost savings to increase the awareness of social behaviors of diabetic patients.

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Dedication

I want to express my gratitude to Agu Nwosu and Daniel Hoops who believed in my growth and challenged me to recognize the power of education. Forever grateful to Christina Washington, Ph.D. and Enrique Washington for recognizing my capabilities before I knew my worth.

I devote the subject to my dissertation to Laverne Perry who has experienced the loss of her son from Diabetes. I am forever grateful from God who connected our souls together. To conclude, I want to thank God for answering Ok Yeon Han prayers, your undeniable faith reconnected the Kwon family to your long lost “Dragon”.

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Chapter 1: Introduction to the Study

There are more than 340 million individuals around the world diagnosed with diabetes and that number is expected to grow over the next 20 years (Shrivastava, Shrivastava, & Ramasamy, 2013). Given this number, the promotion of healthy behaviors is critical. To manage the disease and prevent complications such as poor health and physical limitations, those with diabetes must monitor their diet, physical activity, and emotional wellbeing. Patients with diabetes can still enjoy good health if they properly manage their condition through nutritious eating, physical activity, blood sugar monitoring, and appropriate health-seeking behaviors (Harkness et al., 2013; Shrivastava et al., 2013). However, health outcomes for diabetes patients vary following their diagnosis, and understanding the factors that influence positive health is crucial in managing the disease (Fan et al., 2015; Morgan & Trauth, 2013; Pibernik-Okanović et al., 2015).

A growing number of individuals are living with chronic diseases such as diabetes, so fully understanding the factors that influence patient outcomes is crucial (Earnshaw & Quinn, 2012; Shrivastava et al., 2013). Researchers suggest that patients need consistent and well-managed treatment to have positive health outcomes, and scholars have stressed the importance of physical activity and regular healthcare for patients living with diabetes (Eisenstat, Ulman, Siegel, & Carlson, 2013; Thomas, Holm, & Adhami, 2014; Tödt et al., 2015). In this study, I bridged the gap in empirical research by directly examining the relationship between physical activity (the number of days engaging in moderate and vigorous activity at work/recreation, and meeting/not meeting the minimum recommended amount of ≥150 minutes of physical activity per week), healthcare use (the number of times individual has seen a doctor/healthcare professional at doctor's office or clinic, excluding anyone with overnight hospital stay in the past 12 months), and medication use among diabetic patients (taking insulin, taking diabetic pills, no medication). Data came from participants aged 40-60 who had been diagnosed with diabetes (with no other comorbid conditions) in the last 5 years. Using this age group and time of diagnosis, the sample excluded most individuals diagnosed with Type 1 diabetes. Thus, the sample included only individuals who had Type 2 diabetes.

In this chapter, I provide background information about diabetes research. I explain the rationale for the current study and why further research into the factors influencing health outcomes for diabetic patients is necessary. The research questions and hypotheses are presented as well as an explanation of the theoretical framework used in the study. Finally, I close the chapter with a discussion of limitations, scope, and significance of the study.

Background

Physical activity level has been shown to influence the likelihood of developing diabetes later in life. For example, Fan et al. (2015) demonstrated that physical activity was associated with a decrease in the occurrence rate of Type 2 diabetes in middle to older aged Chinese adults. The study included 6,348 nondiabetic Chinese individuals middle-aged or older residing in urban areas of China. Fan et al. assigned participants into four groups based on their physical activity levels, ranging from sedentary to very active. Fan et al. adjusted for age, sex, geographic region, education level, and risky behaviors such as drinking and smoking. Fan et al. found a negative correlation between activity level and diabetes risk and concluded that high levels of physical activity significantly decreased an individual's risk for diabetes, even after adjusting for body mass index and fasting plasma glucose level.

The positive association between physical activity and overall health has been established as a fundamental principle of healthcare, but researchers also indicate that physical activity may be important for individuals suffering from chronic diseases such as diabetes (Palmer, Espino, Dergance, Becho, & Markides, 2012). Palmer et al. (2012) compared the health outcomes of four groups of Mexican Americans over the age of 65. The groups included individuals with and without diabetes who exercised fewer than 30 minutes a day and individuals who exercised more than 30 minutes a day, and the researchers compared the longitudinal rate of change in disability and physical impairment. Palmer et al. indicated that diabetics who exercised more than 30 minutes/day had significantly slower functional decline over a 10-year period compared to diabetics who exercised fewer than 30 minutes a day. Palmer et al. showed that moderate activity slowed functional decline (i.e., difficulty performing daily activities such as walking, standing, or balancing) among diabetic individuals.

Scholars have indicated a possible relationship between physical activity, healthcare use, and insulin use. In a study with adolescents with Type-2 diabetes, Herbst et al. (2015) found that regular physical activity improved blood glucose levels, lowered body mass index (BMI), and improved (high-density lipoprotein) HDL cholesterol levels. Herbst et al. suggested that physical activity had several positive effects on the diabetic adolescents, which may have made them less reliant on using insulin. Similarly, Pibernik-Okanović et al. (2015) reported positive effects of physical activity on diabetic adults that included reduced diabetic distress, improved diabetic management, and improved metabolic control. Positive effects on diabetic outcomes might lead to fewer doctor visits and less reliance on insulin.

Other scholars indicated that healthcare, mental health support, and self-care knowledge affected outcomes for individuals diagnosed with diabetes. Morgan and Trauth (2013) demonstrated the importance of healthcare knowledge and coping skills on health outcomes for individuals diagnosed with diabetes. Morgan and Trauth instructed 30 patients to educate themselves on diabetic issues and practices related to their condition, and they determined that increased knowledge and positive outlooks influenced patient health outcomes. In a related study, Chaluyoung et al. (2015) found that patients who demonstrated mindfulness acted in a nonjudgmental way regarding experiences, and demonstrated high levels of satisfaction with life had better health outcomes with diabetes than those who did not.

There may be a relationship between physical activity, healthcare behaviors, emotional wellbeing, and positive health outcomes. However, there is a lack of information about the relationship between physical activity, healthcare use, and use of diabetic drugs (i.e., insulin shots and diabetic pills) among diabetes patients. Further study into the connection between those variables is critical to creating positive treatment plans for individuals with diabetes. Without complete information about the factors that influence the health of diabetic patients going forward, doctors are unable to make definitive recommendations or manage patient health effectively. Furthermore, without information about the relationship between physical activity, healthcare-seeking behaviors, and medication use, patients will be unable to advocate for their own health or make informed lifestyle decisions.

Problem Statement

Scholars have indicated an association between health behaviors, overall health, and physical activity, but little is known about the relationship between physical activity and the use of medication. There may be connections between physical activity, diabetes, and medication use. However, there are no studies to date that define the nature of the relationship among those variables. There is a gap in knowledge regarding the connections between physical activity, diabetes, and medication use. In this study, I addressed that gap in the literature by examining the relationship between physical activity, use of healthcare, and the use of insulin shots and diabetic pills among diabetic patients with Type 2 diabetes.

Those with diabetes must closely monitor their diet and physicality, as complications associated with the disease include poor health outcomes and physical limitations. Healthy behaviors associated with appropriate self-management of the disease include good diet, physical activity, blood sugar monitoring, and appropriate healthcare-seeking behavior (Harkness et al., 2013; Shrivastava et al., 2013). Patients diagnosed with diabetes often experience different types of health outcomes following their diagnosis, typically related to their health prior to the diagnosis, physical activity, and capacity for self-care, including healthcare use (Fan et al., 2015; Morgan & Trauth, 2013; Pibernik-Okanović et al., 2015).

The importance of the current study lies in the growing number of individuals living with and managing the complications of a chronic disease like diabetes (Earnshaw & Quinn, 2012; Shrivastava et al., 2013). Further study of these individuals and the factors affecting these aspects of their health is necessary because they need consistent and well-managed treatment for their condition to have positive health outcomes (Eisenstat et al., 2013; Thomas et al., 2014; Tödt et al., 2015). In this study, I addressed the gap by examining the relationship between physical activity, healthcare use, and medication use over a 12-month period among adult diabetes patients. Examining the potential associations between these variables has the potential to support wider research on managing quality of life outcomes for those individuals living with a chronic illness.

Purpose of the Study

The purpose of this quantitative, nonexperimental study was to use data from the National Health and Nutrition Examination Survey (NHANES) for the years 2013 through 2016 (Center for Disease Control and Prevention [CDC], 2016) to examine the relationships between physical activity, healthcare use, and use of medication among Type 2 diabetes patients over a 12-month period. For research Questions 1a and 1b, the independent variables included health care use (low, med, high) and medication use (insulin, diabetic pills, no meds). The dependent variables included activity level (number of days of moderate activity at work and recreation) and activity level (number of days of vigorous activity at work and recreation). Research Questions 1a and 1b were analyzed using a 3 X 4 between-groups MANOVA.

For Research Questions 2a through 2d, logistic regression was used to test each predictor's effect while controlling for each of the other predictors. The predictor variables included age, gender, race, and physical activity (meeting/not meeting the minimum guidelines for the amount of physical activity per week). The outcome variable was medication use (taking insulin, taking diabetic pills, no medication).

Research Questions and Hypotheses

RQ1a: Is there a difference in physical activity level (number of days engaging in moderate activity at work and recreation; number of days engaging in vigorous activity at work and recreation) as a function of healthcare use category (number of times individual has seen a doctor/healthcare professional at doctor's office or clinic, excluding anyone with overnight hospital stay: low, med, high) in the past 12 months for diabetes patients?

$H_0$1a: There is no significant difference in physical activity level among healthcare use categories.

H_a1a: There is a significant difference in physical activity level among healthcare use categories.

RQ1b: Is there a difference in physical activity level (number of days engaging in moderate activity at work and recreation; number of days engaging in vigorous activity at work and recreation) as a function of medication type (insulin, taking diabetic pills, no meds) in the past 12 months for diabetes patients?

$H_0$1b: There is no significant difference in physical activity level among medication types.

H_a1b: There is a significant difference in physical activity level among medication types.

For RQ2 (a-d), each predictor was entered into the logistic regression testing each effect while controlling for each of the other predictors.

RQ2a: Does age predict type of medication use (taking insulin/taking diabetic pills/no medication)?

$H_0$2a: Age does not predict type of medication use.

H_a2a: Age does predict type of medication use.

RQ2b: Does gender predict type of medication use (taking insulin/taking diabetic pills/no medication)?

$H_0$2b: Gender does not predict type of medication use.

H_a2b: Gender does predict type of medication use.

RQ2c: Does race predict type of medication use (taking insulin/taking diabetic pills/no medication)?

$H_0$2c: Race does not predict type of medication use.

H_a2c: Race does predict type of medication use.

RQ2d: Does physical activity (met/not met recommended guidelines for physical activity) predict type of medication use (taking insulin/taking diabetic pills/no medication)?

$H_0$2d: Physical activity does not predict type of medication use.

*H*a2d: Physical activity does predict type of medication use.

Theoretical Framework

The integrated theory of health behavior change was developed on the premise that providers working directly with patients are an important part of helping them to adapt to behavior change (Ryan, 2009). According to the theory, human behavior, specifically as it relates to health management, can be altered through an increased understanding of positive health behaviors and continuous practice of healthy behaviors. The theory states that although individual patients must be responsible for continuously practicing behaviors that influence their own health, doctors and nurses play a role in identifying unhealthy behaviors and recommending new courses of action to patients. The theory stresses that although certain behaviors such as overeating or smoking may be particularly damaging to patients with chronic conditions, the behavior is inherently unhealthy and should be altered in all patients when possible (Ryan, 2009).

Foundational aspects of the theory are that self-management practices are an integral part of improving lifelong health outcomes for patients, especially those who suffered from chronic illnesses (Ryan, 2009). The theory emphasizes the importance of healthy self-management practices by stating that personal behaviors, such as overeating, are responsible for 50% of human illness (Ryan, 2009). Although the remaining 50% of illness may be unspecified, genetic, or otherwise unavoidable, human behavior is a component to managing health and limiting the incidence and impact of chronic and avoidable diseases. Interventions derived from the theory focus on the necessity of increasing understanding about health, promoting self-regulatory behaviors, and removing social stigma regarding care (Ryan, 2009). The theory holds that there are core behaviors that are associated with increased health outcomes across a variety of chronic conditions, including physical activity, good nutrition, stress management, limited alcohol consumption, and smoking cessation (Ryan, 2009).

The theoretical framework outlines behaviors that influence health in diabetics, including the variables of physical activity and regular health examinations. Patient behavior plays a role in predicting their health outcomes, stressing the importance of informed medical professionals and the creation of healthcare plans developed with the influence of empirical research.

Nature of the Study

A quantitative, nonexperimental survey design was used. The use of a quantitative research method aids in the development of research questions, creation of a hypothesis, and the use of a theoretical framework to guide the study. Data for the study were taken from the publicly available NHANES 2013-2016. The NHANES is conducted by the CDC (2016) as a means for monitoring and providing information on health statistics for people in the United States. The population surveyed included children and adults who provided demographic information and health information. Participants for the NHANES provided their have by taking part in an interview during a health examination.

Definition of Terms

Chronic conditions: A chronic condition is a medical condition lasting 3 months or more that generally cannot be prevented by vaccines or cured by medication, as defined by the US Center for Health Statistics (as cited in Earnshaw & Quinn, 2012).

Diabetes: Diabetes mellitus (DM) as a cluster of metabolic illnesses characterized by hyperglycemia that is the result of defects in insulin action, secretion of insulin, or both (The American Diabetes Association [ADA], 2006). Diabetes cases can be categorized into two varieties: Type 1, which is caused by an absolute insulin secretion deficiency, and Type 2, which is caused by a combination of an inadequate compensatory insulin secretory response and resistance to insulin action.

Insulin dependency: Those who are insulin dependent require injectable insulin in instances when the pancreas produces little or no insulin to return the body to normal hormone levels and facilitate the conversion of sugar into energy through cells (Mayo Clinic, 2017).

Moderate physical activity: Light/moderate physical activity is described as causing light sweating or a slight-to-moderate increase in breathing or heart rate (CDC, 2016).

Vigorous physical activity: Vigorous physical activity is described as causing heavy sweating or a large increase in breathing or heart rate and light/moderate as causing light sweating or a slight-to-moderate increase in breathing or heart rate (CDC, 2016).

Recommended minimum amount of physical activity. According to the 2008 physical activity guidelines (U.S. Department of Health and Human Services, 2008), the recommended amount of physical activity is ≥150 minutes per week. Fewer than 150 minutes per week is not recommended. This guideline is calculated using the formula:

moderate activity in minutes + 2 * vigorous activity in minutes per week (CDC, National Center for Health Statistics, Health Indicators Warehouse, 2013).

Assumptions

This study had several assumptions. The first assumption was that the participants in the NHANES survey provided honest and unbiased answers. Researchers have a responsibility to protect the privacy of study respondents and to create a sense of trust to attain responses that are not biased (Creswell, 2008). The second assumption was that the data obtained from the NHANES are reliable and valid data. A third assumption was that the sample was representative of the study's target population. The results should be generalized to the sample of diabetic patients in the United States who are aged 18-years-old and over.

