DIABETES HEALTH LITERACY, DIABETES NUMERACY, AND COGNITIVE FUNCTION AS PREDICTORS OF TYPE 2 DIABETES MELLITUS SELF-MANAGEMENT

by

Twinkle Gupta

Liberty University

A Dissertation Presented in Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy

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APPROVED BY:

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Dr. Joyce Brady, Committee Member

ABSTRACT

The present study assessed older adults (≥ 45 years old) diabetes health literacy, diabetes numeracy, cognitive function, and its association with their Type 2 Diabetes Mellitus (T2DM) self-management outcomes. These factors are of concern as diabetes is a lifelong condition affecting the body's conversion of food into energy and may lead to complications and comorbidities if this condition is not properly self-managed. Diabetes health literacy refers to having the necessary capabilities in finding and analyzing diabetes-related information to make informed decisions regarding their health. Numeracy in diabetes has to do with being able to compute diabetes-related math such as insulin and nutritional calculations. Diabetes self-management outcomes include insulin pump or continuous glucose monitor (CGM) use, medication adherence, physical activity, diet, and cooperation with one's healthcare team. In this study, 88 participants completed an online questionnaire measuring their diabetes health literacy, diabetes numeracy, and cognitive function levels with the expectation there were positive correlations to T2DM self-management outcomes. The results confirmed the first and third hypotheses, there were statistically significant positive correlations between diabetes health literacy, cognitive function, and T2DM self-management outcomes respectively. The second hypothesis of diabetes numeracy being positively associated with T2DM self-management outcomes was not supported; however, the relationship was marginally significant at $p = 0.055$. For hypotheses 4 and 5, the overall models were found to be significant, however when the interaction is added the models do not significantly improve. The results of the present study exhibit diabetes health literacy,

numeracy, and cognitive function are positively associated with T2DM self-management outcomes demonstrating the importance of these factors; this aligns with existing literature purporting 95% of diabetes care is through self-management of the disease.

Dedication

I dedicate this dissertation to my family. My mom and dad, who have been my biggest supporters and have raised me with love and respect. My brother, who has always guided and helped me. My grandparents, uncles and aunts who have encouraged me throughout this arduous process and have always been there for me. My cousins, thank you for always uplifting me. I love you all and I could not have accomplished this without you by my side.

This is for you.

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CHAPTER 1: INTRODUCTION TO THE STUDY

Introduction

Diabetes is a chronic disease that has become a major public health concern globally; the International Diabetes Foundation (2021) estimates diabetes currently affects 540 million people worldwide, and this number is predicted to increase to 783 million by 2045. This lifelong illness is among the top 10 causes of morbidity and mortality worldwide and has costed over 727 billion dollars for people diagnosed with diabetes (Asharani et al., 2021; Dahal & Hosseinzadeh, 2019). Healthcare providers and researchers both purport 95% of diabetes care is through self-management of the disease, making diabetes health literacy and numeracy essential to individuals' capabilities in making health-related decisions and taking care of their health (Tefera et al., 2020; Abdullah et al., 2019).

Limited health literacy and numeracy is a public health problem. A study backed by the U.S. Department of Education found only 12% of people to demonstrate proficient health literacy. Research has also shown over 110 million Americans have limited health numeracy skills; health numeracy has to do with the ability to apply mathematical skills in daily life to manage health conditions through measurement and estimation of medication dosage, nutrition, and so forth (Peters et al., 2014). Diabetes numeracy has to do with applying numeracy skills in diabetes-related treatment and care. Inadequate health literacy is associated with poor glycemic control, low medication adherence, poor diabetes outcomes, and lower uptake of available healthcare services in individuals diagnosed with diabetes (Dahal & Hosseinzadeh, 2019; Rachmawati et al., 2019; Turrin & Trujillo, 2019; Sultana et al., 2019). As people age there are higher rates of cognitive decline and diabetes itself is shown to be a risk factor for impairments and decline in cognitive function (Crespo et al., 2020; Bruce et al., 2003). Acquiring diabetic

health literacy and numeracy skills is imperative for older adults to manage Type 2 Diabetes Mellitus (T2DM) and enhance their self-management outcomes.

Background

Communities across the globe are reportedly experiencing limited access to health-related resources and information; acquiring health literacy skills has become more imperative than ever after the COVID-19 pandemic for older adults (Sentell et al., 2020). Personal health literacy can be conceptualized as the degree to which individuals have the skills to search, comprehend, and utilize health-related information and services to make informed decisions for their health and well-being (Centers for Disease Control and Prevention, 2023; Sentell et al., 2020). Low health literacy has shown to be associated with poorer outcomes for those with Type 2 Diabetes Mellitus along with increased spending on medications yet less medication adherence, poorer communication with healthcare providers, and less participation in health-related decision-making (Abdullah et al., 2022; Sultana et al., 2019; Ueno et al., 2019).

While the connection of health literacy and diabetic outcomes is well-established, studies have not looked at diabetes specific health literacy and numeracy in accordance with older adults' cognitive function. Diabetes specific health literacy has to do with having the skillset to locate and evaluate diabetes-related health information to make educated decisions in management of this diabetes (Tefera et al., 2020). While numeracy in diabetes refers to utilizing fundamental arithmetic skills (addition, subtraction, multiplication) in everyday diabetes self-management duties including insulin administration, prescription adherence, and glucose monitoring. Cognitive function is a factor that should also be highly considered when it comes to diabetic health literacy and numeracy as a person's cognitive condition is likely to decline as they age. Research has shown higher rates of cognitive decline occur amongst people who are

older, leading to poor diabetes self-management and less uptake of diabetic knowledge and resources (Crespo et al., 2020).

Self-management is the primary means of keeping Type 2 Diabetes Mellitus under control (Dahal & Hosseinzadeh, 2019). Self-management is comprised of being well-informed on how to test and monitor blood sugar, administer insulin, adhere to medications, eat healthily, and engage in physical exercise (Lucier & Weinstock, 2023). Empirical scientific evidence on how diabetes self-management outcomes are affected by diabetic health literacy, numeracy, and cognitive function in older adults requires further research on the interrelated connections between these three factors (Marciano et al., 2019; Caruso et al., 2017).

Problem Statement

Diabetes has become a major public health concern globally; currently it is understood as growing at an epidemic rate according to researchers (Saffari et al., 2019). The diagnosis and pervasiveness of Type 2 Diabetes Mellitus increases with age and over 20% of individuals 80 to 89 years old are diagnosed with Type 2 (Bruce et al., 2003). The World Health Organization (WHO) estimates that the world's senior population will reach two billion by 2050 making it imperative to mitigate health-related consequences for older adults. Higher rates of cognitive decline occur amongst people who are older making it crucial to assess if this impacts their ability to self-manage their diabetes. Health literacy and numeracy are fairly new concepts and play a role in diabetes. The term health literacy emerged in the early 1990s and has recently garnered greater attention as one of four public health priorities according to the United States Department of Health and Human Services (Lam & Leung, 2016).

Health literacy is understood as an individual’s ability to seek out, understand, and utilize health services and information to manage one’s health (CDC, 2023; Sentell et al., 2020; Lam &

Leung, 2016). Greater diabetic health literacy can aid individuals with the awareness in recognition of diabetic symptoms, when symptoms are not recognized in a timely manner it may lead to further complications (Asharani et al., 2021). In the United States, 12% of people have proficient health literacy skills and only 3% of those are older adults (U.S. Department of Health and Human Services, 2019). Diabetes numeracy can aid in following treatment guidelines such as recommended insulin and glucose management, nutritional recommendations, and medication management. Results from the National Assessment of Adult Literacy (NAAL) reported only 33.4% of Americans have a basic level of health numeracy with 28.8% falling in the below basic level (Peters et al., 2014).

A meta-analysis conducted by Marciano and colleagues (2019) found much inconsistency regarding the impact of health literacy on diabetes outcomes, specifically research studies have shown conflicting results on its influence on glycemic control, blood monitoring, foot care, medication adherence, insulin, exercise, and diet (Marciano et al., 2019; Caruso et al., 2017). Of the inconsistent outcomes, medication adherence is of vital importance as it occurs in higher rates in adults 50 years old and above; non-adherence in this population is associated with hospitalization and mortality, leading to high healthcare costs emphasizing the need for further research within the population of older adults diagnosed with T2DM (Walsh et al., 2019).

The challenge investigated in this present study was the necessity to learn further about the association between diabetes specific health literacy, diabetes numeracy, cognitive function, and older adults' abilities to self-manage and cope with T2DM (Sayah et al., 2016). Abdullah and colleagues (2019) found health literacy in diabetes to be positively associated with diabetes knowledge, however research has not looked at what the burden is collectively of low diabetes specific health literacy, diabetes numeracy, and cognitive function in people with Type 2

Diabetes Mellitus, and what factors influence this. Further investigation is necessary to assess the strength of the interrelated relationships between these three factors on self-management of Type 2 Diabetes Mellitus (T2DM), which is unknown presently, making it tough to communicate the need for increased diabetes-specific health education amongst older adults to improve self-management outcomes.

Purpose of the Study

The purpose of this quantitative correlational study was to examine the associations between diabetes health literacy, diabetes numeracy, and cognitive function on Type 2 Diabetes Mellitus self-management outcomes in older adults (≥ 45 years old).

Research Question(s) and Hypotheses

Research Questions

RQ 1: What is the association of diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes in older adults?

RQ 2: What is the association of diabetes numeracy and Type 2 Diabetes Mellitus self-management outcomes?

RQ 3: What is the association of cognitive function and Type 2 Diabetes Mellitus self-management outcomes in older adults?

RQ 4: How does diabetes numeracy moderate the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes?

RQ 5: How does cognitive function moderate the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes?

Hypotheses

Hypothesis 1: Diabetes health literacy is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults

Hypothesis 2: Diabetes numeracy is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults

Hypothesis 3: Cognitive function is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults

Hypothesis 4: Increased diabetes numeracy moderates the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes

Hypothesis 5: Increased cognitive function moderates the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes

Assumptions and Limitations of the Study

There are assumptions and limitations in the present study. It was assumed that participants are accurately recalling diabetic history and health details. As this study is directed toward older adults there is a greater likelihood of decline in cognitive function and they may misremember information such as the age they were diagnosed, average HbA1C levels over the past year, or experience reluctance in disclosing their medical condition history. Utilization of self-report assessments introduces the possibility of response bias. Self-report data in this context is prone to biases like difficulties in critical self-assessment, differences in perception of proper nutrition, and diabetic knowledge. This impacts the internal validity of the study and influences the results from the study; however, it was assumed participants are answering accurately.

A limitation to the study design is it may be unclear whether the outcomes in Type 2 Diabetes Mellitus self-management are specifically caused by the three factors (diabetes health literacy, diabetes numeracy, and cognitive function) or a confounding factor like self-efficacy or

depressive and anxiety symptoms. As the study has been conducted post-COVID there is a history threat that is presented. The Anxiety & Depression Association of America (ADAA) has highlighted increased post-COVID anxiety and depression present amongst individuals due to COVID-19. Due to social distancing many people were isolated from loved ones during the pandemic, researchers have found a lonely person's immune system responds differently making them likelier to develop an illness (Solomon, 2020). Another limitation is drop off rates during the survey, some participants may have a greater likelihood of being unable to complete the entirety of the survey due to its length of 71 items.

A threat to external validity is the findings generalizability to people with T2DM internationally. Outside of the United States health resources and information could be more or less accessible, paired with varying cultural norms around physical exercise and nutrition. Finally, the shortage of existing studies to validate the conclusions of this research investigation may influence the interpretation and analysis of the results.

Theoretical Foundations of the Study

In psychological science research, theoretical frameworks are used to guide studies and better understand phenomena of interest. When research has a theoretical foundation, it aids researchers in progressing from a basic understanding of a topic to a thorough comprehension of mechanisms affecting the topic. The Theory of Planned Behavior, Transtheoretical Stages of Change, Social Cognitive Theory, and the Health Belief Model have been implemented as theoretical frameworks guiding behaviors in chronic disease management. After reviewing these theories, the focus was narrowed to the Social Cognitive Theory and the Health Belief Model. The Social Cognitive Theory is comprised of multiple principles such as self-efficacy, self-regulation, knowledge, outcome expectations and values, observational learning and situational

perception (Ghoreishi et al., 2019). This behavioral change model is utilized in the management of chronic health conditions as the focus is on what motivates individuals, shapes behaviors, and ignites them to partake in health positive actions (Ghoreishi et al., 2019; Borhaninejad et al. 2017). Whereas the Health Belief Model's purpose is to explain individuals health-related behaviors, especially in the context of preventative health actions. Moreover, it aims to make sense of their views and perceptions which determine their health-related actions and decisions (Washburn, 2020).

The Health Belief Model (HBM) is a popular behavioral framework implemented by health educators, clinicians, medical and psychological professionals to assist patients in engaging in self-management and health-promoting behaviors. HBM states individuals' health-related behaviors are dependent on the following six elements: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy (Green et al., 2020). This model has been employed in a diverse number of recent studies including individuals' views and actions associated with the COVID-19 vaccine, chronic disease management, mental health, sexual health, as well as health screening behaviors such as for mammograms and colonoscopies. Regarding the study at hand, the Health Belief Model provides a helpful lens on how people view their Type 2 Diabetes Mellitus, what motivates and hinders them in being treatment compliant, making healthier lifestyle changes, and self-managing this chronic condition. Hence, the Health Belief Model (HBM) was selected to serve as the theoretical underpinning for this study (Green et al., 2020). From a biblical perspective, engaging in religion can offer solace when experiencing adversities and aid in coping with uncertainty; religiosity has been shown to influence health related quality of life in patients (Dewi et al.,

2022; Saffari et al., 2019). Thus, religious coping and religious problem-solving are both avenues that can support chronic diabetes management (Saffari et al., 2019).

Definition of Terms

The following is a list of definitions of terms that are used in this study.

Cognitive Function – Cognitive function encompasses multiple mental abilities individuals have such as decision making, attention, knowledge acquisition, memory, motor capacity, and executive function (Crespo et al., 2020; Sanders et al., 2019).

Diabetes Health Literacy (DHL) – Diabetes health literacy refers to individuals having the capabilities to find and interpret diabetes-related health information to make informed decisions about their well-being and manage this life-long condition (Tefera et al., 2020

Health literacy is conceptualized as the ability for individuals to seek, understand, and utilize health-related information to make informed decisions regarding their well-being. Diabetes health literacy refers to having the necessary capabilities in finding and analyzing diabetes-related information to manage this chronic condition.

Diabetes Numeracy (DN) - Diabetes numeracy has to do with applying basic mathematical skills including addition, subtraction, and multiplication in daily diabetic self-management activities such as insulin, glucose monitoring, administering medications and adhering to dietary guidelines (Huizinga et al., 2008).

HbA1c – HbA1c meaning glycated hemoglobin, is a blood test presenting an individual's average blood sugar level over the past 2 to 3 months. An A1c below 5.7% indicates normal, between 5.7% and 6.4% indicates prediabetes, and 6.5% or higher indicates diabetes. A typical goal for those already diagnosed with diabetes is to stay below 7.0%. HbA1c testing is suggested every 3 to 6 months (Lucier & Weinstock, 2023)

Health Belief Model (HBM) - The Health Belief Model was founded in the 1950s and is used to explain and predict changes in people's health behaviors. It focuses on disease prevention and behavior adoption to avoid illness and disease chains. HBM is one of the most precise models used to assess the connection between health beliefs and behaviors (Shabibi et al., 2017).

Health Education - Learning experiences for individuals, groups, societies, institutions, and communities designed to expand health knowledge and skills, influence behaviors and motivation, and enhance health literacy (World Health Organization, 2021).

Health Equity - Health equity indicates that everyone should have a fair and equal chance to achieve their maximal health despite differences economically, demographically, and geographically (World Health Organization, 2021).

Health Literacy - Health literacy is conceptualized as the degree to which individuals have the skills to search, comprehend, and utilize health-related information and services to make informed decisions for their health and well-being (Centers for Disease Control and Prevention, 2023; Sentell et al., 2020). Health literacy skills specific to diabetes range from reading prescribed medication bottles, adhering to medication cadence and lifestyle recommendations, and understanding information about treatment plan and goals (Visscher et al., 2020; Protheroe et al., 2017).

Medication Adherence – Medication adherence has to do with following a medicinal regimen provided by a health practitioner such as complying to the frequency, dosage, and timing of medications as prescribed (Aremu et al., 2022; Walsh et al., 2019).

Older Adults - In the context of this study, this refers to individuals who are 45 years and older (≥ 45 years old).

Risk Factor – These can encompass non-modifiable factors such as family history, age, genetic predispositions, ethnicity as well as modifiable risk factors such as lack of exercise, poor nutrition, smoking and alcohol use, stress, and inadequate sleep (Pradeepa & Mohan., 2021). Physical environments, economic factors, and social status can also be risk factors heightening susceptibility to a particular illness or disease (World Health Organization, 2021).

Self-Management – Self-management refers to engaging in health positive behaviors to manage health conditions (Lucier & Weinstock, 2023). Such as actively engaging in medication adherence, nutrition, exercise, diabetes-related problem solving, and blood glucose monitoring so the HbA1C (glycated hemoglobin) level can be controlled (Dahal & Hosseinzadeh., 2019; Lam & Leung., 2016). Moreover, staying treatment compliant, attending to physical and psychosocial concerns, and managing symptoms is all part of proactive self-management of diabetes (Lam & Leung., 2016).

Spiritual and Religious Coping (SRC) – Spiritual and Religious Coping has to do with partaking in spiritual and religious behaviors to find comfort during difficult life events. Spirituality takes place outside of organized religion (Vitorino et al., 2016). SRC refers to turning to God, a higher power, or connecting with oneself and others to seek solace or guidance through prayer, religious texts, and meditation (Park et al., 2017; Vitorino et al., 2016).

Type 2 Diabetes Mellitus (T2DM) – Type 2 Diabetes Mellitus represents about 90% of diabetes cases and is a preventable condition since the risk factors are based on one's lifestyle such as exercise, diet, and weight (Crespo et al., 2020). T2DM takes place when the body is unable to effectively produce or utilize insulin well (Centers for Disease Control and Prevention, 2023).

Significance of the Study

The significance of this research is the contribution to call attention to and grow the literature on diabetes self-management outcomes within the context of diabetes health literacy, diabetes numeracy, and current cognitive function, studies have not looked at these factors together in older adults. This study can spark future research, increasing researchers and practitioners' understanding of how these particular factors can play a role in older adults' self-management outcomes. An implication of this research would be for future researchers to explore ways of mitigating the limited diabetic health literacy and numeracy in individuals and which interventions are more likely to produce improved results (Dahal & Hosseinzadeh, 2019). On a societal level, this study highlights the need for health positive behaviors and emphasizes the importance of general and disease specific health literacy and numeracy. This can inspire communities to take action towards attaining equitable health education. If there are institutional and structural changes mitigating health education disparities, learning to be health literate can decrease chronic diseases such as Type 2 Diabetes Mellitus and empower individuals to set the course for lifelong habits, and aid in their health decision making, ultimately influencing greater community health (Auld et al., 2020).

This study also has key clinical implications as health literacy assessments are not performed in healthcare settings, thus patients' levels of health literacy and numeracy are unknown. Routine and brief health literacy and numeracy assessments should be incorporated into medical visits (Asharani et al., 2021). Educational materials and communication strategies can then be modified accordingly as patients may have difficulty in understanding the medical information communicated to them by their healthcare team and may feel uncomfortable in asking for clarification. The present study can also inform other aspects of clinical practice such

as the identification of specific needs of older adults to enhance their self-management abilities, this can lead to improved health and quality of life for individuals facing challenges with managing chronic conditions. This research is a call to action for collaboration amongst leaders of the healthcare system, schools, communities, and more. Results can be presented to those in healthcare management, doctors, and to those diagnosed with Type 2 Diabetes Mellitus to not only emphasize the importance of health education but also create initiatives to increase general and disease specific health literacy and numeracy.