Scope and Delimitations

The focus of the study was on the relationship between physical activity and healthcare use and between physical activity and medication use among diagnosed diabetes patients. I addressed the relationship between physical activity and the number of times an individual uses healthcare services, such as doctor or hospital visits and the number of times an individual takes medication. For this study, the use of medication appropriate for managing the chronic condition of diabetes was defined as the number of times an individual uses an insulin shot and whether an individual is taking diabetic pills to lower blood sugar.

The scope of the study was limited to data collection from the publicly available 2013-2016 NHANES. This study only involved individuals who had been diagnosed with diabetes. These included males and females over the age of 18-years-old. This study did not include individuals who were prediabetic or were instructed to engage in prescribed behaviors for other health reasons. Pregnant women and children with diabetes were not included in this study.

The main behavior of interest in this study was physical activity level. I chose this as the main behavior based on the importance of physical activity as discussed in both the theoretical framework and relevant literature. There were presumably many behaviors that influence health outcomes in diabetic patients but I chose physical activity due to its importance as a health indicator in other diabetic studies (see Brethauer et al., 2013; Eisenstat et al., 2013; Müller et al., 2015; Sarathi et al., 2017). Although the theoretical framework discusses the importance of core health behaviors, such as physical activity, to health outcomes of patients with many chronic illnesses, the results were only applicable to individuals with diabetes.

Limitations

This study was limited in that it was a quantitative nonexperimental design and cannot determine a causal relationship between physical activity, healthcare use, and medication use among diagnosed diabetes patients. Another limiting factor was that the NHANES survey did not distinguish between Type 1 and Type 2 diabetics. However, the sample selected using an age group and diagnosis period should have eliminated the Type 1 diabetes. Furthermore, the data presented on the 2013-2016 NHANES were self-reported, creating the possibility of respondents misunderstanding the survey questions or misrepresenting their true behaviors. The information presented was anonymous, therefore limiting the motivation of respondents to misrepresent their true behaviors. Another limitation was that there were no physician reports regarding treatment plans or how patients should manage their disease. In addition, there were no data on medication adherence since it is self-reported.

Significance

The importance of the study lies in the growing number of individuals living with and managing the complications of the chronic disease diabetes (Earnshaw & Quinn, 2012; Shrivastava et al., 2013). Incidences of diabetes are expected to increase over the next 20 years, rising from 340 million people worldwide already diagnosed (Shrivastava et al., 2013). The prevalence and severity of diabetes as a disease makes its management a priority for healthcare professionals and patients. Managing the disease is important from the perspective of individuals diagnosed with diabetes. However, proper management of diabetes by healthcare providers also has ethical and monetary implications and this should be considered as well.

Diet and exercise are important for managing and preventing diabetes. From the perspective of healthcare organizations and insurance providers, preventing disease through inexpensive and noninvasive solutions reduces the necessity of emergency medical interventions that will bear greater cost than preventative measures (Musenge, Michelo, Mudenda, & Manankov, 2015). If the results of this study indicate that physical activity can reduce insulin dependency or the frequency of medication and can reduce the number of times a diabetic patient needs the use of healthcare, then there could be cost savings for both complying patients and health organizations. Managing patient health through physical activity could reduce symptomology at a lower cost, in addition to helping patients create healthy habits that would have further reaching medical implications than managing their condition.

Further study of diabetic individuals and the factors affecting these aspects of their health is necessary because they need consistent and well-managed treatment for their condition to have positive health outcomes (Eisenstat et al., 2013; Thomas et al., 2014; Tödt et al., 2015). However, there is limited empirical research on relationships between physical activity, hospital use, and the frequency of medication use. Examining the associations between these constructs has the potential to support research on managing quality of life outcomes for those individuals living with a chronic illness.

Summary

Individuals with diabetes are required to monitor their diet and physicality, as complications associated with the disease include poor health outcomes and physical limitations. The purpose of this quantitative, cross-sectional study was to analyze secondary data from the NHANES (CDC, 2016) to determine the relationships between physical activity, use of healthcare, and use of medication for diabetes patients within a 12-month period. Chapter 2 provides a detailed explanation of the literature search strategy, theoretical framework, discussion about definition and classification of diabetes mellitus, factors that influence diabetic health outcomes, and health behavior change in diabetic patients.

Chapter 2: Literature Review

The purpose of this study was to examine the relationship between physical activity, use of healthcare, and use of medication among diabetes patients. Past scholars have found an association between these variables without providing a definitive description of how they influence one another (Fan et al., 2015; Morgan & Trauth, 2013; Pibernak-Okanovic et al., 2015). Understanding the interactions among lifestyle variables such as healthcare seeking behavior, physical activity, and use of medication can help to clarify which lifestyle decisions are the best ones for diabetic patients to make. The purpose of this study was to examine secondary data from the NHANES data (CDC, 2016) to examine possible relationships between physical activity, use of healthcare, and medication use in diabetic patients over a 12-month period.

In Chapter 2, I provide a description of the literature search strategy followed by the theoretical framework of the study, which is Ryan's (2009) integrated theory of health behavior change. The chapter also includes a discussion of the definition and classification of DM, factors that influence diabetic health outcomes, and health behavior change in diabetic patients. Lastly, a summary will include the relevant findings discussed in this chapter.

Literature Search Strategy

The following online databases and search engines were used during the literature search: Google Scholar, Medline, PsycInfo, and EBSCOhost Online Research Databases. Key search terms and phrases used to search these databases included the following: *diabetes, healthcare, integrated theory of health behavior change, physical activity,* *exercise*, *insulin use*, *treatment adherence*, *medication adherence*, *health behaviors, chronic illness, chronic disease, diabetic patients, self-regulatory behaviors, diabetes self-management,* and *lifestyle factors*. The focus of the literature search was research published from 2012 to the present. In addition, seminal literature published prior to 2012 that was critical to understanding the topic was included.

Theoretical Framework

The foundational aspects of the integrated theory of health behavior change were used for their basis in self-management practices and efficacy for improving health outcomes over the course of patients' lifetimes (Ryan, 2009). Foundational components of this theory include a patient-centered approach that emphasizes patient knowledge, self-regulation skills and abilities, and facilitation of social skills (Ryan, 2009). These components are crucial to proper diabetes management. This theory was first presented by Ryan (2009) who used previous data to demonstrate the need for a theory on health behavior change that had identifiable and applicable clinical implications. Ryan posited that by fostering knowledge, enhancing self-regulation, and facilitating social interaction, changing the health habits and behaviors people choose becomes possible. The concepts of this theory can be used to develop an intervention intended to prevent or improve the symptoms of osteoporosis. This intervention was intended to enhance their self-efficacy, increase their knowledge, enhance outcome expectations, and establish goal congruence. The improvement of health and successful management of chronic conditions both depend on a person's engagement in healthy behavior (Happell et al., 2014).

Scholars have used similar foundational concepts for the purpose of better understanding people's decisions regarding health behaviors surrounding diabetes management (Hui, Hui, & Xie, 2014; Murphy, Chuma, Mathews, Steyn, & Levitt, 2015; Schmitt et al., 2016). Murphy et al. (2015) analyzed the motivations and experiences that encouraged effective self-management among patients with diabetes and/or hypertension in South Africa. Murphy et al. indicated that a majority of patients were not equipped to care for their illness, which often resulted in diabetic complications or negative health symptoms. One major reason many diabetic patients may not be living a lifestyle suitable for their chronic condition is a lack of knowledge or other resources regarding diabetes self-management. This finding supports the components of Ryan's (2009) proposition that patient knowledge is an integral part of proper diabetes self-management.

Hui et al. (2014) evaluated the association between perceptions of health behaviors and the enactment of that behavior and examined diabetic individuals' knowledge of how physical activity (PA) affects wellbeing in association with their regular level of physical activity. Hui et al. revealed that the levels of PA participants regularly participated in were positively associated with their knowledge of PA. The general education level of participants also influenced their levels of PA, indicating that the more educated participants were, the more likely they were to be physically active. Diabetic patients are more likely to properly manage their chronic condition if they have access to educational resources that emphasize the importance of a healthy lifestyle (Murphy et al., 2015; Ryan, 2009).

Researchers have also used foundational concepts from the integrated theory of health behavior change to create instrumental ways to quantify and analyze differences in the ways diabetic patients manage their condition. Schmitt et al. (2016) established the Diabetes Self-Management Questionnaire (DSMQ) to analyze behavioral problems associated with reduced glycemic control. The DSMQ should be the preferred tool for analyzing self-reported behavioral problems related to glycemic control reduction. Schmitt et al. also indicated that the DSMQ may be an asset for professionals investigating the causes of hyperglycemia in patients through self-management behavior evaluation. The DSMQ is an ideal instrument when researchers intend to use structural equation modeling to analyze the potential impact of factors (such as education level or mental health) on glycemic control and diabetes self-management. Instruments such as this one now make it possible to quantify essential aspects of diabetes self-management as postulated by Ryan (2009).

The rationale for the selection of the integrated theory of health behavior change as the framework for this study centers primarily around the present study's intent to determine ways to improve the proximal outcome of engagement in self-management behaviors and the distal outcome of improved health status in those with chronic conditions as a result of health behavior change (Ryan, 2009). Thus, using this framework to explore the relationship between factors that have been shown to influence health outcomes in diabetic patients, the focus of this study, was an ideal fit.

Definition and Classification of Diabetes Mellitus

The ADA (2006) defined DM as a cluster of metabolic illnesses characterized by hyperglycemia that is the result of defects in insulin action, secretion of insulin, or both. The chronic dysfunction of these diabetes-related processes can result in long-term damage to organs and bodily functions, particularly in those who do not adhere to treatments recommended for diabetic patients. As of 2016, over 29 million people in the United States were living with this condition, while another 86 million fit the criteria for prediabetes (CDC, 2016). The majority of diabetes cases can be categorized into two varieties: Type 1, which is caused by an absolute insulin secretion deficiency, and Type 2, which is caused by a combination of an inadequate compensatory insulin secretory response and resistance to insulin action. The degree of hyperglycemia experienced by diabetic patients can change over time, which may result in a shift in diabetes diagnosis, either between types or back to levels that are not consistent with a diabetes diagnosis. It is often less pertinent for healthcare professionals treating diabetes to establish a diabetes type and more important for them to investigate and resolve the underlying causes of the hyperglycemia (ADA, 2006).

Although diabetes has been studied in a gamut of research settings in the United States, other countries have only recently begun quantifying its impact on citizens. For instance, Soriguer et al. (2012) was the first national research conducted in Spain to examine how prevalent diabetes and impaired glucose regulation were in the country. The lack of focus on diabetes research in certain countries will likely change, however, as rates of diabetes are rising all over the globe. Ginter and Simko (2013) identified diabetes mellitus as a 21st-century pandemic. At the time of their study, over 10% of adults in the United States, Switzerland, and Austria had some form of the disease. Saudi Arabia had an even higher rate of diabetes within their adult population (Ginter & Simko, 2013). Norway, China, and Iceland were found to have some of the lowest rates of diabetes occurrence (Ginter & Simko, 2013). Ginter and Simko noted that epidemiologists predicted an increase of Type 2 diabetes occurrence by up to 2.5 times in Sub-Saharan Africa, India, Latin America, the Middle East, and the rest of Asia.

Factors That Influence Diabetic Health Outcomes

There is a multitude of influential factors that affect the health outcomes experienced by diabetic individuals (Herbst et al., 2015; Sohal, Sohal, King-Shier, & Khan, 2015). Those included in the following subsections have been narrowed to focus on the factors that exert the most influence over health outcomes and/or are the most pertinent to variables addressed in the present study. Self-management habits, use of healthcare, physical activity level, dietary practices, and adherence to recommended medication of individuals with diabetes will be examined.

Diabetes Self-Management Habits

The methods used by diabetic patients to self-manage their condition are predictive of their overall health outcomes (Calyuong et al., 2015; Herbst et al., 2015; Sohal et al., 2015). In the following subsections, I will review previous literature regarding barriers and facilitators to diabetes self-management, as well as the potential effects diabetes self-management can have on health outcomes.

Barriers and facilitators. Many individual factors act as either barriers or facilitators to diabetes self-management. Sohal et al. (2015) reviewed previous studies of South Asian patient perceptions of what factors helped and hindered their diabetes management. Research on South Asian diabetes management is of pertinent concern, as diabetes occurs at 50% higher rates in these countries as compared to global averages (author, year). Many scholars cited misconceptions, lack of knowledge, and lack of strategies that were culture-specific as a hindrance to effective diabetes self-management (author, year). Few researchers noted factors that encouraged proper self-management; family support and culturally appropriate strategies were acknowledged as influential to the process of managing diabetes (author, year). Overall, culturally fitting programs that place emphasis on discussing misconceptions of diabetes management that are common in South Asian communities, improving communication, and leveraging both family support and cultural beliefs as resources may improve diabetes management.

Caluyong et al. (2015) investigated the relationships among self-care habits, positive attitudes, depression, and perceptions of quality of life in individuals with Type 2 diabetes. Results from this study were not indicative of an association between self-care and mindfulness in the diabetes patients studied (Caluyong et al., 2015). There was also a negative association identified between depression and self-care and a positive association between self-care perceived quality of life (Caluyong et al., 2015). Caluyong et al. also revealed that patients acting nonjudgmentally regarding experience, practicing mindfulness, and not reacting to inner experiences had signs of lower depression and higher quality of life overall. Mental health is an influential factor with regards to the effective self-management of diabetes.

Chen and Chang Yeh (2015) examined how diabetic patients monitor their blood glucose levels to describe, interpret, and analyze results of a multitude of studies to better understand diabetic patients' experiences with self-monitoring blood glucose, in addition to offering recommendations for practical and clinical application. Chen and Chang Yeh demonstrated that patients were closely monitoring themselves while also interacting with the environment (and other people) during the process of self-monitoring blood glucose. Emotional perceptions, personal cognition, learning, and adjustment were associated with self-monitoring blood glucose behaviors (Chen & Chang Yeh, 2015). Therefore, emphasis on flexibility and individualization can help patients better adapt to the process. Similarly, Musenge et al. (2015) examined which glycemic self-management behaviors may influence glycemic control and/or glycemic control status. Musenge et al. showed that poor glycemic control remains a challenge to those living with diabetes. Antidiabetic treatment and fasting plasma glucose were correlated with the glycemic control status of diabetic patients, while exercise and self-monitoring blood glucose did not predict the status of glycemic control (Musenge et al., 2015). Musenge et al. also concluded that more in-depth research is needed regarding the efficacy of individual diabetes management strategies. These findings support an increased focus on diabetes self-management education regarding behaviors that are critical to diabetic health outcomes, including self-monitoring blood glucose and glycemic control.

Scholars point to the necessity for diabetic patients to seek information regarding self-management of their condition. Kalanzi et al. (2015) noted that this area of diabetes research was not well explored, especially the factor of how diabetic patients receive care. The forms of care studied included information about diabetes and self-management resources, as well as potential barriers to receiving the care necessary to manage the disease's potential complications (Kalanzi et al., 2015). Kalanzi et al. revealed that information about both diabetes complications and diet were the most pertinent to their overall health outcomes. Participants additionally expressed a need to obtain information directly from the doctor who was treating them, as most reported low Internet use (Kalanzi et al., 2015). Kalanzi et al. also indicated that patients felt the cost and time it took to find resources and information were their greatest barriers to better self-management behaviors. Morgan et al. (2013) investigated the socioeconomic influences that affect the information seeking behavior of diabetic patients in the United States. Morgan et al. examined the influence of proximity to adequate diabetic care, access to transportation to receive care, and use of the Internet as an accessible means to find information about managing diabetes. Patients without socioeconomic means to drive or travel long distances to receive diabetes care may seek more easily accessible means, such as the Internet, to understand their condition. Morgan et al. demonstrated that participants with a motivation to understand their diabetic condition were often motivated by having easily accessible diabetes care and a positive influence from their personal relationships. Although the study did have limitations with regards to participants and location, Morgan et al.'s conclusions provided a better understanding of the way that health information could be structured better and made available to a larger portion of diabetic users.