Summary

This study sheds light on the role of diabetic health literacy, numeracy, and cognitive function on self-management outcomes of Type 2 Diabetes Mellitus in older adults. Acquiring diabetic health literacy and numeracy is of vital importance and can aid in mitigating unfavorable diabetes-related outcomes for older people. Older adults tend to have low health literacy and numeracy making them unlikely to use platforms to access health-related information (Asharani et al., 2021). Given that inadequate health literacy and numeracy is associated with adverse health outcomes, interventions and initiatives are imperative to ameliorate health disparities amongst individuals, communities, and institutions. Health literacy and numeracy is crucial in advancing health equity and increasing people's quality of life. Research findings have also indicated religiosity to positively impact human well-being and quality of life (Dewi et al., 2022). Christianity teaches that the body is a temple of the Holy Spirit; 1 Corinthians 6:19-20 expresses, "Do you not know that your bodies are temples of the Holy Spirit, who is in you, whom you have received from God? You are not your own/ you were bought at a price. Therefore, honor God with your bodies" (King James Version Bible, 1769/2022). Scripture and religious texts such as this can offer guidance and support for values of daily living. This

research can have a meaningful impact on both research literature and clinical practice in empowering older adults to better care for themselves and equipping them with the tools to do so.

CHAPTER 2: LITERATURE REVIEW

Overview

To investigate the association between participants' diabetes health literacy, numeracy, cognitive function, and its impact on their self-management outcomes of Type 2 Diabetes Mellitus, a comprehensive literature review on these constructs and related topics is presented. The literature review begins with a description of the search strategy utilized to uncover the existing findings regarding the effects of health literacy, diabetes health literacy, numeracy, diabetes numeracy, self-management, medication adherence, diabetes-related complications, health education, cognition, and religion. Constructs will be evaluated throughout this section and specific operational definitions will be presented. This section will address how these topics apply especially to older adults, and why this population is in need of improved diabetes health literacy and numeracy to better their health outcomes. The biblical foundations for this study will be presented near the end and the chapter will conclude with a summary of the reviewed literature.

Description of Search Strategy

The search strategy included use of keywords: health literacy, health numeracy, diabetes health literacy, diabetes numeracy, type 2 diabetes mellitus, self-management, medication adherence, diabetes-related complications, faith, religion, cognition, older adults, health education, and health promotion. The studies and references presented were sought primarily through the Jerry Falwell Library at Liberty University and Google Scholar, which linked to several databases. ProQuest, JSTOR, EBSCO, PsychInfo, APA PsychNET, EMBASE, ScienceDirect, and Medline were accessed and the search was limited to articles in English. The

biblical research was conducted through searching phrases such as diabetes and faith, religion, religious coping, as well as religious problem solving.

Review of Literature

Diabetes

In the United States, 37.3 million people are diagnosed with diabetes, with 96 million 18 years old and above who are diagnosed prediabetic (Centers for Disease Control and Prevention, 2022; Asharani et al., 2021; Marciano et al., 2019; Sultana et al., 2019). Diabetes is ranked as one of the top 10 fatal diseases and causes of morbidity and mortality worldwide (Asharani et al., 2021; Dahal & Hosseinzadeh, 2019; Lam & Leung et al., 2016). It is estimated that 1 in every 10 individuals have either Type 1, Type 2, or Gestational Diabetes Mellitus; these are the three major types of diabetes (Centers for Disease Control and Prevention, 2023; Onyishi et al., 2021). Type 1 Diabetes Mellitus (T1DM) is the body's inability to make insulin, known to be caused by an autoimmune reaction in which the body attacks itself mistakenly stemming from genetics or environmental factors (i.e. viruses) (Lucier & Weinstock, 2023; (Centers for Disease Control and Prevention, 2023).

Some individuals may have particular genetics that are passed on from parents to children making them likelier to develop Type 1 Diabetes Mellitus, though many will not develop it despite having these genetics and usually experience a trigger in the environment that may play a role in the development of Type 1 in individuals. People with Type 1 Diabetes Mellitus must take insulin life-long as well as daily to survive as their bodies are unable to create it, whereas those who are diagnosed with Type 2 experience that their body does not utilize insulin well (Centers for Disease Control and Prevention, 2023). Unlike Type 2 Diabetes Mellitus, lifestyle factors and diet do not cause Type 1 (Centers for Disease Control and Prevention, 2023). Type 1

Diabetes Mellitus is historically diagnosed in childhood; it is estimated that 5 to 10% of those with diabetes are diagnosed with Type 1, and the rest have Type 2. Taking a blood test will inform of a diabetes diagnosis and if the healthcare provider suspects Type 1, the individuals blood will be tested for autoantibodies. If these substances are present, it suggests the body is attacking itself and their urine may be tested for ketones as well. Ketones occur when the body is burning fat for energy, having ketones in urine denotes Type 1 Diabetes Mellitus instead of Type 2 (Centers for Disease Control and Prevention, 2023). At the present moment it is not known how to prevent Type 1.

Interestingly, Type 2 Diabetes Mellitus represents about 90% of diabetes cases and is a preventable condition since the risk factors are based on one's lifestyle such as exercise, diet, and weight (Crespo et al., 2020). After diagnosis, these lifestyle factors are still pertinent and need to be taken care of to avoid worsening of the condition or diabetes related complications. In the United States, 1 in 3 adults are at risk of developing Type 2 diabetes and are prediabetic which equates to 96 million American individuals (American Diabetes Association, 2023). Additionally, over 8 in 10 adults with prediabetes are unaware they are prediabetic (Centers for Disease Control and Prevention, 2023). Type 2 Diabetes Mellitus typically presents and is diagnosed in adulthood, occurring when the individual's body is unable to utilize insulin properly and the blood sugar is not kept within the normal range (American Diabetes Association, 2023). This occurs over several years and can be due to several factors such as the pancreas making little to no insulin, or the body being unable to respond to insulin the way it should, as well as aforementioned lifestyle factors such as physical inactivity and poor diet. In spite of, advances in treatment as well as the availability of health information and guidelines,

only 30% of people diagnosed achieve health targets of glycemic control, cholesterol, and blood pressure (Abdullah et al., 2019).

Diabetes-Related Complications and Comorbidities

Many people are not aware they have diabetes in a timely manner, thus being diagnosed late can lead to complications such as diabetic neuropathy and nephropathy (Abdullah et al., 2019). Diabetic neuropathy is one of the most prevalent complications occurring from diabetes affecting at least 50% of those diagnosed with diabetes (Feldman et al., 2019). It is characterized by nerve damage that occurs in the body affecting sensation, movement, and other functions. There are several different ways in which diabetic neuropathy manifests from individual to individual and can affect different parts of the body. There is focal neuropathy which impacts one nerve at a time and can manifest as aching sensations behind the eye, partial face paralysis, severe pelvis pain, chest wall pain, and more. Diabetic polyneuropathy is characterized by attacking multiple nerves and commonly those which are the longest nerves including ones extending from the spine down to feet. Symptoms include pain insensitivity, numbness, loss of coordination, and more which can lead to bodily injuries as they are unable to feel or sense bodily discomfort (Johns Hopkins Medicine, 2020).

Dependent on where the nerve damage is present in the body it can be characterized as peripheral (affecting the feet and legs), autonomic (affecting nerves which control internal organs), or proximal neuropathy (affecting nerves in hips, thighs, or buttock). The National Institute of Diabetes and Digestive and Kidney Diseases (2023) purports proximal neuropathy is the least common to occur, it happens on one side of the body usually, and is disabling; peripheral neuropathy is much more common with rates of 30% to 50% amongst those with diabetes. Diabetic nephropathy is another complication of diabetes characterized by the

deterioration and decline of kidney function. Hypertension is thought to contribute most to diabetic nephropathy, yet it is cyclical, and can also be a consequence of diabetic nephropathy due to physical kidney changes (Johns Hopkins Medicine, 2023).

Additional common complications of diabetes include hypoglycemia and diabetic ketoacidosis (DKA) (Centers for Disease Control and Prevention, 2023). Hypoglycemia is when one has low blood sugar, this occurs quite quickly and must be mediated fast as well. Causes for this include not eating enough or waiting too long between meals to have a snack or engaging in increased physical activity. Experiencing hypoglycemia several times a week is an indicator the treatment plan may need to be adjusted by the individual's healthcare provider. DKA is a complication that can be life-threatening and occurs due to missing insulin shots or experiencing illness. Having an extremely elevated blood sugar and low insulin leads to DKA as the body does not have enough insulin to let in blood sugar into bodily cells.

Individuals diagnosed with diabetes are at a higher risk of experiencing adverse health outcomes such as strokes, heart attacks, end-stage renal disease, blindness, non-traumatic lower limb amputations and more. Additionally, diabetes is associated with other comorbid chronic health conditions such as cancer, cardiovascular disease, kidney disease, and liver disease (Onyishi et al., 2021). These outcomes can be prevented or delayed through engaging in healthy lifestyle behaviors (adequate sleep, nutrition, exercise, low to no alcohol consumption, refraining from smoking) and managing diabetes through a multimodal approach with an emphasis on combining good blood pressure and cholesterol control with proper glucose control (Naha et al., 2021).

Self-Management

As there is no cure for Type 2 Diabetes Mellitus, it requires extensive self-management behaviors to manage health and minimize the chance of diabetes-related complications. This involves engaging in medication adherence, health literacy, consistent monitoring of blood-glucose levels, treatment compliance, nutrition, exercise, and health-centered decision-making. Different from many health conditions, diabetes is primarily managed by oneself with support from one's family, social supports, community, and health care team (primary care doctor, pharmacist, nutritionist, diabetes educator, foot doctor, eye doctor, and more) (Centers for Disease Control and Prevention, 2023).