Ross, Benavides-Vaello, Schumann, and Haberman (2015) supported these conclusions regarding how access to diabetic healthcare and information resources impacts understandings of diabetes self-management. Ross et al. evaluated evidence related to issues that affect the self-management of Type-2 diabetes, specifically in rural communities. Challenges to diabetic self-management cited in the study included conflicting cultural views that may cause patients to choose self-management methods that are less effective than Western methods like insulin injections (author, year). Patients belonging to certain religious groups or ethnicities, for instance, may feel encouraged by their community to abstain from pharmaceutical treatment or other diabetic healthcare recommendations (author, year). Another challenge noted was limited educational background, financial resources, and/or literacy that impeded diabetes management (author, year). Lastly, issues pertaining to geography, such as living in an isolated mountainous region or distance to a clinic, were slightly less significant (author, year). There should be an increased focus on the consistency of diabetes care on the part of rural health care professionals, so their services align with The National Standards for Diabetes Self-Management (Beck et al., 2017).

Sometimes it is not lack of access to information that leads to poor self-management of chronic conditions, but who provides it and the form that information comes in. Harkness et al. (2013) investigated the self-management habits of British adults with chronic health conditions, including diabetes. Poor health symptoms discussed in this study included mental health problems and poor overall health functions (author, year). Harkness et al. found a significant amount of patient dissatisfaction, as well as dissatisfaction on the part of the providers treating those with the disease. These findings are indicative of communicative issues that occur between healthcare providers and patients who visit them regarding the management of their chronic conditions. These communicative problems need to be addressed to ensure that patients receive the best understanding possible regarding self-management, whether it be for diabetes or another chronic condition (Kalantzi, Kostagiolas, Kechagias, Niakas, & Makrilakis, 2015).

Effects of Diabetes Self-Management Habits on Health Outcomes

Diabetes self-management behaviors can directly impact both short-term and long-term health outcomes (Loprinzi, Smit, & Pariser, 2013). When clinical recommendations for diabetes self-management are not heeded by patients, their overall health and wellbeing can be affected in various ways (Loprinzi et al., 2013; Pevrot et al., 2013). In the following subsections, I will investigate common effects that can arise depending on the degree of diabetes self-management a patient engages in. The potential effects that will be discussed include common diabetic health complications and quality of life (QOL).

Complications. Countless health complications can come about as a result of poor adherence to diabetes self-management habits. Loprinzi et al. (2013) examined the potential relationship between comorbid conditions experienced by those with diabetes and separate health problems, including sensory function and physical impairments. Loprinzi et al. investigated if physical problems and/or sensory functioning impacted depression levels simultaneously or independently in diabetic individuals. Loprinzi et al. showed that impairments to vision, hearing, and physical function were related to higher depression levels; these negative health consequences were far more common in patients who did not adhere to their recommended diabetes treatment and/or self-management habits. Overall, those living with diabetes who had a greater number of health impairments showed a greater likelihood of being depressed (author, year). Those with higher levels of impairment required more attention and consideration during care, which could lead to less frequent complications related to diabetes.

Peyrot et al. (2013) reported similar findings regarding health complications due to poor self-management of diabetes. Peyrot included an assessment of specific mental health outcomes for adult individuals with diabetes. Overall, the condition of diabetes was found to negatively impact different aspects of a person's life, including physical health, relationships, and the presence of mental health conditions such as depression. Most participants indicated a lack of patient-centered care and support. Self-care management habits were rated as poor for most respondents, and less than half of respondents actually participated in diabetes education for self-management of their conditions. Schmitz et al. (2014) had similar findings after examining the association between the functionality of diabetes, depression occurrence, and diabetes self-management habits in Canadian subjects. Schmitz et al. found that approximately half of the participants demonstrated at least one symptom of depression. The researchers also found that the risk level for having poor health outcomes and/or physical impairment was approximately three times higher for those who had experienced four or more episodes of depression. This stresses the interdependent nature of diabetes self-management habits, mental health, and physical impairment for diabetic patients, as patients with poor mental health or physical abilities may be less likely to adhere to proper diabetes self-management (Pevrot et al., 2013). Pevrot et al.'s results also indicated that poor physical functioning and physical impairment often reduce the quality of life for those suffering from depression, as well as playing a role in increasing the risk of diabetes-related complications. Boehme, Geiser, and Renneberg (2014) confirmed the influence of physical health or impairment on depression in diabetic patients. Their research included data from over 3000 Type 2 diabetic individuals and further supported the complication-causing effects that physical health problems can have on the mental health and self-management ability of diabetic patients.

Some of the most serious complications that can occur due to diabetes self-management decisions are those related to cardiovascular health. While patients may be advised to use certain diabetes self-management strategies and treatments to help their condition, some may pose a threat to cardiovascular health. Scirica et al. (2013) examined the effects of glucose-lowering treatments or strategies on diabetic patients' cardiovascular risk levels. From the findings, saxagliptin significantly improved glycemic control, but it also increased the risk of hospitalization for heart failure or hypoglycemic events. The researchers noted that few antihyperglycemic agents have been analyzed as extensively, particularly for their effects on cardiovascular health. Thus, more common antihyperglycemic agents should be evaluated in similar large-scale studies to determine which one(s) is/are the least likely to increase diabetic patients' risk of cardiovascular complications.

Rubin et al. (2013) similarly investigated the correlation between depression, antidepressant use, and cardiovascular risks and complications among diabetic individuals. They found that depressed diabetic patients with high cholesterol, BMI, or blood pressure were more likely to experience cardiovascular health issues. These quantitative measures were associated with poor diabetes self-management habits, which include eating well and exercising to stay healthy. Anstee et. al. (2013) reviewed literature that focused on similar cardiovascular effects in diabetic patient populations. Specifically, they examined how a progressive spectrum of liver disease that is closely associated with Type 2 diabetes, is connected to an increased risk of both cardiovascular disease and other diabetes-related complications. Results indicated the high rate of liver-related morbidity among those with liver disease and confirmed support for liver diseases' association with Type 2 diabetes and abdominal obesity. This research points out the importance of treating liver disease early on to avoid the progression of the disease, as well as the importance of practicing healthy diabetes self-management habits to help avoid complications like liver disease. Liu et al. (2013) demonstrated similar findings regarding cardiometabolic risks in diabetic and non-diabetic populations in relation to their irisin level; their research was potentially the first to report a reduction in circulating irisin in Type 2 diabetes populations, which could have been due to the relatively limited sample size. The researchers observed that irisin was positively correlated with several factors of cardiometabolic risks such as fasting glucose, BMI, LDL-cholesterol, total cholesterol, diastolic blood pressure, and total triglycerides in the study's non-diabetic participants. The researchers hypothesized that the increased plasma irisin could have occurred in response to an increased burden of metabolic dysregulation in non-diabetic individuals, but further tests would be necessary to confirm this.

Other scholars have examined the diabetes self-management factors that make some diabetic patients more likely to experience specific diabetes complications than others. Loh et al.'s (2015) research examined ethnic disparities in rates of diabetic kidney disease (DKD) in a Singapore primary care cluster, as well as attempting to identify DKD risk factors within a multi-ethnic Asian population. To study this, healthcare data was examined from 57,594 patients of varying genders, ages, and ethnicities. Results indicated that patients with DKD tended to be older than those without it. More advanced stages of DKD also indicated a longer diabetes duration. Additionally, many ethnic sub-populations displayed different rates of DKD; 45.3% of Indians, 52.2% of Chinese, and 60.4% of Malays had DKD, respectively. Malays had a 1.42 times higher DKD prevalence, while Indians had a 0.86 times lower DKD prevalence. Other factors that were related to DKD occurrence were gender, duration of diabetes and hypertension, HbA1c, and body mass index (BMI). This research supports future investigation into the factors and causes behind varying levels of DKD prevalence among ethnic minorities and other sub-populations.

Another factor that influences diabetic self-management related health complications are the coping behaviors individuals choose post-diabetes diagnosis (Lawson et al., 2013). Lawson et al. (2013) studied the influential role in diabetic coping strategies, such as active self-care, played in improving health outcomes and avoiding diabetes-related complications. The authors investigated different coping strategies, how they were related to the patient's personality, and how the patients chose to adapt post-diabetes diagnosis. They examined newly-diagnosed patients in six-month intervals over the course of two years. Their results indicated that over the course of the study patients demonstrated reduced active coping. Their results also indicated less planning, a more negative outlook, less healthcare seeking behavior, and less social support. The trait found to be the most closely related to social support seeking and active coping was intellect. Additionally, feelings of threat stemming from their diabetes diagnosis also lessened over time. Those with a good foundational knowledge of diabetes and associated self-management behaviors showed the best planning and coping ability. Their results indicated the necessity of continually promoting health care seeking behavior, education about diabetes, and providing effective post-diagnosis treatment that promotes healthy coping behavior.

Quality of life. Poor health outcomes resulting from poor diabetes self-management can be highly-influential with regards to the quality of life (Daher, AlMashoor, & Winn, 2016). Daher et al. (2016) found that using insulin to obtain ideal glycemic levels resulted in a greater negative impact on quality of life than using tablets and/or changes in diet. Safita et al. (2016) also investigated the health-related aspects of quality of life in diabetic populations. Their research examined the complex relationship between health-related quality of life and diabetes in lower-middle income countries. This research was conducted through specifically studying populations with and without diabetes in Bangladesh. Results demonstrated that the burden of having diabetes places on health-related quality of life in Bangladesh is greater than in many other Asian, North American, or European countries. It was also acknowledged that lack of education, being female, a long diabetes duration, low income, and the presence of diabetes complications like a diabetic foot ulcer were statistically significant predictors for reduced health-related quality of life in Type 2 diabetes patients. Safita et al. (2016) concluded that additional preventative efforts and lowered socioeconomic boundaries are crucial to lessen the burden of diabetes and its associated complications on quality of life.

Healthcare Utilization of Diabetic Patients

The decisions diabetic patients make regarding their healthcare can exert incredible influence over their short and long-term health outcomes (Jimnez-Trujillo et al., 2015). Diabetic healthcare utilization components that will be discussed in the following sub-sections are adherence to diabetes treatment, clinical approach to treatment, mental health, and stigma.

Adherence to diabetes treatment. Adherence to diabetes treatment, such as taking prescribed medication or following a clinically recommended diet, can have a considerable impact on the health outcomes of those with diabetes (Jimnez-Trujillo et al., 2015). Jimenez-Trujillo et. al. (2015) attempted to quantify adherence to seven preventative clinical services among Spanish adults who have diabetes to identify possible predictors of adherence to multiple practices among diabetic adults and to compare service adherence with non-diabetic adults. The specific health services or types of services studied were cholesterol measurement, adherence to blood pressure checkup, vaccination against influenza, fecal occult blood test, dental examination, mammography, and cytology. They indicated that participants who adhered to these recommended health services were more likely to adhere to clinically recommended diabetes treatments as well. However, they found that adherence to recommended treatment was still poor, with 36% of participants studied completing less than half of the recommended practices based on their sex and age. Conversely, adherence was deemed acceptable for blood pressure and cholesterol checkups, as well as for mammography. Those with lower education status and unhealthy lifestyle choices who were not married or cohabitating were found to be the least likely to adhere to proper preventative care. Similar research by Sumlin et. al. (2014) examined how the treatment adherence habits of those with diabetes were impacted by the presence or lack of a mental health disorder (i.e., depression). Results indicated that those with depression were less likely to adhere to recommended diabetes treatments such as exercise, medication use, or healthy eating habits. Additionally, it was discovered that depression symptoms decreased patients' desire to seek diabetes treatment by inhibiting adherence to self-care behaviors.

While Jimenez-Trujillo et. al.'s (2015) and Sumlin et. al.'s (2014) discovered patient-only factors that impact adherence, other scholars has indicated the influential nature of the patient-physician relationship. Hynes, Byrne, Casey, Dinneen, & O'Haraet (2015) studied clinic attendance among 29 British youth with diabetes to better understand their patterns of healthcare utilization. Hynes et al. indicated that an open and collaborative communication style between the patients and healthcare providers increased the satisfaction and value patients associated with such services. Conversely, poor perceptions of healthcare providers and/or a lack of trust were discovered to be barriers to the uptake of such services.

Clinical approach to treatment. Another highly influential factor for diabetic health outcomes is the treatment approach utilized by those who provide them with health care services (ADA, 2014). The ADA (2014) released a recommended treatment guide that outlines standards for glucose monitoring, medication administration, and many other facets that encompass a holistic approach to diabetic treatment. However, it is important to note that not all of these treatment approaches are internationally recognized or adhered to by physicians. This explains the variety seen in traditional clinical approaches to diabetes in other countries in comparison to the United States.

Clinical approaches often vary between clinics, even within the same country or region. Adisa and Fakeye (2016) assessed the diabetes management approach utilized (and resulting outcomes) in two different endocrinology clinics in Nigeria. They analyzed data regarding diabetes-specific parameters, treatment adherence, self-management practices, and prescribed medications. They showed that different amounts and types of medication were administered when comparing the two clinics studied. Their research draws attention to the often-inconsistent treatment patients receive depending on the healthcare provider they choose, which can ultimately influence their health outcomes. Similar research conducted by Ferwana, Alshamlan, Al Madani, Al Khateeb, and Bawazir (2016) compared the success of diabetic control at community diabetic centers (CDC) and primary health-care centers (PHCC) in Saudi Arabia. Ferwana et al. demonstrated that both CDCs and PHCCs were ineffective at improving either HbA1c or

BMI over the course of 5 years. Lipid profiles, however, improved in both healthcare settings. Regardless of the clinical approach that was utilized, poor health outcomes occurred often. Thus, they demonstrated the necessity of improvements to healthcare offered to diabetic patients in the healthcare settings that were studied.

Clinical approaches to diabetes treatment may also vary based on the presence or absence of other chronic conditions which may require treatment (Atlantis et al., 2014). Atlantis et. al. (2014) reviewed research that examined how a collaborative care model can help patients living with comorbid conditions. In particular, they examined those who were living with both diabetes and depression. They discovered that the collaborative care model improved both glycemic scores and depression levels in seven different trials. Atlantis et al. noted that no association was uncovered between depression reduction and predicting improved glycemic control. However, they provide support for the collaborative care model for improving comorbid conditions, particularly in the context of diabetes and depression. Similarly, Schierhout et. al. (2013) examined how depression impacts those living with other chronic conditions, as well as how these patients are managed by health care providers. The researchers specifically examined how depression levels were documented, how physical problems influenced these levels, and the use of prescribed antidepressants by Type 2 diabetes in an Australian primary health care setting. Data from over 40 separate health centers was evaluated, including information concerning standards of practice and quality of care within the past 12 months. They compared normative healthcare practices with regards to screening for and documenting depression, as well as prescriptions prescribed to patients with varying levels of disease severity. It was discovered that patients who were treated for glycemic control problems were screened less frequently for depression than those not receiving glycemic control treatment. Additionally, no correlation was found between prescribed antidepressants and diabetes severity or control. Screening for depression was particularly low for patients with higher diabetes severity. In their findings, they point to an urgent need for diabetic treatment options that encourage screening and/or treatment for other conditions that may impact health outcomes in diabetic patients.

Aside from making diabetes treatment less effective, ignoring comorbid conditions or symptoms is one avenue by which diabetic patients can experience adverse treatment-related effects (McEwan et al., 2016). McEwan et al. (2016) investigated both the combined and individual contributions of HbA1c, hypoglycemia frequency, and weight changes for predicting quality adjusted life years for a population of individuals with Type 1 diabetes. In the results section, they highlighted the positive impact of glycemic control improvement on quality adjusted life years can be offset by treatment-specific adverse effects. Specific adverse effects that were uncovered in this study included hypoglycemia and weight gain, symptoms which can worsen or otherwise influence diabetes symptoms. Another study conducted by Singh et al. (2013) investigated the potential effects of glucagonlike peptide 1 (GLP-1)-based therapy in adults ages 18-64 years old with Type 2 diabetes. They highlighted a significantly greater risk of hospitalization for acute pancreatitis, as well as a significant association between acute pancreatitis and the use of sitagliptin or exenatide. Thus, keeping treatment-related adverse effects to a minimum is critical to ensure the benefits of treatment are not outweighed by other negative health consequences.

Additional scholars have indicated that treatment for other diseases and symptoms can worsen diabetes, or even cause its occurrence in non-diabetic patients (Culver et al., 2012). Culver et al. (2012) examined the relationship between statin use for high-cholesterol and new-onset diabetes within populations of postmenopausal women. The authors concluded that post-menopausal women had a heightened risk for diabetes if they took statin medication, although the degree of increased risk in relation to statin dosage was unclear. They pointed to the importance of ensuring treatment for other health concerns does not interfere with, or even potentially cause, diabetes.

More recently, scholars have examined treatments that lead to favorable health outcomes for diabetic patients. Müller et al. (2015) assessed how German patients with Type 2 diabetes utilize healthcare and treatment options; particularly, they were interested in information regarding the treatments they received and the associated cost. Data from 2.7 million people in the Allgemeine Orts-Krankenkasse database (the largest statutory health insurance provider in Germany) identified as Type 2 diabetic was utilized. They indicated both the prevalence of Type 2 diabetes and cost of care are increasing in Germany and that favorable health outcomes, such as increased quality of life, were more likely for diabetic patients who pursued blood pressure therapy in a clinical setting than those receiving no blood pressure treatment. Additionally, regional differences in the prevalence of diabetes were uncovered, which was attributed in part to differences in diabetes treatment. Similarly, Bhatt, Thomas, and Nanjan (2012) uncovered results regarding the effects of a specified treatment on diabetic health outcomes. Bhatt et al. sought to examine the effects of oral resveratrol medication on glycemic control and associated risk factors in patients with Type 2 diabetes. They supported the researchers' hypothesis that improved glycemic control and associated risk factors would occur as a result of oral resveratrol supplementation. In their findings, they also indicated that resveratrol may be a beneficial adjuvant therapy in conjunction with a traditional hypoglycemic regimen to treat Type 2 diabetes. The American College of Physicians (Qaseem et al., 2012) provided additional support for oral pharmacological treatment for Type 2 diabetes. Qaseem et al. created a guideline for treatment based on a systematic review of the literature. They provided three key recommendations for oral medication to administer to Type 2 diabetes patients: 1) healthcare professionals should add oral pharmacological treatment when lifestyle modification, including exercise, diet, and weight loss, are unsuccessful at improving hyperglycemia, 2) monotherapy with metformin should be prescribed for initial pharmacological therapy to treat the majority of patients, and 3) a second agent should be added to metformin in order to treat patients with hyperglycemia that persists when monotherapy and lifestyle changes with metformin fail to regulate hyperglycemia. In their findings, they provide strong evidence for specific treatment options that have successfully helped diabetic patients achieve favorable health outcomes.

Mental health. The mental health of patients is another critical factor that can influence diabetic health outcomes. Indeed, scholars indicates that the comorbid occurrence of diabetes and mental health conditions, such as depression, can reduce patients' quality of life and detrimentally impact overall health outcomes (Atlantis et al., 2014; Fisher et al., 2012; Pibernik-Okanović et al., 2015; Sacco et al., 2013). Fisher et al. investigated the cause of negative mental health outcomes in diabetics and found that diabetes and depression affect one another in comparable ways due to the associated biological, mental, physical, and cultural factors. Their findings indicated that cooperation between public health officials and health care providers was crucial to ensuring a proper understanding of the relationships between mental health, physical health, and diabetes.

Sacco Bykowski, and Mayhew (2013) also studied negative physical health outcomes that mediate mental health symptoms in diabetic patients. Sacco et al. investigated whether functional injury and/or pain mediate the association between depression and diabetes symptoms in those with Type 2 diabetes. They hypothesized that poor management of diabetes symptoms would result in poor physical and negative mental health outcomes. They found that functional injuries and pain significantly (but independently) influence depression. Additionally, they found that the increased occurrence of mobility problems, as well as pain related to the weight of participants, significantly contributed to higher levels of depression. Scott et al. (2012) conducted a similar study investigating the prevalence of chronic physical health illnesses, such as diabetes, that occur alongside diagnosed mental health disorders in Australian adults. Scott et al. found that there was a higher rate of reported mental health issues in those with a higher BMI; additionally, adjusted odds rations concerning disorders such as asthma, diabetes, coronary heart problems, and irritable bowel syndrome demonstrated that chronic physical illnesses was significantly related to participants having or not having mental health issues. In their findings, they highlight the notion that taking mental health conditions into account when treating chronic physical illnesses is imperative to the success of treatment. Thomson et al. (2012) also demonstrated support for these conclusions. They indicated participants' motivations, moods, and physical complaints were associated with the severity of their chronic health condition symptoms, and that symptoms of depression were related to their physical illness symptoms. Therefore, it can be deduced that treating physical health problems can also impact mental health outcomes related to diabetes, and vice versa.

Stigma. Another component of diabetic health outcomes is the impact of the stigma associated with receiving healthcare for a chronic illness (Earnshaw & Quinn, 2012). Earnshaw and Quinn (2012) posit that approximately 50% of adults with a chronic illness have experienced or felt illness-related stigma while receiving related healthcare services. They utilized 184 voluntary participants who had chronic diseases such as diabetes and asthma. They suggested that participants who had experienced condition-related stigma outside of a healthcare setting were less likely to utilize treatments recommended by healthcare providers, as they also expected to experience stigma in a healthcare setting. In turn, participants who experienced stigma the most were also more likely to experience poor health outcomes than those who were not impacted by stigma. In this way, helping patients to feel less stigma in a healthcare setting is critical for positive health outcomes in diabetic patients.

Physical Activity Level and Diabetes

Physical Activity level before diabetes diagnosis. A person's physical activity (PA) level can greatly influence their likelihood of developing diabetes later in life. Fan et al. (2015) examined the relationship between the occurrence rate of Type 2 diabetes and PA level in middle to older aged Chinese adults. The participants did not have diabetes or heart disease at the beginning of the study. The participants' PA level was estimated based upon their self-reported daily exercise habits that ranged from sedentary to very active. Fan et al. concluded that higher PA levels were positively correlated with a reduced risk of developing Type 2 diabetes after adjusting for body mass index and fasting plasma glucose level.

PA level after diabetes screening. Changes to PA level may occur as a measure to avoid diabetes after those who are at risk for diabetes get screened for the disease (Vähäsarja et al., 2015). Vähäsarja et al. (2015) conducted qualitative research to assess whether those with diabetes risk factors change their exercise habits based on recommendations during a diabetes screening. Emerging themes from the results included perceptions of threat concerning the adoption of changes to PA level. Some participants felt a threat when faced with the notion that they were at risk for diabetes, while other denied or ignored the risk. Those who developed a sense of threat increased their PA level after the initial screening. Additionally, some participants experienced hopelessness and/or inevitability with regard to developing the disease. Those who rejected the screening results demonstrated skepticism and made no change to their PA level. Implications from the study show those who are at risk for developing diabetes should be encouraged to be more active, but the way by which they are notified of their risk status must be handled with care. In another research, Tanner et al. (2015) partially confirmed these findings. Tanner et al. examined whether being screened for diabetes would influence health outcomes by bringing to light the importance of health behaviors like physical activity. They indicated that no change in health outcomes came about directly from patients taking part in a diabetes screening. However, if the patient then opted to treat glucose-related issues detected in the screening with glucose lowering drugs and increased health behaviors like physical activity, the progression of diabetes was significantly delayed.

Changes to PA level after diabetes diagnosis. Other changes to PA level can occur resulting from a diabetes diagnosis, depending on the presence or absence of influential factors (Priess et al., 2014). Priess et al. (2014) determined whether those who are diagnosed with Type 2 diabetes change their regular PA levels post-diagnosis. A total of 2816 participants with diabetes took part in a rigorous lifestyle modification program which was consistent with similar programs studied in past diabetes research. They concluded that those who developed Type 2 diabetes had no change in physical activity level following completion of the program, although they had made significant changes to their physical activity level while participating.

Other scholars have examined specific long-term and short-term health outcomes associated with physical activity level in those with diagnosed diabetes (Herbst et al., 2015). Herbst et al. (2015) examined the effects of regular physical activity on blood glucose control and cardiovascular risk factors in adolescent participants with Type 2 diabetes. They inestigated whether lifestyle modification, especially as it pertained to physical activity, could improve either glycemic control or cardiovascular health in adolescents with Type 2 diabetes. They demonstrated that over half the participants were rarely physically active, and more of these inactive patients were girls than boys. Non-exercising individuals also tended to be older than those who were physically active. The researchers concluded that those with a higher frequency of regular physical activity had improved blood glucose levels (i.e., lower HbAlc levels), a lower BMI, and a higher HDL-cholesterol. They alos suggested that the positive effects of regular exercise among diabetic adolescents may have made them less reliant on using insulin. In a similar study, Liese et al., (2013) found increased physical activity and low levels of sedentary behavior were linked to a decrease in long-term cardiovascular complications and disease in diabetic patients. The scholars provide clear support for those with Type 2 diabetes who practice regular physical activity experiencing more favorable health outcomes that those who engaged in more sedentary lifestyles.

Yet in another study, Pibernik-Okanović et al. (2015) reported positive effects of physical activity on diabetic adults that included reduced diabetic distress, improved diabetic management, and improved metabolic control. Pibernik-Okanović et al. examined whether the treatment of subsyndromal depression would result in improved depression-related and diabetes-related outcomes among adult Type 2 diabetes patients. They included an examination of the efficacy of psychoeducation and physical exercise on 1-year changes in levels of depressive symptoms, diabetes distress and self-management, and quality of life and metabolic control. They showed that depressive symptoms in participants who participated in the psychoeducational program and engaged in regular physical exercise significantly improved equally from baseline to 12-month follow-up. In addition, significant improvements were found in diabetes distress and quality of life, diabetes self-care, triglycerides, and total cholesterol and LDL-cholesterol as a function of psychoeducation and physical exercise.

The association between physical activity and mental health outcomes in those with chronic conditions has also been examined recently (Vallance et al., 2015). Vallance et al., (2015) investigated the relationship between physical activity level and mental health outcomes only in participants who had survived colon cancer. Their results indicated that participants who reported moderate physical activity experienced a more positive outlook and greater life satisfaction than those who did not exercise regularly. These results highlight the importance of exercise for those with or recovering from serious health conditions, as diabetic patients are more likely to adhere to other suggested health behaviors when they feel physically healthy (Loprinzi et al., 2013). Similarly, Lee (2015) assessed the relationship between physical activity and depression symptoms on elderly women with various chronic diseases. Participants' physical activity level was measured by assessing their capability of completing physical tasks including gripping, a six-minute walk, 30 second chair stand, 30 second arm curl, and similar sit and reach exercises. Significant relationships were discovered between some of the exercises and depression levels. Conversely, no association was discovered between BMI and depression, back strength, or stance. The participant's ability to effectively perform most of the physical exercises was ultimately connected to depression symptoms, a finding that is suggestive of physical activity contributing to the prevention of depression. This association between physical activity and depression is particularly relevant to diabetic patients, as the comorbid occurrence of depression and diabetes can lead to poor adherence to diabetes treatment and poor overall health (Loprinzi et al., 2013).

Physical activity is a factor that impacts health outcomes in diabetic patients (Palmer et al., 2012). The positive association between physical activity and overall health has long been established as a fundamental principle of healthcare, but research also indicates that physical activity may be important for individuals suffering from chronic diseases such as diabetes (Palmer et al., 2012). Palmer et al. (2012) compared the health outcomes of four groups of Mexican Americans over the age of 65. The groups included individuals with and without diabetes who exercised less than 30 minutes a day, and individuals who exercised more than 30 minutes a day. They included 3,050 participants, and the researchers compared the longitudinal rate of change in disability and physical impairment using a latent growth curve modeling approach to create a model involving disability and physical function data. They found that diabetics who exercised more than 30 minutes/day had significantly slower functional decline over a ten-year period compared to diabetics who exercised less than 30 minutes a day. Their results showed that moderate activity slowed functional decline (i.e., difficulty performing daily activities such as walking, standing, or balancing) among diabetic individuals (Palmer et al., 2012). Comparisons between diabetes statuses within the same physical activity groups showed worse disability trajectories among those with diabetes. Thus, physical activity level played a critical role in the functional decline and/or disability patients with diabetes felt in their everyday lives. The longitudinal decline in physical function and disability was moderated most notably by physical activity. The diabetes status further moderated decline in function and disability over time. Increased physical activity appeared to be protective of disability in general and lessened the influence of diabetes-related disability in older Mexican Americans, particularly at the end of life.

In summary, physical activity level appears to play a critical role in the functionality and/or disability patients with diabetes feel in their everyday lives (Palmer et al., 2012), as well as the symptoms and health outcomes associated with their condition (Herbst, et al, 2015; Tödt et al., 2015; Thomas et. al., 2014), and the general state of their mental health (Vallance et al., 2015). Again, the scholars would suggest that the positive effects of physical exercise on diabetic outcomes might lead to fewer doctor visits and less reliance on insulin.

Dietary Practices of Diabetic Patients

Dietary practices are another key lifestyle variable which influences diabetic health outcomes Ozcariz et al., 2015). Ozcariz et al. (2015) utilized a population-based approach to examine the regular dietary practices of those with diabetes and hypertension in comparison to the diets of healthy people, in Florianópolis, Brazil. In their results, they indicated that healthy dietary practices were low in occurrence in the healthy participants, as well as for those with diabetes and/or hypertension. This was concerning to researchers considering the high mortality rate for both diseases studied. Additionally, the overall health of these diabetic participants was found to be directly impacted by their dietary habits. In particular, regulating blood glucose successfully was much harder for participants who did not follow a healthy diet. Overall, it was determined that healthy eating habits needs to be encouraged at an educational and policy level, particularly to benefit individuals with chronic conditions like diabetes whose health outcomes depend, in part, on their dietary choices.