Collaborative efforts from multiple organizations including the American Diabetes Association (ADA), American Association of Diabetes Educators (AADE), National Institute of Diabetes and Digestive and Kidney Diseases, CDC as well as healthcare professionals and research communities have played important roles in the development of the Diabetes Self-Management Education and Support (DSMES). The goal of DSMES is to enhance diabetes-related self-care behaviors, quality of life, and reduce risk of diabetes-related complications in people diagnosed with diabetes (Powers et al., 2015). DSMES offers educational and supportive services to provide people with diabetic knowledge and skills to manage their condition optimally (American Diabetes Association, 2021). It includes diverse components such as psychosocial support, blood glucose monitoring, medication management, diabetic education, and is offered in several settings such as community centers, healthcare facilities, and online platforms.

Researchers have implemented DSMES programs as interventions in their research. One such study is by Freeman and colleagues (2018) who conducted a DSMES centered study

comprised of three phases over the span of 1 year. They focused their intervention on a rural setting and underserved population where educational interventions are limited. The first phase centered on weekly 1-hour diabetic healthcare education in groups of 12 to 15 participants. Weekly topics included diabetes education, medications, acute emergencies, as well as physical activity and meal planning. Half of the sessions were taught by hospital staff implementing ADA curriculum and the other 8 were instructed by a YMCA diabetes life coach. Participants kept a comprehensive health journal during this phase noting glucose levels, food intake, as well as heart rate before, during, and after physical activity. Hospital personnel carefully reviewed these throughout the program to modify individual plans and identify any potential concerns. Participants met biweekly in Phase II and delved deeper into topics around living a healthy lifestyle. Phase III focused on building independence amongst participants in self-management of their condition. Results exhibited that equipping people with a supportive environment and information paired with practical application, people successfully self-managed their Type 2 Diabetes Mellitus. Similarly, many studies have found DSMES to be effective in participants with diabetes and a systematic review conducted by Chrvla and researchers (2016) evaluating DSMES programs found them to be most effective when both group and individualized interventions are combined. DSMES programs were also found to be increasingly effective when conducted by a multidisciplinary team rather than singularly as Freeman and researchers (2018) did.

Diabetes is a life-long condition impacting how the body converts food into energy, and as there is no cure, engaging in self-management behaviors including medication adherence, symptom management, communication with healthcare team, treatment compliance, administering insulin, blood sugar monitoring, staying physically active, and healthy eating are

the primary means to keep diabetes under control (CDC 2023; Dahal & Hosseindazeh, 2019). Active self-management of diabetes is crucial to have positive health outcomes and minimize the chances of diabetes-related complications. Pillars of effective self-management including medication adherence, increasing one's diabetes health literacy and numeracy, greater health education and committing to health-centered decision-making will be discussed in subsections below.

Medication Adherence

A crucial element of self-management is medication adherence which refers to engaging in a regimen prescribed by a healthcare professional such as complying to the frequency, dosage, and timing of medications (Aremu et al., 2022). Medication adherence to treatments which are long term is alarmingly low, this is present in both nations which are developed and developing (Anghel et al., 2018). In the United States, at any given moment 50% of Americans are non-adherent, they stop taking medications within one year of being prescribed (Centers for Disease Control and Prevention, 2017). Researchers have found duration of disease heavily predicts medication adherence, in which those who had been diagnosed for more than 5 years were less likely to have high adherence compared to those with a lesser duration, suggesting there is a negative relationship between disease duration and medication adherence (Al-Noumani et al., 2021; Garcia-Perez et al., 2013).

It is vital to understand patterns of medication adherence in those with Type 2 Diabetes Mellitus, understanding this is key in creating strategies and initiatives to improve rates of adherence along with disease related complications, lower hospitalization rates, and reduced health-care costs. Adherence to medications can be measured through the MPR (medication possession ratio), pharmaceutical refill records, self-report adherence scales, pill counts, and

testing of biological blood or urine levels (Aremu et al., 2022). The ramifications of low adherence on the effectiveness of treatments of chronic diseases is detrimental including higher healthcare costs, worsening health conditions, and lower quality of life (Anghel et al., 2018). Reasons patients have cited for this include affordability and cost, lack of understanding of the medication importance, cultural and religious beliefs, alcohol use, side effects, treatment complexity, polypharmacy, and increase of treatment intolerance as disease duration increases (Aremu et al., 2022; Centers for Disease Control and Prevention, 2017).

Nonadherence can occur intentionally or unintentionally, patients who intentionally do not adhere to medication guidelines often have strong opposing values or beliefs to the treatment or medicines. Unintentional nonadherence has to do with barriers to accessing the necessary medications, language hindrances, polypharmacy, and forgetfulness (Anghel et al., 2018). The National Association of Chain Drug Stores (NACDS) has found for every 100 prescriptions, 50 to 70 are filled by the pharmacy, 48 to 66 are picked up, 25 to 30 are taken properly, and 15 to 20 are refilled as prescribed (Centers for Disease Control and Prevention, 2017). Approximately 50% of medicines for chronic diseases are not taken as prescribed (National Association of Chain Drug Stores, 2017).

There are factors to medication adherence which are highly influential including the providers, patients, and the medications (Aremu et al., 2022). Providers encompass nurses, physicians, pharmacists and more who play a larger role than realized in medication compliance amongst patients. Providers may incidentally focus more on the condition’s treatment options and dynamics rather than focusing on whether the patient will be receptive to the treatment regimen. Hence, several providers fail to sufficiently educate their patients about the importance of taking the prescribed medicines with regard to timing, frequency, dosage, as well as side

effects. Provider education must be focused upon as continuing medication education and hospital grand rounds can aid providers in being more well-versed in factors influencing adherence and what their role is in patient adherence to medications. Beyond medication education for providers, they must be able to effectively communicate with patients. Providers expressing empathy, acknowledging the challenges associated with a medication regimen, and sharing any personal testimonies can foster an open line of communication and trust with the patient. Pharmacies can offer reminders via e-mail, phone call, text, or mail to foster compliance and lessen medication forgetfulness. Research has found pharmacist-provided services such as pharmacist-led medication management and multicomponent interventions, accompanied with reminders, and education with behavioral support have greatly improved medication adherence amongst patients (National Association of Chain Drug Stores, 2017). The patient themselves is the primary controller of their health in most cases and must consider their impediments to adherence and how they can abide by healthcare provider recommendations. Being well-versed and informed with the potential implications of noncompliance can also foster greater adherence.

The medication itself can come in many different forms such as a pill, syrup, injection, powder, cream, and more which can also be a barrier to adherence if people do not prefer to take it in its particular form. Hence, drug manufacturers should make medications in multiple different formulations as this can greatly help adherence levels. Additionally, when possible, having treatment regimens that require a less frequent administration cadence may also aid in adherence. Employment status can also determine access to health insurance as well as medication costs, hence patients may not be able to afford medications, interfering with medication adherence (Aremu et al., 2022). Some studies have found unemployed patients to have higher adherence than those who are employed or retired; however there has been

conflicting evidence finding worse adherence amongst unemployed people due to high medication costs (Al-Noumani et al., 2021). Elected government officials and those in power to influence medicinal costs should place caps on out-of-pocket spending on prescribed medications and should be informed of the implications regarding medication nonadherence.

Nonadherence of medication occurs at greater rates in adults aged 50 and above than younger cohorts; non-adherence amongst older people is associated with both hospitalization and mortality, leading to high healthcare costs (Walsh et al., 2019). Age can greatly influence medication adherence too, older patients are likelier to develop worsening cognition, impaired vision, and limited dexterity contributing to unintentional nonadherence. Those with chronic illnesses who are non-adherent have hospital admission rates which go up by 69% (Centers for Disease Control and Prevention, 2017). In the United States, non-adherence results in nearly 125,000 deaths, and $100 to $289 billion annually (National Association of Chain Drug Stores, 2017). Familial or medical professional support was found associated with increased levels of medication adherence and living alone was found to have a negative relationship with adherence (Anghel et al., 2018). Several studies have concluded that improving interventions aimed at medication adherence will have a much greater effect on population health than any improvements in particular medical treatments (Anghel et al., 2018).

Health Literacy

Health literacy plays a major role in the self-management of a disease and is pivotal in impacting individuals medication adherence. The concept of health literacy surfaced in the 1990s and has received much traction after the Office of Surgeon General of United States Department of Health and Human Services judged health literacy as one of the top 4 public health priorities (Luo et al., 2018; Lam & Leung, 2016). Health literacy definitions are varied, and researchers

have not come to a consensus regarding a standardized definition of health literacy yielding in difficulties correlating variables and designing effective assessment tools and measures. The nation's interpretations of health literacy itself has changed overtime. An organization created by U.S. Department of Health and Human Services (HHS), Healthy People, had posited in 2010 and 2020 people were to understand health information, however in Healthy People 2030 there is an emphasis on one's ability not only to understand but to *use* health information (Centers for Disease Control and Prevention, 2023; Healthy People 2030, 2023). The common theme amongst researchers is limited health literacy leads to poor health outcomes for individuals. There is also consensus on health literacy rates being lower than ideal in the United States, causing concern and research on how to increase health literacy rates amongst people.

Health literacy is posited to come in many forms such as functional, interactive, critical, personal, and organizational (Health Resources & Services Administration, 2022; Asharani et al., 2021; Marciano et al., 2021). Functional health literacy refers to the basic health skills comprised of reading and gathering health-related information (Asharani et al., 2021; Marciano et al., 2021; Mukanoheli et al., 2020). Interactive health literacy, interchangeably referred to as communicative, has to do with the comprehension and application of healthcare information in changing contexts to make well-informed decisions (Asharani et al., 2021; Van der Heide et al., 2015). Asharani and colleagues (2021) purport critical health literacy is defined as the skillset to examine and utilize health-related knowledge for the betterment of one's health. While interactive and critical health literacy are the utilization of a more advanced skillset than functional health literacy, these two definitions seem to have minimal distinction and can inadvertently overlap. Personal health literacy pertains to individuals capabilities to search for, comprehend, and utilize healthcare information to make informed health-related decisions.

Whereas organizational health literacy refers to the degree to which institutions equitably enable people to gain personal health literacy (Healthy People, 2023). Healthy People emphasizes in both types of health literacy the goal is to use health-related information, not just understand it, and to make well-informed decisions rather than "appropriate" ones (Health Resources & Services Administration, 2022).