Summary and Conclusions

In summation, diabetes mellitus is a chronic condition characterized by hyperglycemia, which is attributable to a variety of insulin-related causes. The complications and health problems that can arise from diabetes make understanding which patient factors are most influential to favorable diabetic health outcomes critical. Commonly cited influential health factors include healthcare utilization, physical activity level, medication adherence, dietary practices, and diabetes self-management. Efforts to improve health behavior change in diabetic patients often point to the importance of diabetes self-care and self-management education programs. A number of health behavior intervention programs have also found success; these methods included yoga, acceptance commitment therapy, diabetes reversal interventions, behavioral health coaching, and group visits. A gap exists in the literature regarding the specific influence of physical activity on healthcare utilization and medication use among diabetes patients. This research will address this literature gap by examining the relationship between these variables among diabetic patients.

In Chapter 3, I will outline the research method to be used. The research design and rationale will be discussed. The methodology will be outlined, including the population, sampling procedure, instrumentation and operationalization of constructs, data analysis plan, and threats to validity. Ethical procedures will be discussed as well.

Chapter 3: Research Method

The purpose of this quantitative, cross-sectional study was to analyze secondary data from the National Health and Nutrition Examination Survey (NHANES; CDC, 2016) to examine the relationships between physical activity, use of healthcare, and use of medication among diabetes patients within a 12-month period. In Chapter 3, I discuss the research design and rationale, research questions, and methodology. This includes a discussion of the sampling and sampling procedures, data collection and use of archival data, instrumentation, and data analysis plan. The chapter concludes with a discussion of threats to validity and ethical procedures.

Research Design and Rationale

I used a nonexperimental survey design in this study. The data came from the NHANES database for the years 2013 through 2016 (CDC, 2016). Data from the CDC database were used to examine the relationships between physical activity, healthcare use, and medication use among Type 2 diabetics over a 12-month period.

For the first set of research questions (1a and 1b), the independent variables included healthcare use (low, med, high) and type of medication use (taking insulin, taking diabetic pills, no medication). The dependent variables included activity level (number of days of moderate activity at work and recreation) and activity level (number of days of vigorous activity at work and recreation). Thus, Research Questions 1a and 1b were analyzed using a 3 X 4 between-groups MANOVA.

For the second set of research questions (2a through 2d), multinomial logistic regression was used testing each predictor’s effect while controlling for each of the other predictors. The predictor variables included age, gender, race, and physical activity (meeting/not meeting the minimum guidelines for the amount of physical activity per week). The discrete outcome variable was medication use (taking insulin, taking diabetic pills, no medication).

A quantitative research method with a correlational design was appropriate for this study to examine relationships between variables. According to Creswell (2013), researchers using quantitative data emphasize objective measurements and the statistical, mathematical, or numerical analysis of data collected through questionnaires and surveys or by manipulating preexisting statistical data using computational techniques. A qualitative approach was not appropriate, as qualitative researchers focus on establishing a theory, a model, a definition, or the understanding of a phenomenon (Creswell, 2013). Due to the nature of the archival data set, a quantitative nonexperimental design was the best fit for this study because it determined if there was a relationship between physical activity, healthcare use, and medication use among Type 2 diabetes patients in the past 12 months.

Methodology

Population

The data for the study were taken from the publicly available NHANES II and III. The NHANES is a survey conducted by the CDC (2016) as a means for monitoring and providing information on health statistics for people in the United States. NHANES data from 2013-2014 and 2015-2016 were used. The population surveyed included children and adults who provided demographic information and health information. Participants for the NHANES provided their information by taking part in an interview during a health examination. A sample of 27,801 persons aged 6 months to 74 years of age participated in the nationwide survey for the NHANES II taking place between 1976-1980 (CDC, 2016). A sample of 39,695 people aged 2 months and older participated in the NHANES III that took place between 1988 and 1994 (CDC, 2016). Both NHANES II and III are publicly available data sets. Thus, no permission was required for access.

Sampling and Sampling Procedures

I employed purposive sampling. Purposive sampling is a nonprobability sampling technique in which the researcher relies on his or her own judgment when choosing members of population to participate in the study based on characteristics of a population and the objective of the study (Yang & Banamah, 2014). Purposive sampling was conducted because it has certain advantages applicable to this study. These include greater accessibility, faster speed, and lower costs associated with recruiting samples for the study (Coy, 2008). A purposive sampling strategy was chosen for the study because participants need to meet a set of inclusion criteria to be eligible to participate in the study (see Yang & Banamah, 2014). The inclusion criteria of the study were individuals aged 40-60 years who had been diagnosed with diabetes (with no other comorbid conditions) in the last 5 years. Using this age group and time of diagnosis excluded most individuals diagnosed Type 1 diabetes. The sample included only individuals who had Type 2 diabetes. Only those with diabetes confirmed by the diagnosis of the physicians were included in the sample. Also, the sample of data excluded pregnant women and children. Individuals with other comorbidities (e.g., heart issues, stroke, etc.) were also excluded.

Power analysis was conducted through G*Power software (see Faul, Erdfelder, Lang, & Buchner, 2007). The sample size computation was based on effect size, the level of significance, and the statistical power. The power analysis for the 3 X 4 MANOVA included the following parameters: (a) statistical power of 0.95, which is normally used in quantitative studies (Faul et al., 2009); (b) medium effect size of *f*2(v) = .0625; (c) significance level of 0.05; (d) nine groups; and (e) two dependent variables. This yielded a minimum recommended sample size of 152 (see Appendix A). Although a minimum sample size of at least 152 was required, all of the participants in the database who met the criteria for inclusion were selected.

The calculation of a minimum sample size for logistic regression requires previous knowledge about the expected odds ratio, a proportion of observations in either group of the dependent variable, and the distribution of each independent variable. If these are not known, it is best to use an estimate to determine an appropriate sample size. Hosmer, Lemeshow, and Sturdivant (2013) suggested a minimum sample of 10 observations per independent variable in the model but cautioned that researchers should seek 20 observations per variable if possible. Likewise, LeBlanc and Fitzgerald (2000) suggested a minimum of 30 observations per independent variable. Using the calculation suggested by Leblanc and Fitzgerald, a minimum sample size of 120 was required for the logistic regression (30 X 4 = 120). Because the power analysis for MANOVA resulted in a larger sample size, I used the recommended sample size of 152 for the study.

Procedures for Recruitment, Participation, and Data Collection

The NHANES population sample was selected through a random statistical process based on U.S. Census information by the CDC. The NHANES combines health interviews and physical examinations to evaluate the health and nutritional status of the noninstitutionalized civilian U.S. population. Local health and government officials in each survey location were notified prior to the actual survey. Potential participants received letters from the NCHS director introducing the survey. Officials conducted health interviews in the participants' homes while the physical examinations were conducted inside mobile examination centers.

Officials used advanced computer systems to collect and process the NHANES data. This enabled the NHANES staff to access the NHANES data within 24 hours after collection and ensure the respondents' privacy. The participants were provided transportation to and from the exam center and were also given compensation for their participation. A report of the medical findings of the participant was also provided by the CDC, which is the agency that administered the NHANES. No names were collected during the survey process, and participant information was kept strictly confidential (CDC, 2016).

Data collected from the NHANES are used to develop public health and safety policies, create health programs and services, and deepen the understanding of health for the nation. National standards for height, weight, and blood pressure are benchmarked on the data collected by the NHANES. The data are also used to assess the incidences of major diseases and the risk factors for diseases. Lastly, the NHANES data are also used to establish U.S. residents' nutritional status and its effect on promoting health and mitigating the development of diseases (CDC, 2016). More information about the NHANES can be accessed from the CDC website. To gain access of the data from the NHANES, I accessed the CDC's website and was directed to the subsection on the NHANES where the datasets were available for download.

The inclusion criterion of the sample were individuals diagnosed with diabetes who were aged 40-to 60-years-old. Only the NHANES data during years 2015 to 2016 were used while the data during years 2013 and 2014 were not used in the final data collection due to NHANES process changing. In the year 2018, NHANES updated their process for obtaining information and the turn-around time is 60 to 90 days. The current database of NHANES during the years 2015 to 2016 was sufficient for the sample requirement of this study. I used archival data from the NHANES for the years 2015 through 2016. I pulled all of those reporting diabetes from both data sets and combined them.

Instrumentation and Operationalization of Constructs

The NHANES is a program of studies designed to assess the health and nutritional status of adults and children in the United States. The survey is unique in that it combines interviews and physical examinations. NHANES is a major program of the National Center for Health Statistics (NCHS). NCHS is part of the CDC, and it has the responsibility for producing vital and health statistics for the Nation. The NHANES program began in the early 1960s and has been conducted as a series of surveys focusing on different population groups or health topics (CDC, 2016). The survey examines a nationally representative sample of about 5,000 persons each year. Participants are located in counties across the country, 15 of which are visited each year.

The NHANES interview includes demographic, socioeconomic, dietary, and health-related questions. The examination component consists of medical, dental, and physiological measurements, as well as laboratory tests administered by trained medical personnel. Data were also collected on the prevalence of chronic conditions in the population. Risk factors, those aspects of a person's lifestyle, constitution, heredity, or environment that may increase the chances of developing a certain disease or condition, were also collected by the NHANES survey. The diseases, medical conditions, and health indicators studied included the following:

- Anemia
- Cardiovascular disease
- Diabetes
- Environmental exposures
- Eye diseases
- Hearing loss
- Infectious diseases
- Kidney disease
- Nutrition
- Obesity
- Oral health
- Osteoporosis

- Physical fitness and physical functioning
- Reproductive history and sexual behavior
- Respiratory disease (asthma, chronic bronchitis, emphysema)
- Sexually transmitted diseases
- Vision

Smoking, alcohol consumption, sexual practices, drug use, physical fitness and activity, weight, and dietary intake were also included. Data on certain aspects of reproductive health, such as use of oral contraceptives and breastfeeding practices, were also collected. NHANES findings are basis for national standards for such measurements as height, weight, and blood pressure.

The NHANES surveys have been widely used in epidemiological research. The NHANES has been conducted periodically since the early 1960s and has become a continuous survey with data released every 2 years since 1999 (CDC, 2016). Honda (2014) evaluated the test-retest reliability of the NHANES 2011–2014 protocol involving 77 adults at baseline and 2.5 weeks. Intraclass correlations ranged from $r = 0.47$ to $r = 0.71$ (moderate to strong). The NHANES protocol has acceptable or good levels of test-retest reliability. Archer, Hand, and Blair (2013) investigated the NHANES caloric energy intake data from years 1971–2010 and found that across the 39-year history of the NHANES, energy intake data on the majority of respondents were accurate or reasonable data. Improvements in measurement protocols after NHANES II led to small decreases in underreporting, artifactual increases in reported energy intake, but only trivial increases in validity in subsequent surveys. The confluence of these results and other methodological limitations suggest that the ability to estimate population trends in caloric intake and generate empirically supported public policy relevant to diet-health relationships from U.S. nutritional surveillance is limited. Also, Rawal, Hoffman, Honda, Huedo- Medlin, and Duffy (2015) investigated the test-retest reliability and validity of the taste and smell questionnaire in the United States NHANES for the years 2011 to 2014. These included a report of the short- and longer-term test-retest reliability and validity of this protocol against broader chemosensory measures involving 73 adults (Rawal et al., 2015). Intraclass correlations for NHANES taste measures showed moderate-to-good agreement after 2 weeks (r = 0.42) and 6 months (r = 0.71). There were higher intraclass correlations beyond 6 months wherein the CSQ items showed good-to-excellent agreement over 6 months (r = 0.66 and r = 0.90; Rawal et al., 2015). Whole-mouth quinine intensity was significantly correlated with other taste intensities, supporting its utility as a marker for overall taste functioning (Rawal et al., 2015). Lastly, the reliability of eight different anthropometric measures from the NHANES was investigated by Marks, Habicht, and Mueller (1989) who found that the anthropometric measures of weight, height, sitting height, and arm circumference had reliabilities in excess of r = 0.97, which showed high reliability. The other anthropometric measures of triceps and subscapular skinfolds, the breadth, and elbow breadth also showed acceptable reliabilities (r = 0.81 to r = 0.95). The reliability appears to be adequate in all anthropometry in the NHANES II.

Physical Activity

Physical activity was measured on the NHANES with four survey items: (a) number of days engaging in moderate activity at work, (b) number of days engaging in vigorous activity at work, (c) number of days engaging in moderate activity for recreation, and (d) number of days engaging in vigorous activity for recreation. Light/moderate physical activity was defined as causing light sweating or a slight-to-moderate increase in breathing or heart rate (CDC, 2016). The NHANES survey defined vigorous physical activity as causing heavy sweating or a large increase in breathing or heart rate and light/moderate as causing light sweating or a slight-to-moderate increase in breathing or heart rate (CDC, 2016).

Moderate physical activity was measured using two questions. NHANES question PAQ.625 asked, “In a typical week, on how many days do you do moderate-intensity activities as part of work?” NHANES question PAQ.670 asked, “In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational activities?” Vigorous physical activity was measured using two questions. NHANES question PAQ.610 asked, “In a typical week, on how many days do you do vigorous-intensity activities as part of your work?” NHANES question PAQ.655 asked, “In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational activities?” Participants responded to each of the physical activity questions by entering the number of days between 1 and 7 days. The number of days of moderate physical activity (at work and recreation) and the number of days of vigorous physical activity (at work and recreation) served as the dependent variables in the 3 X 4 MANOVA.

For the multinomial logistic regression, participants were divided into two categories according to the 2008 physical activity guidelines (U.S. Department of Health and Human Services, 2008): not meeting the recommended amount of physical activity (fewer than150 minutes per week) and meeting the recommended amount of physical activity (≥150 minutes per week). This was achieved by calculating the amount of physical activity performed per week in minutes using the formula: moderate activity in minutes per week + 2 ∗ vigorous activity in minutes per week (Centers for Disease Control and Prevention, National Center for Health Statistics, Health Indicators Warehouse, 2013). This equivalent combination formula was based on the assumption that 1 minute of vigorous activity is equivalent to 2 minutes of moderate activity (U.S. Department of Health and Human Services, 2008; Centers for Disease Control and Prevention, National Center for Health Statistics, Health Indicators Warehouse, 2013). This dichotomous physical activity variable (meeting/not meeting the recommended guidelines) served as a predictor variable in the multinomial logistic regression (predicting type of medication use).

Healthcare Use

Healthcare use had two measures. NHANES question HUQ.051 asked, “During the past 12 months, how many times have you seen a doctor or other health care professional about health at a doctor's office, a clinic or some other place?” Any participants who responded “don’t know or refused” to this question were excluded from the sample. NHANES question HUQ.080 asked, “How many different times did you stay in any hospital overnight or longer during the past 12 months?” The participants responded to this question using the actual number of times they stayed in the in any hospital overnight or longer. Any individual who reported he or she stayed overnight in a hospital was excluded from the sample. I then create three levels for the healthcare use variable (low, medium, and high) depending on the distribution of scores on the measure of healthcare use. Thus, healthcare use (number of times individual has seen a doctor/healthcare professional at doctor’s office or clinic, excluding anyone with overnight hospital stay: low, med, high) served as one of the independent variables in the 3 X 4 MANOVA. The possible response values of number of times individual has seen a doctor/healthcare professional at doctor’s office or clinic was between 0 to 8 times. The categorization of low, medium, and high was determined by equally dividing that range into three categories. The following was the distribution: low (zero to two times), medium (three to five times), and high (six to eight times).

Medication Use

The NHANES survey included two measures for medication use. Specifically, NHANES question DIQ.050 asked, “Are you taking insulin now?” The participants responded to this question by choosing among the response categories of yes, no, refused, and don’t know. The participants who responded “don’t know or refused” to this question were excluded from the sample. NHANES question DIQ.070 asked, “Are you now taking diabetic pills to lower blood sugar?” The participants answered the question using response categories of yes, no, refused, and don’t know. The participants who responded “don’t know or refused” to this question were excluded from the sample. Thus, I created three categories for type of medication use: taking insulin, taking diabetic pills, and no medication. Medication type served as one of the independent variables in the 3 X 4 MANOVA. In the multinomial logistic regression, medication type served as the discrete outcome variable.

Demographics

Relevant demographic data are included in the multinomial logistics regression analysis which are age, gender, race. All of these are independent variables in the multinomial logistic regression. Age is a continuous measured variable using the actual age of the respondent. The range of possible age data is between 40 and 60 years old. Gender is a categorical measured variable with two groupings of (1) male and (2) female). Race is a categorical measured variable with five groupings: (1) Mexican American, (2) Other Hispanic, (3) Non-Hispanic White, (4) Non-Hispanic Black, and (5) Other race (including multi racial).

Data Analysis Plan

In this quantitative nonexperimental study, I examined the relationships between physical activity, healthcare utilization, and medication use among Type 2 diabetics over a 12-month period. A 3 X 4 multivariate analysis of variance (MANOVA) was used to determine if there are differences in the amount of physical activity as a function of healthcare utilization and type of medication use. In addition, a multinomial logistic regression was conducted using age, gender, race, and physical activity as predictor variables for the discrete outcome variable of medication type. Prior to the main analyses, assumptions for MANOVA and multinomial logistics regression were tested. All data analyses were conducted using the Statistical Package for the Social Sciences (SPSS) 24.0 program.

The assumptions for MANOVA included no significant outliers in the data of the continuous measured dependent variables, normality, and homogeneity of covariance and variances. The data were screened for multivariate outliers using calculation of Mahalanobis distances statistics. If the distances statistics are less than .001, that case is considered a multivariate outlier. Normality was assessed using skewness and kurtosis statistics. To determine whether the data follows a normal distribution, skewness statistics greater than three indicate strong non-normality and kurtosis statistics between 10 and 20 also indicate non-normality (Kline, 2005). The assumption of equal covariance was tested using Box's tests of equality of covariance matrices. The *p*-value of the Box's test of equality of covariance matrix should be greater than the level of significance value of 0.05 to prove that the covariance of the dependent variables are equal or homogenous across the different categorical groups of the independent variables. Homogeneity of variance was assessed for the dependent variables in each cell of the design using Levene's test. The *p*-value of the Levene's test should be greater than the level of significance value of 0.05 to prove that the variances of the dependent variables are equal or homogenous across the different categorical groups of the independent variables.

The assumptions for multinomial logistic regression included linearity between the continuous independent variables and the logit transformation of the dependent variable, absence of multicollinearity, and absence of significant outliers. Linearity was tested using the Box-Tidwell procedure. This assumption can be tested by including in the model interactions between the continuous independent variable and their logs. If such an interaction is significant, then the assumption has been violated. Multicollinearity was tested by determining significance of correlations among the independent variables.

Research questions 1a and 1b were analyzed using a 3 X 4 between groups MANOVA. Research questions 2a through 2d were analyzed using multinomial logistic regression. The following research questions and hypotheses were addressed.

RQ1a: Is there a difference in physical activity level (number of days engaging in moderate activity at work and recreation; number of days engaging in vigorous activity at work and recreation) as a function of healthcare utilization category (number of times individual has seen a doctor/healthcare professional at doctor's office or clinic, excluding anyone with overnight hospital stay: low, med, high) in the past 12 months for diabetes patients?

H_0: There is no significant different in physical activity level among healthcare utilization categories.

H_A: There is a significant difference in physical activity level among healthcare utilization categories.

RQ1b: Is there a difference in physical activity level (number of days engaging in moderate activity at work and recreation; number of days engaging in vigorous activity at work and recreation) as a function of medication type (insulin, taking diabetic pills, no meds) in the past 12 months for diabetes patients?

H_0: There is no significant difference in physical activity level among medication types.

Ha: There is a significant difference in physical activity level among medication types.

RQ2a: Does age predict type of medication use (taking insulin/taking diabetic pills/no medication)?

H_0: Age does not predict type of medication use.

H_a: Age does predict type of medication use.

RQ2b: Does gender predict type of medication use (taking insulin/taking diabetic pills/no medication)?

H_0: Gender does not predict type of medication use.

H_a: Gender does predict type of medication use.

RQ2c: Does race predict type of medication use (taking insulin/taking diabetic pills/no medication)?

H_0: Race does not predict type of medication use.

H_a: Race does predict type of medication use.

RQ2d: Does physical activity (met/not met recommended guidelines for physical activity) predict type of medication use (taking insulin/taking diabetic pills/no medication)?

H_0: Physical activity does not predict type of medication use.

H_a: Physical activity does predict type of medication use.

For research questions 1a and 1b, the independent variables included 1) healthcare utilization (low, med, high) and 2) medication use (insulin, diabetic pills, no meds). The dependent variables included 1) activity level (number of days of moderate activity at work and recreation) and 2) activity level (number of days of vigorous activity at work and recreation). Thus, research questions 1a and 1b was analyzed using a 3 X 4 between-groups MANOVA. The two-way multivariate analysis of variance is an extension of the two-way ANOVA for situations where there are two or more dependent variables.

For research questions 2a through 2d, multinomial logistic regression was used testing each predictor's effect while controlling for each of the other predictors. The predictor variables included age, gender, race, and physical activity (meeting/not meeting the minimum guidelines for amount of physical activity per week). The discrete outcome variable was medication use (taking insulin, taking diabetic pills, no medication).

Threats to Validity

In this study, I used a non-random sampling method of purposive sampling. As such, this may limit the ability to generalize the findings to the population of diabetes patients. The implementation of the study within a specific population is also considered a threat to its generalizability. The results of the study were only generalizable to the sample of individuals diagnosed with diabetes aged 40 to 60 years old. This does not include pregnant women and children; and diabetic patients with other comorbidities (e.g. heart issues, stroke, etc.). Although the NHANES a sample of 27,801 persons aged six months to 74 years of age across the United States, the survey was not representative of the United States population regarding population demographics for age, gender, ethnicity, and socioeconomic status. In addition, the NHANES survey does not distinguish between Type 1 and Type 2 diabetes. The sample was selected using a specific age group and diagnosis period to eliminate Type 1 diabetics. However, this does pose as a threat to validity if any Type 1 diabetics end up in the sample.

There were also threats to validity regarding the measures of physical activity, healthcare use, and medication use. For example, while the NHANES survey asked participant about their physical activity at work and for recreation, it did not specify whether the person's job required or limited physical activity. In addition, participants may have been encouraged or restricted regarding physical activity by their physician as part of their treatment plans. With regards to hospital utilization, the specificity of this variable is also limited. The NHANES survey did not include information about the reason participants sought healthcare services or why they were admitted to a hospital. Some of the reasons may have been the result of other health issues unrelated to their diabetes (e.g. dental visits, routine checkups, flu shot, etc.). Validity of the medication use data could also be limited. The NHANES survey simply asked for self-report data on medication use and did not include actual physician treatment plans or any data on medication adherence.

The findings of this study did not include conclusions regarding causal relationships between the variables, but only significant associations or relationships between variables. Causal relationships cannot be determined through a correlational analysis. The study used quantitative methodology. Other research approaches involving qualitative and mixed methods were not employed in the study. As such, the study did not benefit from qualitative interviews, observations, and focus groups which assist to procure in-depth descriptions of participants' own experiences in association with a phenomena or the problem being studied.

Ethical Procedures

Because an existing dataset was used, this study did not require informed consent procedures. I retrieved data from the publicly available National Health and Nutrition Examination Survey's (NHANES) II and III (CDC, 2016). The NHANES survey personnel collected informed consent forms from the study participants and no names were collected during the data collection process. Because participants were not identifiable in the data, no special precautions were required to safeguard anonymity of participants.

Summary

The purpose of this quantitative correlational study is to investigate the relationships between physical activity, healthcare utilization, and medication use among people with diabetes. I analyzed data by examining secondary data from the National Health and Nutrition Examination Survey (CDC, 2016). A 3 X 4 multivariate analysis of variance (MANOVA) was used to determine if there are differences in the amount of physical activity as a function of healthcare utilization and type of medication use. In addition, a multinomial logistic regression was conducted using age, gender, race, and physical activity as predictor variables for the discrete outcome variable of medication type. In the next chapter, I provide results regarding the relationships between physical activity, healthcare seeking behavior, and medication use among NHANES participants with diabetes.

Chapter 4: Results

Introduction

The purpose of this quantitative, nonexperimental study was to analyze archival data from the NHANES II and III for the years 2015 through 2016 (CDC, 2016) to examine the relationships between physical activity, use of healthcare, and use of medication for Type 2 diabetes patients over a 12-month period. The following research question and hypotheses guided this study:

RQ1a: Is there a difference in physical activity level (number of days engaging in moderate activity at work and recreation; number of days engaging in vigorous activity at work and recreation) as a function of healthcare use category (number of times individual has seen a doctor/healthcare professional at doctor's office or clinic, excluding anyone with overnight hospital stay: low, med, high) in the past 12 months for diabetes patients?

$H_0$1a: There is no significant difference in physical activity level among healthcare use categories.

H_a1a: There is a significant difference in physical activity level among healthcare use categories.

RQ1b: Is there a difference in physical activity level (number of days engaging in moderate activity at work and recreation; number of days engaging in vigorous activity at work and recreation) as a function of medication type (insulin, taking diabetic pills, no meds) in the past 12 months for diabetes patients?

$H_0$1b: There is no significant difference in physical activity level among medication types.

H_a1b: There is a significant difference in physical activity level among medication types.

For RQ2 (a-d), each predictor was entered into the logistic regression testing each effect while controlling for each of the other predictors.

RQ2a**:**Does age predict type of medication use (taking insulin/taking diabetic pills/no medication)?

$H_0$2a: Age does not predict type of medication use.

H_a2a: Age does predict type of medication use.

RQ2b: Does gender predict type of medication use (taking insulin/taking diabetic pills/no medication)?

$H_0$2b: Gender does not predict type of medication use.

H_a2b: Gender does predict type of medication use.

RQ2c: Does race predict type of medication use (taking insulin/taking diabetic pills/no medication)?

$H_0$2c: Race does not predict type of medication use.

H_a2c: Race does predict type of medication use.

RQ2d: Does physical activity (met/not met recommended guidelines for physical activity) predict type of medication use (taking insulin/taking diabetic pills/no medication)?

$H_0$2d: Physical activity does not predict type of medication use.

H_a2d: Physical activity does predict type of medication use.

This chapter contains a presentation of the results of the data analysis including descriptive statistics analysis to summarize the study variables, evaluation of statistical assumptions, results of MANOVA, and results of multinomial logistic regression analyses that were conducted to address the objectives of the study.

Data Collection

Initially, the chosen target population for this study consisted of 9,971 participants who completed data for the NHANES for 2015 and 2016. The inclusion criteria of the sample were individuals diagnosed with diabetes who were aged 40-to 60-years-old. Of 9,971 participants, 4,522 were excluded because they were not within the age range of 40 to 60 years. Another 5,147 were excluded since they were nondiabetic. Sixteen provided a “don't know” or “refused” responses in the healthcare use questions were excluded. There were additional 51 respondents who were excluded who reported overnight hospital stays. The resulting 235 individuals diagnosed with diabetes and aged 40 to 60 years comprised the sample.

Results

Descriptive Statistics

Demographic information of the 235 individuals diagnosed with diabetes is presented in Table 1. The mean age of the sample was 52.10-years-old (*SD* = 5.85). There were slightly more males than females. The race distribution of the 235 individuals was diverse.

Table 1

Frequency and Percentage of Gender and Race

Demographic	Frequency	Percent
Gender		
Male	120	51.1
Female	115	48.9
Race		
Mexican American	60	25.5
Other Hispanic	32	13.6
Non-Hispanic White	51	21.7
Non-Hispanic Black	61	26.0
Other race, including multiracial	31	13.2

Information regarding health care use, medication use, and physical activity for the sample are shown in Tables 2 and 3. Half of the 235 individuals received healthcare at a frequency of two to five times (*n* = 145; 50.7%). Health care use was categorized into three categories comprising low (zero to two times), medium (three to five times), and high (six to eight times) use. The greatest percentage of individuals reported low levels of health care use (Table 2). Half of the sample reported taking diabetic pills; fewer reported taking insulin or taking both insulin and diabetic pills. Only 29.8% (*n* = 70) followed the recommended CDC guidelines for amount of physical activity per week of more than 150 minutes per week. The mean numbers of minutes of moderate and vigorous physical activity per week are reported in Table 3.

Table 2

Frequencies and Percentages of Physical Activity, Type of Medication Used, and Health Care Use

Study variable	Frequency	Percent
Physical activity category		
Not recommended (<150 min per week)	165	70.2
Recommended (≥150 min per week)	70	29.8
Type of medication used		
No medication	52	22.1
Taking diabetic pills	113	48.1
Insulin	27	11.5
Both insulin and diabetic pills	32	18.3
Health care use: Frequency		
None	21	7.3
1	30	10.5
2 to 3	71	24.8
4 to 5	74	25.9
6 to 7	24	8.4
8 to 9	12	4.2
10 to 12	28	9.8
13 to 15	9	3.1
16 or more	17	5.9
Health care use: Category		
Low	111	47.2
Medium	86	36.6
High	38	16.2

Table 3

Descriptive Statistics for Physical Activity

Study Variable	*N*	Minimum	Maximum	Mean	Std. Deviation
Minutes of Moderate Activity Per Week	235	0	3360.00	222.94	561.34
Minutes of Vigorous Activity Per Week	235	0	6720.00	366.79	713.11

Evaluation of Statistical Assumptions for MANOVA

The first test was to verify no significant outliers in the data of the continuous measured variables in the MANOVA that were the dependent variables of two physical activity level measures of number of minutes of moderate physical activity per week and number of minutes of vigorous physical activity per week. Outliers were investigated using Mahalanobis distances. If the distances are less than 0.001, that case is considered a multivariate outlier. Mahalanobis distances statistics showed that the range of Mahalanobis distances for the number of minutes of moderate physical activity per week (0.22 to 6.97) and number of minutes of vigorous physical activity per week (0.22 to 6.97) were in the acceptable range of not less than 0.001. There was no presence of multivariate outlier. Thus, the assumption of multivariate outliers was not violated.