Increasing one's health literacy is a vital goal for both the prevention and management of chronic health conditions (Asharani et al., 2021). Health literacy is imperative in advancing health equity and building peoples' trust with health institutions (U.S. Department of Health & Human Services, 2010). It is also integral to developing patient's sense of self-empowerment, positive attitudes, and self-management skills (Dahal & Hosseinzadeh., 2019; Yadav et al., 2019). Having adequate health literacy is essential for those with Type 2 Diabetes Mellitus to manage their condition as it is a chronic disease entailing ongoing health-related decision-making and interactions with the healthcare system.

Diabetes Health Literacy

There is scant literature on diabetes specific health literacy in people diagnosed with diabetes, however there is much knowledge on general health literacy in individuals with diabetes. Diabetes health literacy has to do with people employing their cognitive, analytical, and social skills to find, ask for, and disseminate diabetes-related health information to manage the condition (Tefara et al., 2020). Studies have shown health literacy to be an indicator of how well people recognize diabetic symptoms and manage their health, and it has shown to improve knowledge of diabetes, quality of life, and self-efficiency (Asharani et al., 2021; Rachmawati et al., 2019). People with low diabetic health literacy may have difficulty interpreting blood glucose results, take medications incorrectly, and experience difficulties with health advisories and

follow-up care (Tefara et al., 2020). Research has found people with diabetes and lower levels of health literacy have poorer communication with their healthcare support team and play less of an active role in decision-making surrounding their diabetes condition (Abdullah et al., 2019).

A systematic review conducted by Abdullah and colleagues (2019) found wide-ranging levels of health literacy across countries in participants with Type 2 Diabetes Mellitus. The most limited health literacy was found in Taiwan at 82% and the lowest in Switzerland at 7.3%. In the United States, the prevalence of inadequate health literacy was 28.9%. Those with lower than a high school education documented a greater prevalence of limited health literacy (Abdullah et al., 2019). Similarly, Tefara and colleagues (2020) found participants who attained higher education had greater diabetic health literacy scores. Even so, interactions with healthcare providers can help offset the effects of educational level. Research has also shown having a family history of diabetes is connected to greater diabetic health literacy levels compared to those without diabetic familial history, likely explained by the exposure increasing disease awareness (Tefara et al., 2020).

People with diabetes have a higher risk of complications like end-stage renal disease, loss of vision, and limb removal. Poor self-management of risk factors cholesterol, glycemic control, and blood pressure contribute substantially to the risk of developing complications (Tefera et al., 2020). Research findings confirm diabetic individuals with low health literacy tend to have poor glycemic control and multiple diabetes complications (Marciano et al., 2019; Sultana et al., 2019). Adding on to this, respondents experiencing difficulties understanding health information and connecting with healthcare providers, had higher odds of engaging in unhealthy behaviors (Friis et al., 2016). Diabetes essentially requires extensive self-management and often relies on verbal instructions from providers and educational materials to relay self-management

information. Those with lower levels of diabetes health literacy may experience difficulties with finding, adhering to, and integrating these guidelines in their everyday management of T2DM.

Health and Diabetes Numeracy

Asides from diabetes-related health literacy, comprehension and understanding of numbers is a vital component in treatment management. Numbers aid in giving meaning to information to assist people in making well-informed decisions, though research has shown not everyone is able to effectively use numbers. Particularly, individuals vary in numeracy skills. Numeracy refers to the ability of using quantitative skills and applying them in everyday life such as basic arithmetic and probability (Lau et al., 2022; Peters et al., 2014). Health numeracy has to do with utilizing mathematical abilities and applying them to healthcare related decisions such as selecting treatments and choosing health plans (Peters et al., 2014). Health numeracy is associated with health literacy however requires distinct capabilities in estimation, measurement, multistep processes, and logic to pinpoint which mathematical skills should be applied to solve specific problems. Interestingly, higher education level is not shown to correlate to greater numeracy, and individuals with strong health literacy levels may be insufficient in basic diabetes numeracy (Turrin & Trujillo., 2019; Peters et al., 2014). Moreover, Peters and colleagues (2014) report health numeracy to be more strongly correlated with health outcomes than health literacy, however they report ceiling effects on health literacy potentially obscured these results.

There are general, overarching measures to assess health numeracy such as the Subjective Numeracy Scale and General Health Numeracy Test. In addition to those assessments to measure specific health conditions include the Diabetes Numeracy Test and Asthma Numeracy Questionnaire. Diabetes numeracy refers to accurately using mathematical skills in the management of this chronic disease such as medication dosage, insulin administration, checking

blood sugar levels, and following nutritional serving sizes and exercise guidelines (Peters et al., 2014). Questions assessing diabetes numeracy from the Diabetes Numeracy Test-15 (DNT-15) include “You test your blood sugar 4 times a day. How many strips do you need to take with you on a 2-week vacation?” Questions on the test assess self-management activity domains including insulin adjustment, blood glucose monitoring, nutritional counting, exercise, and medication dosage (Huizinga et al., 2008). They employ mathematical skills comprised of fractions, decimals, numeration, counting, hierarchy, time, multi-step math, multiplication, division, addition, and subtraction. There is limited research in diabetes numeracy specifically, yet it is important to assess because older adults have an increased risk of declining cognitive function which can play a role in worsening self-management of diabetes yielding in less attentiveness to daily activities such as administering the accurate insulin dose and correct nutritional serving sizes.

Older Adults and Diabetes Management

There is some research on self-management of diabetes that has focused on older adults and factors specific to their management of the disease. Crespo and colleagues (2020) have purported cognitive function to be a pertinent component associated with health literacy in older adults with diabetes, for all components associated with self-management such as medication adherence, diet, and physical activity. As such, older adults with low health literacy may find it tough to self-manage any comorbidities, diabetes-related complications, as well as treatment recommendations and medication across multiple health conditions. The prevalence of several chronic diseases rises with age and diabetes itself has shown to be a risk factor for impairments and decline in cognitive function (Nematzad et al., 2023; Bruce et al., 2003). The process of aging directly impacts one’s cognitive function such as memory, executive function, and motor

capacity. Older adults also experience visual or aural impairments, require assistance filling out paperwork, reading daily newspapers, or taking notes, and have a greater likelihood of experiencing difficulties comprehending health-related information (Crespo et al., 2020; Cutilli et al., 2018). Research has demonstrated physical activity optimizes cognitive condition amongst older adults, especially in those who experience mild cognitive impairments already (Sanders et al., 2019).

Research has also shown older adults to be unlikely to utilize platforms for finding healthcare-related information, however greater health literacy and income moderate this relationship (Asharani et al., 2021; Cutilli et al., 2018). According to Cutilli and colleagues (2018), older adults predominantly rely on healthcare professionals as their primary source as well as radio and television shows with a healthcare focus as secondary sources of healthcare information. Since older individuals largely depend on their healthcare practitioners for medical guidance, the most beneficial time for advising older adult patients is while they are seeing the healthcare provider. Findings also suggest healthcare practitioners should initiate involvement as opposed to waiting for patients to request health-related information. Even so, there is a clear need for health promotion and educational materials to be both user-friendly and user-involved; this is a vital component in improving health literacy in this population.

Health Promotion and Education

Health-related information can come from many avenues, a great deal of our values and views can stem from the beliefs of the people we surround ourselves with. Research has shown families listen to messages from organizations within their community as well as religious and spiritual leaders (Aremu et al., 2022). Faith-based leaders are known to be members of the community who are trusted and offer support and guidance. Health organizations can seek to

cultivate a partnership with local faith-based organizations as it can aid in improving health literacy amongst its members. Search engines and social media can also be a powerful tool in health promotion, both positively and negatively. There is misinformation and conspiracy theories present on the web that may create distrust in the healthcare system. However, the web can also provide access to many educational materials and information benefitting one's health. Healthcare associations and organizations should be at the frontlines of disseminating healthcare information on social networking platforms, mobile applications, websites, printed media, as well as television and radios (Aremu et al., 2022). When individuals pick up their prescriptions from pharmacies or visit healthcare product stores, printed media such as flyers, pamphlets, and posters should be viewable and accessible to consumers as this is another avenue to increase health education. Empathic one-on-one interactions with healthcare providers during appointments can be influential in patients' healthcare education.

The Centers for Disease Control and Prevention (CDC) (2023) developed the National Diabetes Prevention Program (National DPP) in 2010, a national effort which seeks to address prediabetes and help prevent Type 2 Diabetes Mellitus across the United States. It is a 1-year structured CDC-recognized lifestyle change program offering both evidence-based and cost-effective interventions on healthy diet, physical movement, and tailored to individuals with prediabetes to cut their risk of developing Type 2 Diabetes Mellitus. Statistics have shown people with prediabetes who have taken part of the National DPP have decreased their risk of T2DM by 58% and for those over 60 years old 71% (Centers for Disease Control and Prevention, 2023). Thus, this nationwide program has proven to prevent or delay T2DM in adults with prediabetes.

The CDC brought together and partnered with faith-based and community organizations, government agencies, health care organizations, employers, and private insurers in a national effort to reduce diabetes across the United States. Key aspects of this initiative included a lifestyle trained coach, CDC-approved curriculum, and group meetings and support over the 1 year. Since this effort is directed toward those with prediabetes, people who are already diagnosed with T2DM can still search for and participate in other initiatives and take actionable steps such as meetings with a diabetes educator. They can aid in providing guidance and support on how to test blood sugar, recognizing signs of elevated or low blood sugar and how to mediate it, administering insulin to oneself, monitoring signs in feet, eyes, and skin, purchasing diabetes supplies, managing diabetes daily care and stress, as well as creating and following a healthy diet and physical activity routine (Centers for Disease Control and Prevention, 2023).

In a review conducted by Dahal & Hosseinzadeh (2019) health literacy interventions led in a community setting were more effective than patient-focused health literacy interventions. A study by Cortez and researchers (2017) implementing a randomized cluster trial found those in the intervention group that participated in their community-based health literacy intervention, had yielded a statistically significant improvement in their HbA1c (glycated hemoglobin) compared to the control group. Significant improvements in the intervention group were also seen in nutrition, exercise, healthcare related decision-making, and diabetes knowledge. The control group presented worse scores when the post-education tests took place on diabetes knowledge and self-care (Cortez et al., 2017). Similarly, de Wit and researchers (2018) found community-based health literacy initiatives directed at older adults and their community resulted in them gaining greater levels of healthcare knowledge through collaborative learning (co-learning) and social support. Co-learning in this context refers to sharing health knowledge with

their community members which can include their family, caretakers, peers, support group, healthcare providers, and more.

Older adults gained knowledge by exchanging their treatment experiences, their coping strategies, as well as management of information, disease, and consultations with their healthcare providers (de Wit et al., 2018). These findings show how co-learning contributes to greater levels of health literacy amongst older adults. People are better able to retain health-related knowledge and learn more when they are collaborating with a group rather than individually (de Wit et al., 2018; Gokhale, 1995). Although there is not much research on collaborative learning and its role in health literacy, a study conducted by Xie (2011) linked collaborative learning in improving older adults' e-health literacy; e-health refers to the ability to use electronic devices in finding and applying healthcare-related information. These findings suggest community-based health literacy interventions have positive impacts on Type 2 Diabetes Mellitus outcomes (Freeman et al., 2018; Cortez et al., 2017; in Lee et al., 2017; de Wit et al., 2017; Wichit et al., 2017).

Health Belief Model

As a theoretical framework for this research, the Health Belief Model was appropriate because it allows for the study of self-management through the lens of six key constructs and highlights that a person’s health-related behavior is dependent on their view of perceived barriers, benefits, self-efficacy, susceptibility, severity, and cues to action. The Health Belief Model is used in various fields like disease prevention, rehabilitation, health-related behaviors, and health promotion initiatives. It is amongst one of the most used models for analyzing health-related behaviors and can be used to guide both short and long-term interventions. HBM can aid in determining the strength of the relation between diabetes health literacy, diabetes numeracy, cognitive function and self-management of Type 2 Diabetes Mellitus (Sayah et al., 2016).

The Health Belief Model was founded by psychologists Hochbaum, Rosenstock, and Kegels in the 1950s working for the United States Public Health Service who were examining why Americans were not utilizing health services such as screeners and immunizations. According to the Health Belief Model, an individual's health-related behavior is determined by their perception of four crucial domains: severity of a potential sickness (perceived severity), vulnerability to that illness (perceived susceptibility), beneficial effects of taking preventative action (perceived benefits), and barriers to taking action (perceived barriers) (Center for Disease Control and Prevention, 2023). In later years, cues to action and self-efficacy were added to the model with a total of six critical areas. Cues to action has to do with information, events, people, or various other factors that can trigger people to modify their behavior, and self-efficacy pertains to an individual's confidence to perform an action (Center for Disease Control and Prevention, 2023; Washburn et al., 2020). The six areas all critically impact the probability of engaging in health-promoting behaviors, however perceived barriers are viewed to be the most important component in whether people engage in modifying their behaviors. Barriers can include and are not limited to transportation difficulties, financial means, childcare needs, pain aversion, mental health, embarrassment, or inconvenience (Washburn, 2020).

Nematzad and researchers (2023) conducted a quasi-experimental study implementing the Health Belief Model in older adults with hypertension to promote self-care behaviors. According to the CDC and National Health and Nutritional Examination Survey (NHANES), 73.6% of people diagnosed with Type 2 Diabetes Mellitus have hypertension (Naha et al., 2021). This comorbidity is not surprising as people with T2DM tend to exhibit a cluster of metabolic abnormalities known as the cardiometabolic or cardiorenal metabolic syndrome (Naha et al., 2021). Having both hypertension and diabetes can lead to the likelihood of other adverse clinical

outcomes being cardiovascular or chronic kidney disease, cerebrovascular accident, and dyslipidemia. The World Health Organization states that hypertension can be managed through self-care behaviors, which refers to treatment adherence, low-salt diet, blood pressure monitoring, avoidance of alcohol, and more. Two 1-hour long sessions were conducted in health centers and participants in the intervention group were given a booklet validated by health education professors named "Self-Care Education for the Older Adults." The control group was solely given routine care from healthcare practitioners. Interestingly, the results exhibited no significant increase nor difference in the knowledge score between both groups. However, self-care behaviors increased significantly post-intervention and five of six HBM constructs improved post-intervention indicating HBM-based educational interventions can improve the self-care habits of hypertensive older individuals (Nematzad et al., 2023).

One of the leading causes of blindness worldwide is due to diabetes-related ocular complications. Pezeshki and authors (2022) examined the impact of the HBM on eye care practice of patients diagnosed with Type 2 Diabetes Mellitus. The experimental group attended 8 one-hour educational sessions; an optometrist came to assess participants in one session. In another session, a 55-year-old man who became blind due to diabetes was invited to speak and share his story which heightened participants' perceived severity. No significant differences were found in demographic variables of the two groups, familial diabetic history, and knowledge levels. However, 3 months post-educational intervention there were significant differences between the two groups in the six HBM constructs and knowledge. According to researchers, follow-up contact, messaging group for exchanging and communicating information, optometrist availability, educational films and booklets all aided in the improvement of participants eye care in the experimental group.

Shabibi and colleagues (2017) conducted an educational intervention amongst participants with Type 2 Diabetes Mellitus based on the Health Belief Model. The intervention was aimed at the promotion of self-care behaviors; self-care and self-management are similar constructs and are interchangeably used in these contexts. Self-care behaviors include blood sugar monitoring, medication compliance, feet care, physical activity, and nutrition. This intervention comprised of four 1-hour sessions held over one month and respectively taught symptoms of and diabetes-related complications, self-care knowledge, proper diet, and testing blood sugar in session through practical demonstration and activity practice. The content presented and educational methods used were through varied modalities consisting of presentations, videos, group discussions, posters, and practical demonstrations including physical exercises and blood sugar testing. A family member was requested to attend particular sessions with them to acquire skills in management of diabetes. Results found there was a positive association between the improvement of the six aspects of the Health Belief Model and self-care behaviors. Perceived susceptibility specifically was found to differ greatly pre- and post-intervention in this study and others; however the lack of a control group limits the findings (Shabibi et al., 2017). Similarly, Tehrani and colleagues (2019) conducted a randomized educational intervention on nutritional behaviors grounded in the Health Belief Model and found it was effective in improving diabetic participants' eating behaviors.

These studies demonstrate the integration and application of the Health Belief Model in research designed to promote self-management behaviors. HBM has become one of the most broadly applied conceptual framework of health behavior employed by healthcare professionals (Green et al., 2020). The Health Belief Model consists of constructs risk perception to illness, perceived severity of illness, perceived benefits of behavior modification, perceived obstacles,

self-efficacy, and cues to action. These constructs are key to better learn about how people view their perceived diabetes-relates risks and what encourages or discourages them from practicing healthier habits or complying to treatment. The Health Belief Model was the most suitable to tackle the research questions of this study asking to which extent does diabetes health literacy, diabetes numeracy, and cognitive function predict self-management outcomes in Type 2 Diabetes Mellitus? As well as, to which extent does diabetes numeracy and diabetes health literacy change the relationship of self-management outcomes in Type 2 Diabetes Mellitus?

Biblical Foundations of the Study

Religious participation has been shown to influence physical health, specifically diabetes and obesity are major health outcomes in which religion plays a role according to research (Bentley-Edwards et al., 2020). This is so because religion functions as a protective factor to detrimental behaviors by inspiring people to practice self-control, positive thinking, and confidence (Dewi et al., 2022). Saffari and colleagues (2019) examined factors social support and religious coping in older adults with Type 2 Diabetes Mellitus and assessed their medication adherence and quality of life. It was discovered that participants with this chronic condition may desire reduced social interactions and connections than their healthy counterparts, and as such impacting their medication adherence. As older adults are more likely to be reliant on family members and loved ones than the average person given their age-related infirmity, social support ought to be considered an essential factor impacting their health. Several authors have pointed out that social support is crucial in helping people engage in lifestyle modifications and treatment adherence (Saffari et al., 2019). Consequently, multiple studies have demonstrated when individuals experience social exclusion, they have reported increased religious affiliation levels. Religious membership not only alleviated the emotional strain brought on by social exclusion,

but it also increased devotion to God. Thus, persons who were socially excluded reported substantially greater degrees of both individual and social religiousness than included respondents (Bryan et al., 2016).

Specific to Type 2 Diabetes Mellitus in older adults, Saffari and authors (2019) found religious coping to be a significant moderator for religiosity and medication adherence; religious coping is a method of finding comfort and guidance from a higher power through one's religion or spirituality (Bryan et al., 2016). Along with religious coping there is also spirituality; Spiritual and Religious Coping (SRC) involves engagement in both spiritual and religious behaviors to find solace in difficult times. Spirituality is a highly personal process which occurs outside of organized religion (Vitorino et al., 2016). It refers to finding purpose in life and connecting with a greater being, with nature, with oneself and others, as well as the present moment. Spiritual habits and customs are reflected in these attributions. SRC is purported to be a salient concern and area of research in older adults as aging is associated with losses of loved ones, chronic illness, and decline in cognitive and physical functioning. Older adults are also found to be likelier than those who are younger to engage in SRC (Vitorino et al., 2016). SRC can be positive or negative; positive coping is having a trusting and secure connection with God and is inclusive of seeking guidance in religious texts and making religious reappraisals (Park et al., 2017; Vitorino et al., 2016). Negative SRC presents as punitive appraisals, religious discontentment, and exhibiting a less secure relationship with God (Park et al., 2017; Vitorino et al., 2016).