The second assumption tested is normality of the data. The dependent variables in the MANOVA included the two physical activity level measures including minutes of moderate physical activity per week and minutes of vigorous physical activity per week. Normality was tested through an examination of the skewness and kurtosis statistics.

To determine whether the data follows a normal distribution, skewness statistics greater than 3 indicate strong nonnormality and kurtosis statistics between 10 and 20 also indicate nonnormality (Kline, 2005). The skewness (0.80 and 1.22) and kurtosis (0.13 and 2.04) statistic values of the dependent variables of minutes of moderate physical activity per week and minutes of vigorous physical activity per week were within the acceptable range.

The third assumption tested was homogeneity of covariance matrices. The results of the Box's test of equality of covariance matrices showed that the covariance of the two physical activity level measures of minutes of moderate physical activity per week and minutes of vigorous physical activity per week was not homogenous (Box's M = 222.25,, $F(27, 6632.19) = 7.67$, $p < 0.001$) across the different categories of the independent variables of health care use category and type of medication used. The homogeneity of covariance assumption was violated. However, MANOVA tends to be robust to violations if the group sizes are more than 30, which they were in the case of this analysis. In addition, the F statistic is quite robust against violations of this assumption (Tabachnick & Fidell, 2013). If homogeneity of variance cannot be assumed for one or more dependent variables in the MANOVA, then the use an alpha level stricter than the conventional value of 0.05 should be used to evaluate the MANOVA.

The fourth assumption tested was that the variances of each of the dependent variables of the two physical activity level measures of minutes of moderate physical activity per week and minutes of vigorous physical activity per week should be homogenous across the different categories of the independent variables of health care use category and type of medication used. The results of the Levene's test showed that the variances of each of the two physical activity level measures of minutes of moderate physical activity per week ($F(11, 223) = 3.05$, $p = 0.001$) and minutes of moderate physical activity per week and minutes of vigorous physical activity per week ($F(11, 23) = 2.36$, $p = 0.01$) were not homogenous across the different categories of the independent variables of healthcare use category and type of medication used. The homogeneity of variances assumption was violated. According to Tabachnick and Fidell (2013), if the homogeneity of variances is violated, a stricter critical level for determining significance in the univariate *F*-test should be used. Tabachnick and Fidell suggested using a level of significance of 0.025 or 0.01 rather than the conventional 0.05 level of significance. Thus, a level of significance of 0.025 was used for the MANOVA.

MANOVA Results for Research Question 1

Table 4 shows health care use and medication use as a function of physical activity.

Table 4

Physical Activity Levels in Health Care Use (HCU) and Medication Groups

Variable	Statistics	Minutes of vigorous physical activity per week	Minutes of moderate physical activity per week
Health care utilization category			
Low	N	111	111
	Mean	261.76	469.68
	Std. Deviation	634.58	920.25
	Minimum	0	0
	Maximum	3360	6720
Medium	N	86	86
	Mean	220.81	277.67
	Std. Deviation	547.71	430.32
	Minimum	0	0
	Maximum	2520	1860
High	N	38	38
	Mean	114.34	267.89
	Std. Deviation	299.69	461.27
	Minimum	0	0
	Maximum	1500	1500
Type of Medication use category			
No medication	N	52	52
	Mean	331.15	412.21
	Std. Deviation	822.09	764.21
	Minimum	0	0
	Maximum	3360	3960
Taking diabetic pills	N	113	113
	Mean	165.09	265.04
	Std. Deviation	420.58	483.38
	Minimum	0	0
	Maximum	2400	2580
Insulin	N	27	27
	Mean	318.70	701.11
	Std. Deviation	638.37	1367.35
	Minimum	0	0
	Maximum	2400	6720
Both insulin and diabetic pills	N	43	43
	Mean	183.95	369.30

	Std. Deviation	424.27	491.26
	Minimum	0	0
	Maximum	1440	1980

A 3 X 4 MANOVA was conducted to examine if there were significant differences in the physical activity level (minutes of moderate physical activity per week and minutes of vigorous physical activity per week) as a function of healthcare use (categorized as low, medium, and high) and the type of medication used (categorized as insulin, diabetic pills, insulin and diabetic pills, or no medication) in the past 12 months for diabetes patients. Results of the MANOVA (Table 5) showed that there were no statistically significant differences in both the two physical activity level measures of minutes of moderate physical activity per week, $F(2, 229) = 1.15$, $p = 0.32$, partial $\eta^2 = 0.01$, and minutes of vigorous physical activity per week, $F(2, 229) = 0.61$, $p = 0.54$, partial $\eta^2 = 0.01$, as a function of healthcare use category in the past 12 months for diabetes patients considering a level of significance of 0.025. There were also no statistically significant differences in both physical activity level measures of minutes of moderate physical activity per week, $F(3, 229) = 2.16$, $p = 0.09$, partial $\eta^2 = 0.03$ and minutes of vigorous physical activity per week, $F(3, 229) = 1.13$, $p = 0.34$, partial $\eta^2 = 0.02$ as a function of type of medication used in the past 12 months for diabetes patients considering a level of significance of 0.025. With these results, the null hypotheses for Research Questions 1A and 1B were not rejected.

Table 5

MANOVA Results of Significance of Differences of Physical Activity Level Measures of Number of Minutes of Moderate Physical Activity and Number of Minutes of Vigorous Activity by Health Care Utilization Category and Type of Medication Used

Source	Dependent variable	Type III sum of squares	*df*	Mean square	*F*	*p*	Partial Eta squared
Corrected Model	Vigorous activity	1685990.19[a]	5	337198.04	1.07	0.38	0.02
	Moderate activity	5437593.60[b]	5	1087518.72	2.19	0.06	0.05
Intercept	Vigorous activity	7304716.54	1	7304716.54	23.22	0.00	0.09
	Moderate activity	23834708.37	1	23834708.37	48.07	0.00	0.17
Health care utilization	Vigorous activity	385903.57	2	192951.79	0.61	0.54	0.01
	Moderate activity	1142435.43	2	571217.72	1.15	0.32	0.01
Type of Medication Used	Vigorous activity	1070200.16	3	356733.39	1.13	0.34	0.02
	Moderate activity	3207774.67	3	1069258.22	2.16	0.09	0.03
Error	Vigorous activity	72048183.85	229	314620.89			
	Moderate activity	113558305.80	229	495887.80			
Total	Vigorous activity	85413800.00	235				
	Moderate activity	150611125.00	235				
Corrected Total	Vigorous activity	73734174.04	234				
	Moderate activity	118995899.40	234				

Note. a. R Squared = 0.02 (Adjusted R Squared = 0.002)

b. R Squared = 0.05 (Adjusted R Squared = 0.03)
*Significant at level of significance of 0.05

Evaluation of Statistical Assumptions for Logistic Regression

The different required assumptions for a logistic regression include linearity between continuous independent and dependent variable and absence of multicollinearity. In terms of the assumption of linearity between continuous independent and dependent variable, there should be a linear relationship between the continuous independent variable of age and dependent variable of type of medication used. Linearity was investigated using Box-Tidwell procedure between age and type of medication. The assumption can be tested by including in the model interactions between the continuous independent variable and their logs. The results are shown in Table 6. The interaction model interactions between the continuous independent variable of age and their logs in each of the category of the dependent variable of type of medication used were all insignificant at the level of significance of 0.05. Thus, the linearity assumption was satisfied.

Table 6

Multinomial Logistic Regression Results of Significance of Predictive Relationships Between Logs Age and Type of Medication Used

Type of medication use category (dependent variable)	Independent variable	*B*	Std. Error	Wald	*df*	*p*
No medication	Age (log)	2.11	1.83	1.33	1	0.25
Taking diabetic pills	Age (log)	0.37	1.54	0.06	1	0.81
Insulin	Age (log)	-1.60	2.06	0.61	1	0.44

The next assumption tested was absence of multicollinearity among the different independent variables in predicting the dependent variable. Multicollinearity occurs when you have two or more independent variables that are highly correlated with each other. Multicollinearity among the four independent variables of age, gender, race, and physical activity were tested using Spearman correlation analysis. The results are presented in Table 7. Results of the Spearman correlation analysis showed that none of the four independent variables were significantly correlated with each other. Thus, we can assume no multicollinearity among the different independent variables in predicting the dependent variable.

Table 7

Results of Spearman Correlation Analysis of Correlation among Independent Variables in Logistic Regression

	1	2	3	4
1. Age in years at screening				
2. Gender	-0.04			
3. Race	-0.10	-0.07		
4. Physical activity category	-0.004	-0.12	-0.12	

Multinomial Logistic Regression Results

A multinomial logistic regression was conducted to determine whether age, gender, race, and physical activity (meeting/not meeting the minimum guidelines for amount of physical activity per week) were significant predictors of type of medication used. Multinomial logistic regression was used, since the dependent variable Type of Medication has more than two categories, which include taking (1) no medication, (2) diabetic pills, (3) insulin, and (4) both insulin and diabetic pills. A single multinomial logistic regression was created including all independent variables of age, gender, race, and physical activity in one model. An independent variable significantly predicts the dependent variables if *p*-value of the *Wald* statistic was less than or equal to the level of the significance value.

The results of the multinomial logistic regression are presented in Table 8. Result of the likelihood ratio test showed that the overall combined impact of age, gender, race, and physical activity, $X_2(12) = 9.92$, $p = 0.62$, did not significantly predict type of medication used by the diabetic patients. The individual results of the significance of the B coefficient of the impacts of age, gender, race, and physical activity were all insignificant at the level of significance of 0.05. Thus, the null hypotheses associated with Research Question 2 were not rejected.

Table 8

Multinomial Logistic Regression Results of Differences of Significance of Predictive Relationships of Age, Gender, Race, and Physical Activity With Type of Medication Used

Type of Medication used	Independent Variable	B	Std. Error	Wald	df	*p*	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
1 No medication.	Intercept	-2.05	2.16	0.90	1	0.34			
	Gender	0.46	0.43	1.13	1	0.29	1.58	0.68	3.67
	Age in years at screening	0.04	0.04	1.09	1	0.30	1.04	0.97	1.12
	Race	-0.13	0.15	0.69	1	0.41	0.88	0.65	1.19
	[Physical activity category= Not recommended	-0.12	0.47	0.07	1	0.80	0.89	0.35	2.24
	[Physical activity category = Recommended	0b	.	.	0	.	.	.	.
2 Taking diabetic pills	Intercept	1.37	1.83	0.56	1	0.45			
	Gender	-0.14	0.37	0.15	1	0.70	0.87	0.42	1.79
	Age in years at screening	0.00	0.03	0.01	1	0.94	1.00	0.94	1.07
	Race	-0.12	0.13	0.78	1	0.38	0.89	0.69	1.15
	[Physical activity category= Not recommended	0.04	0.41	0.01	1	0.92	1.04	0.47	2.32
	[Physical activity category = Recommended	0b	.	.	0	.	.	.	.
3 Insulin	Intercept	2.20	2.48	0.79	1	0.37			
	Gender	-0.27	0.51	0.27	1	0.61	0.77	0.28	2.10
	Age in years at screening	-0.04	0.04	0.78	1	0.38	0.96	0.89	1.05
	Race	-0.01	0.18	0.00	1	0.97	0.99	0.70	1.42
	[Physical activity category= Not recommended	-0.53	0.53	0.99	1	0.32	0.59	0.21	1.68
	[Physical activity category = Recommended	0b	.	.	0	.	.	.	.

Note: Cox and Snell R-Square = 0.04, Likelihood Ratio $X_2(12) = 9.92$, $p = 0.62$

a. The reference category is: 4 Both insulin and diabetic pills

b. This parameter is set to zero because it is redundant.

*Significant at level of significance of 0.05

Summary

The purpose of this quantitative non-experimental study was to conduct secondary analysiks utilizing data from the National Health and Nutrition Examination Survey for the years 2015 through 2016 (CDC, 2016) to examine the relationships between physical activity, use of healthcare, and use of medication for Type 2 diabetes patients over a 12-month period. MANOVA and multinomial logistic regression analyses were conducted to test the hypotheses posed in this study. The results of the MANOVA showed that there is no significant difference in physical activity level among medication types and among healthcare utilization categories. The results of the multinomial logistic regression showed that age, gender, race, and physical activity were not significant predictors of medication use. Chapter 5 contains the key findings from the study.

Chapter 5: Discussion, Conclusions, and Recommendations

The dangers of diabetes are a growing concern as the number of individuals worldwide affected has been rising (Müller et al., 2015). There is an estimate of 451 million adults, or 8.4% of the world population, diagnosed with diabetes, with 5 million deaths during 2017 attributed to it (Cho et al., 2018). By the year 2045, the incidence of diabetes is expected to increase up to 693 million, or 9.9% of the world population (Cho et al., 2018). The malignancy of diabetes can be felt not just from its status as a lifetime impairment, but also from the comorbid diseases or complications that may arise from it such as sensory impairment, depression, kidney failure, cardiovascular diseases, stroke, muscle atrophy, and certain types of cancer (Liu et al., 2015; Loprinzi et al., 2013; Perry et al., 2016; Tao, Shi, & Zhao ,2015). These complications often develop along with the risk factors associated with diabetes, including obesity and sedentary lifestyle (Liu et al., 2015).

Diabetes has negative financial effects. Cho et al. (2018) found that USD 850 million was allocated to diabetes healthcare in the year 2017. As diabetes is a chronic disease, these expenditures are not isolated to the time of diagnosis but rather throughout the patient’s lifetime (Müller et al., 2015). Patients with diabetes often spend a vast amount of money for hospitalization and medicine (Müller et al., 2015). Diabetes and healthcare specialists have suggested inexpensive and noninvasive solutions to reduce these costs, such as maintaining a healthy lifestyle to avoid hospitalization and decrease medicinal intake (Musenge et al., 2015). Patients with diabetes are encouraged to lead a healthy lifestyle through proper nutrition and physical activity to avoid complications and decrease expenditures on healthcare use and medication (ADA, 2017). However, there is currently a lack of empirical data supporting the relationships between physical activity, healthcare use, and use of diabetic drugs. The purpose of this quantitative, nonexperimental study was to use data from the NHANES for the years 2013 through 2016 (CDC, 2016) to examine the relationships between physical activity, healthcare use, and use of medication among Type 2 diabetes patients over a 12-month period.

The theoretical framework used in this study was the integrated theory of health behavior change by Ryan (2009), which posits that human behavior, specifically as it relates to health management, can be altered through an increased understanding of positive health behaviors and continuous practice of healthy behaviors. This theory gave light to the important role of healthcare providers as advisers and educators for patients regarding their self-management of their own health (Ryan, 2009). Self-management is important for patients with chronic diseases, such as diabetes, as it may prevent further complications and lead to a better QOL (Caluyong et al., 2015; Musenge et al., 2015). The integrated theory of health behavior states that 50% of human illnesses are attributed to a lack of self-management (Ryan, 2009). Two aspects of self-management are physical activity and regular health examinations (Ryan, 2009). However, there remains to be empirical evidence relating these two aspects together along with use of diabetic medication.

Interpretation of the Findings

In a sample of 235 individuals with Type 2 diabetes, I found no significant difference in physical activity level among medication type and healthcare use.

Furthermore, age, gender, race, and physical activity were not found to be significant predictors of type of medication use. With these results, the null hypotheses of the current study were not rejected; however, further interpretation of the findings could be made. These are discussed in the following sections.