Religiosity and spirituality play a crucial role in people's health outcomes (Dewi et al., 2022; Park et al., 2018; Vitorino et al., 2016). When facing physical adversities, older adults tend to rely on spiritual and religious coping methods compared to younger adults (Vitorino et al.,

2016). Findings suggest older adults who engage in religion or spirituality gain health-related benefits such as buffering health-related stress, viewing themselves as physically healthy, complying to treatment management, and have a decreased risk of physical illness and disability (Vitorino et al., 2016). Findings also show practicing religiosity and spirituality are key factors in strengthening one's meaning and quality of life, self-efficacy, self-esteem (Dewi et al., 2022; Park et al., 2018). Spirituality and religion can be foundational to safeguarding older adults' health and well-being in adverse times and can be relied upon as a coping mechanism playing an essential part in patients' healing (Dewi et al., 2022).

In Christianity, health is highly regarded and actions to jeopardize one's health is condemned. Noncompliance with treatments is frowned upon, and people must do what they can for the restoration of their health; there is also a great emphasis on helping and aiding those who are underprivileged, grieving, cognitively impaired, older, and disabled. Messages of restoration of humankind and ethical living principles are promoted including health-related decisions, such as good hygiene practice, practice of healthy lifestyle behaviors, and doing acts of service. There is emphasis on well-being including mind, body, and spirit as mentioned above (1 Corinthians 6:19-20). It communicates on the mind-body connection we all experience and its interconnectedness. Healing, prayer, as well as mindfulness and meditation are all outlets to nurture and soothe the mind-body connection. In essence, faith provides its disciples with having a sense of purpose in life, this aids in overall well-being and living a healthy life.

The practice of faith and religion indeed bears a relationship to health promotion (Bentley-Edwards et al., 2020). In times of sickness, people often turn to prayer, and call upon God to heal and restore one's health. From a biblical perspective, the belief is the ultimate source of health and healing comes from God and people should seek to align their health decisions with

biblical principles. For instance, Jeremiah 30:17 purports “For I will restore Health to you and heal you of your wounds" (King James Version, 1997). This outlook highlights the significance of taking care of one's health as a means of honoring God and encourages people to adopt healthy behaviors and lifestyles that promote overall well-being.

Summary

The review of the current literature and faith-based research on medication adherence, diabetes, older adults, social support can be linked to the common thread of diabetes health literacy and numeracy. T2DM is a substantial public health concern particularly amongst the elderly (Saffari et al., 2019). Some risk factors for this chronic condition include family history, sedentary lifestyle, obesity, and poor diet. Higher rates of cognitive decline occur amongst people who are older, and diabetes itself also puts people at risk for cognitive impairments (Bruce et al., 2003). Hence, optimal cognitive function as well as diabetes health literacy and numeracy is vital for older adults’ self-efficacy in managing T2DM. The Health Belief Model was found to be the most fitting to guide the present study as it is one of the most effective models of change in health-related behaviors (Green et al., 2020).

Biblically, empirical research has shown religion to help with a person’s coping capabilities in a wide range of personal and social stressors, including illness, grief, traumatic experiences, terrorist danger, and warfare (Bryan et al., 2016). People seek comfort in a higher divine power during tough life events and cope through prayer. According to Dewi and authors (2022) religiosity is vital as it provides a foundation for sustaining quality of life in patients. Spiritual beliefs are deeply individualized ideals that grow in importance with age; religious teachings and scriptures offer guidance on how people should spend their lives and respect others (Vitorino et al., 2016). Older adults especially are likelier to engage in spiritual and religious

coping than those who are younger as they experience a growing number of familial or social losses, as well as decline in health. In Scripture it is taught that the body is a temple of the Holy Spirit. In essence, the Bible encourages us to glorify God with our bodies since they are temples of the Holy Spirit and must be properly cared for (King James Version Bible, 1769/2022, I Corinthians 6:19-20).

CHAPTER 3: RESEARCH METHOD

Overview

A research methodology is presented for examining the connections among participants' diabetes health literacy, diabetes numeracy, and cognitive function on their self-management outcomes of Type 2 Diabetes Mellitus. The chapter begins with a description of the research questions and hypotheses guiding the study. This section will address the layout of the research design and study procedures to uncover relationships between variables. Methods of recruitment and participant eligibility will also be described. Specific operationalization of variables (diabetes health literacy, diabetes, numeracy, cognitive function, and T2DM self-management outcomes) will be presented and the scales evaluating these variables will be outlined. The delimitations, assumptions, and limitations of the study will be reported near the end and the chapter will conclude with a summary of the information presented.

Research Questions and Hypotheses

Research Questions

RQ1: What is the association of diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes in older adults?

RQ 2: What is the association of diabetes numeracy and Type 2 Diabetes Mellitus self-management outcomes?

RQ 3: What is the association of cognitive function and Type 2 Diabetes Mellitus self-management outcomes in older adults?

RQ 4: How does diabetes numeracy moderate the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes?

RQ 5: How does cognitive function moderate the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes?

Hypotheses

Hypothesis 1: Diabetes health literacy is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults

Hypothesis 2: Diabetes numeracy is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults

Hypothesis 3: Cognitive function is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults

Hypothesis 4: Increased diabetes numeracy moderates the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes

Hypothesis 5: Increased cognitive function moderates the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes

Research Design

Methodologies which are quantitative in nature concentrate on numerical and statistical information obtained by responses on questionnaires and surveys, or from manipulating prior statistical data gathered. The main objective of a quantitative research design is to determine the impact of an independent variable on a dependent or consequence variable in the context of a population. The quantitative method has been considered reductionist, essentially the information at hand is reduced to a number and expressed through statistics (Mehrad & Zangeneh, 2019). According to Stockemer (2019) the key instrument in discovering empirical associations is quantitative research. Moreover, Franz (2021) states quantification is the fundamental cornerstone of modern empirical psychological science.

Qualitative research employs inductive reasoning and aims to assess non-quantifiable phenomena, in which quantitative approaches are not appropriate (Mehrad & Zangeneh, 2019). Data in qualitative research tends to be gathered through case studies, interviews, focus groups, and observations. This type of research focuses on the exploration and comprehension of people's lived experiences and social phenomenas development rather than assessing for a relationship or correlation (Nassaji, 2020). There is a dynamic, open-ended, and broad strategy to assessment, whereas quantitative investigations are fixed in research design and defined in statistics (Mehrad & Zangeneh, 2019). Another distinction between quantitative and qualitative research is the observation quantity. Quantitative research works with numerous amounts of statistical data, whereas qualitative research involves a small number of observations, this is so because qualitative data involves an in-depth exploration of its topic at hand (Stockemer, 2019). In qualitative research studies, there is a greater likelihood for the primary investigator to inadvertently influence respondents. However, in quantitative designs as this survey is being answered independently there is no undue influence on participants responses. Thus, the nature of this methodology is able to decrease bias and effectively predict findings on the relationship between diabetes health literacy, diabetes numeracy, cognitive function, and self-management of Type 2 Diabetes Mellitus.

Quantitative and qualitative designs are both scientific illustrations of concepts, and their measurement utilization binds results to concepts, however they are varied in their approach to research and data collection, namely measurement and observation quantity (Mehrad & Zangeneh, 2019). The two methods vary in many ways, yet they are complimentary; researchers in the social sciences should be well-familiarized with both research techniques (Stockemer, 2019). Using a quantitative methodology may not be suitable in every research study any more

than qualitative research is (Howitt, 2016). Recognizing the optimal research method and utilizing it accurately is critical to answer the researchers' questions (Mehrad & Zangeneh, 2019).

For this study, a quantitative non-experimental correlational research design was considered appropriate to understand and shed light on how diabetes health literacy and numeracy levels, and cognitive function play a role in the self-management outcomes of Type 2 Diabetes Mellitus. A quantitative research design allowed for assessing connections of bivariate or multiple relationships and predictions among the multiple variables in this study at once (diabetes health literacy, diabetes numeracy, cognitive function, self-management scores). The guiding theoretical framework of this study is the Health Belief Model, hence the quantitative design was most effective as it is also theory driven, beginning and ending with theory (Stockemer, 2019). Quantitative research approaches enable the researcher to employ preset, instrument-based questions. A cross-sectional quantitative survey comprised of four scales was answered by participants (Cognitive Assessment Questionnaire, Diabetes Health Literacy Scale, Diabetes Numeracy Test-5, and Diabetes Self-Management Questionnaire-Revised). Participants self-reported their diabetes history including diagnosis age, family history, HbA1c levels, and comorbidities. Participants also self-reported demographic covariates including current age, gender, country of residence, race/ethnicity, marital status, and education level. The questionnaire was available to answer on electronic devices with results analyzed through IBM SPSS (Statistical Package for the Social Sciences). To ensure unbiased data collection and

analysis, a quantitative method was adopted, examination of data through IBM SPSS occurred after respondents submitted the survey.

Quantitative research approaches are deductive and classified into four types: correlational, causal-comparative, quasi-experimental, and experimental (Stockemer, 2019; Mertler, 2014). An experimental design involves variable manipulation, control groups, as well as random assignment and random selection, which are not implemented in this study (Mehrad & Zangeneh, 2019). In quasi-experimental designs, random selection occurs in which every person of the population has an equal probability of being chosen to be a sample member. Random selection cannot be incorporated in this study as the group of interest is adults above 45 years of age with Type 2 Diabetes Mellitus, due to the aforementioned reasons experimental nor quasi-experimental design were found suitable.

Causal-comparative design also known as ex post facto design, or "after-the-fact" design aims to retrospectively view study conditions which have already taken place and determine potential reasons there is an observed difference between groups (Stockemer, 2019; Mertler, 2014). As both the study conditions and results have already occurred this design is retroactive in nature. This design is most like a correlational design as both research designs are exploring things that have already occurred. Causal-comparative research is unable to truly indicate a cause and effect as no variables are being controlled unlike in experimental designs. Since a causal-comparative design is unable to imply direct causality and can only identify multiple *possible* causes, a correlational design was deemed best as strength and direction between the variables can be measured (Mertler, 2014).