Physical Activity as a Function of Healthcare Use

I found no statistically significant differences in two physical activity level measures as a function of health care use in the past 12 months for Type 2 diabetes patients. More physical activity did not seem to result in fewer visits to healthcare providers, and vice versa. This finding appears to be inconsistent with past studies that displayed the positive health benefits of physical activity on patients with or at risk of Type 2 diabetes (Colberg et al., 2016; Fan et al., 2015; Herbst et al., 2015; Pibernik-Okanović et al., 2015). As these scholars demonstrated, physical activity assists in improving blood glucose levels, BMI, cholesterol, metabolic control, and even psychological wellbeing (Colberg et al., 2016; Fan et al., 2015; Herbst et al., 2015; Pibernik- Okanović et al., 2015), which can be related to improved physical activity.

Considering the amount of past studies supporting the benefits of physical activity on patients with Type 2 diabetes, patients may still feel the need to visit their healthcare specialists for other reasons not related to their diabetic condition or their physical activity. Although this does not fully support the hypothesis, it could help explain the lack of a significant difference for these variables, as healthcare use may not be related to physical activity, but instead to other variables beyond the scope of this study. Hynes et al. (2015) demonstrated that patients with a healthy relationship with their doctors regularly visited them for check-ups. Beck et al. (2017) and Chen and Chang Yeh (2015) reiterated the importance of the ongoing psychological and emotional support brought by clinicians to sustain patients' healthy behaviors, which could be a reason why patients would visit them even if they feel physically healthy. Bagonza, Rutebemberwa, and Bazeyo (2015) recommended patients visiting a diabetes educator for at least 30 minutes every 3 months to stay on track and achieve health goals.

Another possibility is that healthcare providers may not be providing enough knowledge or information to patients with diabetes. Regardless of the number of visits patients make to their healthcare specialists, if they were not informed of self-management practices such as proper physical activity, they would still continue to seek healthcare advice. This interpretation has been reflected in some past studies. Patients with diabetes from South Africa, Greece, and Saudi Arabia displayed insufficient self-management knowledge and skills even after consulting healthcare providers (Adisa & Fakeye, 2016; Ferwana et al., 2016; Kalantzi et al., 2015; Murphy et al., 2015).

Ross et al. (2015) highlighted the importance of healthcare providers' use of evidence-based tools to educate patients regarding self-management, especially in rural areas. Clark et al. (2017) indeed found that some physicians may not have the knowledge or tools such as handouts that could inform patients regarding proper physical activity. Some physicians felt that physical activity education was not within the scope of their practice and are better suited to allied healthcare providers such as exercise professionals (Clark et al., 2017). If healthcare providers do not have these tools, patients may not be aware of how much physical activity they require; hence, their visits to such providers would not affect their level of physical activity.

It is possible that healthcare providers, knowledgeable as they may be, may not be adequately communicating self-management practices and strategies to their patients (Kalantzi et al., 2015). Motivational interviewing, a well-known intervention for Type 2 diabetes patients, was found to be effective only in diet modification adherence, but not in encouraging physical activity, alcohol reduction, and smoking cessation (Ekong & Kavookjan, 2016). Vähäsarja et al. (2015) also noted how patients differed in their reactions after initial screening for diabetes. Vähäsarja et al. found two types of risk perceptions related to patient reactions: threatening and rejected. Those who felt threatened by the screening results were more motivated to increase their physical activity, while those who rejected their screening results with indifference and skepticism were less motivated to do so (author, year). Vähäsarja et al. then urged providers to be more careful and more realistic in conveying screening results and the risks associated with it. These findings present a problem of miscommunication between patient and healthcare provider, which could explain the lack of a significant relationship between healthcare use and physical activity.

Regardless of the type of problem behind this finding, several past studies have recommended further and better guidance from healthcare specialists in educating patients about self-management (ADA, 2017; Kalantzi et al., 2015; Ozcariz, Bernardo, Cembranel, Peres, & González-Chica, 2015; Vähäsarja et al., 2015). The ADA (2017) specified critical time points for patients to receive education or re-education from healthcare providers, including: during diagnosis, annually for assessment, on the onset of new complications, and during transitions in care. This is in line with the integrated theory of health behavior change (Ryan, 2009). The theory emphasizes the integral collaboration between patients and all their healthcare providers in maintaining healthy practices (Ryan, 2009). While the data from this study do not explicitly reveal the reason behind the insignificance of the relationship between healthcare utilization and physical activity, what the scholars found is a need for a better collaboration between patients and healthcare specialists that would encourage self-management of their disease.

Physical Activity as a Function of Type of Medication Used

The second key finding of this study was that I found no statistically significant differences in both the two physical activity level measures as a function of type of medication used in the past 12 months for Type 2 diabetes patients. This finding is surprising as well, as physical activity was found by past studies to allow better insulin control for the body (Bohn et al., 2015; Colberg et al., 2016; Herbst et al., 2015; Johansen et al., 2017). While none of the relationships in this study's results were significant, it should be noted that a p value of 0.09 was found in moderate physical activity as a function of type of medication. This reflects a slight trend in the type of medication used for patients who exercised moderately. Bohn et al. (2015) noted how physical activity was related not just with blood glucose control, but also with other diabetes-related comorbidities and cardiovascular risk factors. Johansen et al. (2017) found that participants who attended an aerobics program in addition to standard diabetes care had more reduced diabetes medications than those in standard care alone. These findings then display at least a minor function of physical activity in type of medication used.

In Herbst et al.'s (2015) study, weight loss, which can be brought upon by physical activity, was found to assist in controlling blood pressure, HDL-cholesterol, and triglycerides, as well as in reducing diabetes medication. Herbst et al. also found, however, that while increased physical activity assisted in these aspects, it did not, similar to the present study's finding, differ in treatment regimens (Herbst et al., 2015). Their findings confirm that, while physical activity may be indirectly related to type of medication through weight loss, no such direct relationship exists (Herbst et al., 2015). It should also be noted that diabetes is a chronic condition that often involves continuous and escalating medication (Sohal et al., 2015). Examining this relationship directly, Musenge et al. (2015) revealed that blood glucose control was predicted mostly by medication adherence and fasting plasma glucose but not by physical activity, thereby supporting the present study's finding.

Colberg et al. (2016), on the other hand, noted that physical activity recommendations must be tailored to fit the individual needs of each patient that includes consideration of medications. Chen and Chang Yeh (2015) found that patients not dependent on insulin were more focused on maintaining a healthy lifestyle, including regular exercise, as compared to insulin-dependent patients, who only focused on their insulin dosage amounts. Muscle atrophy, a condition that may be present in patients with severe Type 2 diabetes, is further aggravated by inactivity, revealing yet another importance of physical activity in relation to diabetes treatment (Perry et al., 2016).

While these studies contradict the present study's finding and promote physical activity to reduce diabetes medication, certain precautions must also be made regarding its adverse effects.

Hypoglycemia may be caused by too much physical activity paired with increased insulin sensitivity (ADA, 2017). Hypoglycemia after exercise is more common among insulin-dependent patients (ADA, 2017), showing yet again results contrasting to those of the present study. Colberg et al. (2016) noted that some medications, aside from insulin, may also cause hypoglycemia after intense exercise. Bohn et al. (2015) found that physical activity was inversely related to hypoglycemia, especially in females; however, those who reported the most physical activity were also the lowest in terms of risk of hypoglycemic coma.

Patients who have experienced adverse effects, regardless of the cause, may be disinclined to perform more physical activities. Patients who are not insulin-dependent, even those without a diabetes diagnosis, may still experience hypoglycemia, although not as commonly as insulin-dependent patients (Lamos, Younk, & Davis, 2018). Other adverse effects that may prevent patients from performing physical activities include musculoskeletal pain or discomfort, which may also be present in patients regardless of medication type (Johansen et al., 2017). This yet again calls for better patient education regarding health behavior (Ryan, 2009) as healthcare providers work to customize the right amount of physical activity necessary for each type of patient with diabetes (Colberg et al., 2016). The contradictory results in the past studies, and the inconclusive finding from this study, revealed how physical activity may not be as strongly related to diabetes medication use, yet it cannot be fully dismissed due to past evidence of its benefits.

Impact of Age, Gender, Race, and Physical Activity on Type of Medication Used

The final key finding is that I found that neither age, gender, race, nor physical activity predicted the type of diabetes medication used. The lack of a relationship between physical activity and diabetes medication type has been established in the previous section. Demographic characteristics have been rarely considered as individual predictors of health variables (Colberg et al., 2016). Nonetheless, some past studies have highlighted certain relationships between these demographic variables and diabetes outcomes (Caluyong et al., 2015; Jimenez-Trujillo et al., 2015; Joseph et al., 2016; Kim, Kim, Bowman, & Cho, 2015; Safita et al., 2016).

Findings from the present study, in general, contradict those of other studies. For example, females and those of older age were found to predict poor quality of life in patients with Type 2 diabetes (Caluyong et al., 2015; Safita et al., 2016). On the other hand, females were also found to be more adherent to diabetes medication and other preventive measures (Jimenez-Trujillo et al., 2015; Kim et al., 2015). Race was found to influence the relationship between sedentary behaviors and diabetes risk, as an inverse relationship between physical activity and Type 2 diabetes risk was only significant for whites (Joseph et al., 2016).

Limitations of the Study

Certain limitations may have influenced the findings of this study as well. Data utilized in this study were limited to archival records from the NHANES. Thus, data are historical and secondary, which means that it is limited to the particular times when the patients were surveyed, which were between 1976 and 1980 for NHANES II, and 1988 and 1994 for NHANES III (CDC, 2016). The findings then, even if they came from the most recent data, cannot be generalized to other time settings.

The NHANES does not differentiate between Type 1 and Type 2 diabetes, which could have affected the findings, as self-management strategies differ for each type (Colberg et al., 2016). The NHANES reports were also limited in the sense that they did not present specific details regarding treatment plans, self-management strategies, or the reasons behind patients' utilization of healthcare. Patients may have been motivated or demotivated by reasons other than what was purported by this study to adhere to self-management strategies or to utilize healthcare. Also, the integrated theory of health behavior change (Ryan, 2009) presents a complex interplay of variables that may affect patients' health behaviors, which were not available in the NHANES reports. Thus, this empirical test of the theory is limited. That being said, the value of the present study lies in the idea that the role of physical activity in healthcare utilization and type of diabetes medication used may be much more complex than the variables examined would allow.

Recommendations

A more contemporaneous dataset would potentially generate more generalizable findings. A similar quantitative study on physical activity, healthcare utilization, and type of diabetes medication used, but with the added variable of blood glucose levels would strengthen the validity of this study. Random sampling and use of current data would strengthen its generalizability (Babbie, 2016).

As I found no significant relationship between the three variables, further exploration on possible mediating variables, such as diet modification, could be done. Other factors that may be considered include: family history of diabetes, education level, and socio-economic status. Furthermore, to establish causality, experimental designs could be utilized to measure these variables (Babbie, 2016). Patients with Type 2 diabetes could be grouped according to type of medication used and placed in sub-groups according to a physical activity program they could be enrolled in, with varying levels. This design, although ideal, may be considered obtrusive by some; hence, a longitudinal nonexperimental study, where none of the variables are controlled, may be more plausible. A longitudinal study would also yield a more valid set of findings (Babbie, 2016).

In order to explore the reasons behind the findings of the present study, qualitative measures could also be utilized. Patients with Type 2 diabetes could be interviewed regarding their motivations for healthcare utilization and physical activity. They could also provide suggestions on how healthcare providers could improve self-management education for patients with diabetes. On the other hand, healthcare specialists could also provide in-depth information regarding proper self-management strategies and practices and on the proper physical activities for specific types of patients. Different types of healthcare providers could participate in a focus group discussion in order to elicit best practices when it comes to patient education regarding proper physical activity.

Implications

In this quantitative nonexperimental study, I generated surprising results regarding the relationship, or lack thereof, between physical activity, healthcare utilization, and type of diabetic medication used. Several interpretations of the findings were proposed. As such, the findings signify several implications for patients and practitioners alike. For patients with diabetes, the findings imply that physical activity alone may not be enough to manage the disease. Self-management requires much more than just daily physical activity. The ADA (2017) highlighted the importance of diet modification, smoking cessation, and psychosocial well-being in diabetes self-management. I found that physical activity was not related to both healthcare utilization and type of medication used further justifies the need for these other self-management measures. However, I do not fully dismiss the value of physical activity. It simply implies the need for other measures to complement physical activity.

For physicians and other healthcare providers, care should be taken to properly inform and educate diabetic patients regarding the recommended amount and type of physical activity for their individual cases (Colberg et al., 2016). From the findings of the present study, there may be a miscommunication between healthcare providers and some patients, which may have led to the insignificant relationship between physical activity and healthcare utilization. While regular checkups with healthcare specialists are recommended (Bagonza et al., 2015), this should not be used as an excuse for practitioners to bypass discussion of self-management strategies and practices. As Vähäsarja et al. (2015) emphasized, practitioners need to provide realistic descriptions of patients' disease and the risks that accompany it. Healthcare providers remain to be patients' preferred source of information (Ross et al., 2015). It is, therefore, crucial that they constantly ensure that all patients are well-informed about diabetes self-management, including physical activity recommendations.

For policy makers, it is crucial to ensure that healthcare providers are not only prescribing proper treatments for diabetes, but also educating patients about self-management. The lack of a significant relationship between physical activity and healthcare utilization may reflect a lack of specific policies on practitioners' recommendations for patient physical activity. From this study's findings, physical activity alone may not be sufficient for self-management, policy makers should also include the other variables in forming their patient education policies. Healthcare institutions should also ensure that their providers are updated regarding diabetes self-management and current best practices.

In terms of the methodological implications of this study, the quantitative nature provided empirical evidence that physical activity may not be as influential on patients' healthcare utilization and medication use as initially purported. This suggests that much research is still needed to establish the right formula of self-management in order to decrease expenditures on Type 2 diabetes. As the integrated theory of health behavior change (Ryan, 2009) suggests, self-management or self-regulation skills must be developed by complex collaborations in order to change and maintain patients' healthy behaviors. As to how these may be developed, the findings of the present study call for further exploration by both researchers and practitioners alike in order to arrive at the proper formula.

Conclusion

This chapter revealed the interpretations of results as supported or contrasted by previous studies. I found that there was no significant difference in physical activity level among healthcare utilization and medication types and that age, gender, race, and physical activity did not predict medication use. There was no alignment of this study's findings with evidence from past studies revealing benefits of physical activity. However, while these findings could simple mean that physical activity was not influential in diabetic self-management, other interpretations and implications may be made. Miscommunication between patients and healthcare providers, or fear of adverse effects such as hypoglycemia, could be preventing patients from performing the recommended amount of physical activity. This then implies that more effort is needed for healthcare providers to ensure proper patient care and education. It is also possible that other variables, such as diet and psychosocial well-being, may mediate these relationships. This study provided empirical data that would potentially raise awareness regarding the complexities of Type 2 diabetes and physical activity, thereby opening the doors for wider inquiries. Further investigations into the matter are called for in order to find the right formula for providing better self-management education for patients with diabetes, and reducing their healthcare expenditures.

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Appendix A: G*power Sample Size Computation Results