Correlational designs aim to examine the connection between a variable and its impact on another, to assess how they might affect, covary, or co-relate with one another (Stockemer, 2019;

Mertler, 2014). The goal is to explore whether certain behaviors, traits, conditions, and more are causing or related to the other. In this design, a researcher investigates if and to how great an extent there is a statistical association among two or more factors. This design is comprised of one group of people measured on two or more variables; for the present study this was adults over 45 years of age who have been diagnosed with Type 2 Diabetes Mellitus measured on their health literacy and cognition levels to examine its relation to their self-management outcomes. It is important to note that when a correlation is found between variables this does not equate to causation as there are likely additional variables at play having a causal influence. Accordingly, correlation results imply a prediction of association not of causation (Mertler, 2014). Thus, the quantitative correlational design was deemed best for this study to run regression analyses and assess the relationship strength of predictor variables, diabetes health literacy, diabetes numeracy and cognitive function, on criterion variable, self-management outcomes of diabetes. This quantitative study using a correlational design presents data and insight supplemented by the Health Belief Model to individuals diagnosed with Type 2 Diabetes Mellitus 45 years old and above, caretakers, medical personnel, and members of healthcare administration.

Participants

Participants eligible to participate included those diagnosed with Type 2 Diabetes Mellitus and above 45 years of age. In accordance with the NIH Revitalization Act of 1993, participant demographics ranged in gender, race, and ethnicity. The 45 years old and above demographic was targeted as the onset and diagnosis of Type 2 Diabetes Mellitus increases with age and most commonly develops in people over age 45 (Centers for Disease Control and Prevention, 2023). Convenience sampling was employed in this study, a sampling method of recruiting participants who are easily accessible and found anywhere such as clinics, online

interest group, posters and so forth. Regardless of the numerous routes of recruitment convenience sampling offers, this technique is not considered randomized since people do not have an equal chance of being selected. This method targeted people who specifically met the inclusion criteria of the study and were willing to participate in the research.

Convenience sampling tends to be low cost, and useful when researchers are unable to gain access to the full target population to obtain a sample that is representative. As participation was voluntary, a drawback of this approach included self-selection, as individuals who are more interested in the subject of the study and motivated to participate may be disproportionately represented in the data (Stratton, 2021). Participants were recruited through social media outreach and diabetes support groups. Participants were required to have access to a laptop, phone, or tablet to complete the survey. Qualtrics was used for the questionnaire and data collection. Prior to beginning the survey, potential participants read through the informed consent stating participation is optional and they may withdraw at any time without repercussions. A sample size of 74 participants was determined by utilizing the G*Power analysis version 3.1.9.7 to obtain 80% statistical power at an alpha level of .05 and medium effect size of 0.15; along with a priori power analysis, linear multiple regression, a fixed model, and R squared.

Study Procedures

Access to the questionnaire was available via survey link, email, and more through online community forums, health professionals, peers, and other routes of participant recruitment. When the link was accessed, screener questions were asked to assess if they were eligible to participate in the study, and informed consent was conducted. Individuals were made aware they may withdraw from the study at any given time without consequence, as well as the potential

risks and benefits of participation, compensation, length of the participation, and confidentiality of information. Participants were made aware they are participating in a research study about Type 2 Diabetes Mellitus, and researchers are studying diabetes health literacy, diabetes numeracy, and cognitive function effects on self-management of Type 2 Diabetes Mellitus. The questionnaire for the study contained four scales, which are discussed in the next section. The length of involvement in the study was approximately 20 minutes.

Instrumentation and Measurement

The variables in this study were examined using previously validated scales. Diabetes health literacy levels were measured through Lee and colleagues (2018) Diabetes Health Literacy Scale (DHLS). Cognitive function was measured through the Cognitive Assessment Questionnaire (CAQ) (Broadbent et al., 2008). Diabetes numeracy levels were measured through the Diabetes Numeracy Test (DNT-5) (Huizinga et al., 2008; Estrella & Allen-Meares, 2020). Type 2 Diabetes Mellitus Self-Management outcomes were measured through the DSMQ-R Diabetes Self-Management Questionnaire-Revised (Schmitt et al., 2022).

Measures

Demographic and Socioeconomic Information. Participants self-reported demographic and socioeconomic covariates including current age, gender, country of residence, race/ethnicity, marital status, and education level to contextualize the findings and increase the generalizability of the study.

Diabetes History. Participants self-reported their diagnosis age of Type 2 Diabetes Mellitus, whether any immediate family members have diabetes, HbA1C levels, diabetes related complications (retinopathy, neuropathy, nephropathy, or cardiovascular issues), and any other

medical conditions they may have. This information was used for additional participant characterization and findings contextualization.

Cognitive Assessment Questionnaire (CAQ). The CAQ is a 25-item scale used in this study to assess for cognitive functioning (Rast et al., 2008; Broadbent et al., 2008). Previously, this scale was originally called the Cognitive Failures Questionnaire (CFQ) developed by Broadbent and colleagues (1982). Rast and researchers (2008) found the questionnaire's items load onto three factors of forgetfulness, distractibility, and false triggering. The scale was found to have good test-retest reliability, with Cronbach's alpha r = 0.80 (Rast et al., 2008). Items of the CAQ (1982) include "Do you read something and find you haven't been thinking about it and must read it again?" and "Do you start doing one thing at home and get distracted into doing something else (unintentionally)?." The items are reported with a 5-point Likert scale ranging from 0 (never) to 4 (very often) (Broadbent et al., 1982).

Diabetes Health Literacy Scale (DHLS). The Diabetes Health Literacy Scale was developed to assess individuals understanding of their diabetes and was used in this study to assess participants levels of diabetic literacy. This scale was found to have high test-retest reliability, with Cronbach's alpha r = 0.91 (Lee et al., 2018). This scale also exhibited high internal consistency with interclass coefficient (ICC) = 0.89. Participants were asked to rate 14 items such as "I can interpret if my blood-glucose level is within the normal range" and "I can judge if diabetes-related information is reliable." The items are reported with a 5-point Likert scale ranging from 0 (not really) to 4 (very much).

Diabetes Numeracy Test (DNT-5). The DNT-5 is a shortened version of the DNT (43 items) and DNT-15. This assessment was developed to assess numeracy skills in people with diabetes. Evaluation of diabetes numeracy is essential as people may have adequate health

literacy but inadequate skills in numeracy. Diabetes numeracy has to do with applying basic mathematical skills including addition, subtraction, and multiplication in daily diabetic self-management activities such as insulin, glucose monitoring, administering medications and adhering to dietary guidelines (Huizinga et al., 2008). This scale was developed from the top 5 items on the DNT-15 which had the highest correlations with the Wide Range Aptitude Test (WRAT 4). The DNT-15 had high reliability with Kuder-Richardson's coefficient r = .90 (Estrella & Allen-Meares, 2020). Further research showed the DNT-5 and DNT-15 to be highly intercorrelated (r > 0.90) and researchers findings support the validity of tool DNT-5 to measure diabetes numeracy (Estrella & Allen-Meares, 2020).

Diabetes Self-Management Questionnaire-Revised (DSMQ-R). The DSMQ became available in 2013, originally there were 16-items however now it is comprised of 27-items and is known as the DSMQ-R (Schmitt et al., 2022; Schmitt et al., 2013). This questionnaire assesses individuals' self-management practices in accordance with diabetes. It includes items on medication adherence, exercise, glucose testing and monitoring, diabetes-adjusted eating, as well as cooperation with the diabetes healthcare team. The scale was found to have high internal and retest reliability, with Cronbach's alpha r = .87 (Schmitt et al., 2022). Items of the DSMQ-R include "The foods I choose to eat make it easy for me to achieve food glucose levels," "I keep a diary/log of my glucose levels to inform and improve my diabetes management," and "I am less physically active than would be good for my diabetes." The items are reported on 4-point Likert scale ranging from 0 (does not apply to me) to 3 (applies to me very much) (Schmitt et al., 2022).

Operationalization of Variables

Diabetes Health Literacy – Diabetes Health Literacy is an interval variable and was measured by total mean score on the Diabetes Health Literacy Scale along with subscale mean scores for Informational, Numeracy, and Communicative Health Literacy (Lee et al., 2018).

Diabetes Numeracy – Diabetes Numeracy is a ratio variable and was measured by the total mean score on the Diabetes Numeracy Test (Estrella & Allen-Meares, 2020).

Cognitive Function – Cognitive Function is an interval variable and was measured by the total mean score on Cognitive Assessment Questionnaire along with subscale mean scores for Forgetfulness, Distractibility, and False Triggering (Rast et al., 2008; Broadbent et al., 2008).

T2DM Self-Management Outcomes – Diabetes self-management outcomes is an interval variable and was measured by the total mean score on the Diabetes Self-Management Questionnaire-Revised and subscale mean scores for Glucose Management, Dietary Control, Physical Activity, Health Care Use, and *Insulin Use (*Optional 7 items to be answered by people with intensive insulin treatment only) (Schmitt et al., 2022; Schmitt et al., 2013).

Data Analysis

The collected data was assessed using IBM Statistical Package for the Social Sciences (SPSS) software program version 29 to evaluate for bivariate and multiple relationships, as well as predictions amongst variables. Pearson's Product Moment Correlation Coefficients was run for the first three research questions and regression analyses was run for research questions 4 and 5. Both correlational and regression analyses was implemented to investigate the strength and direction of relationships between variables diabetes health literacy, diabetes numeracy, cognitive function, and T2DM self-management outcomes. This paired approach of analyses demonstrates how these relationships predict T2DM self-management outcomes, and how the

relationship between diabetes health literacy and T2DM self-management outcomes changes when diabetes numeracy and cognitive function are introduced. This method reveals the amount of variance related to certain variables while holding others constant.

Analysis also included descriptive statistics comprising measures of central tendencies: mean, median, mode, range, frequency, variance, and standard deviation.

Delimitations, Assumptions, and Limitations

There are delimitations, assumptions, and limitations apparent in the present study. The study population is a delimitation as participants had to specifically have Type 2 Diabetes Mellitus, rather than Type 1 or gestational diabetes. Participants had to also be 45 years old or above. These constraints were placed as T2DM is a condition that develops mostly in older adults due to lifestyle factors like nutrition and exercise. Hence the research focused on whether their cognitive function, diabetes health literacy and numeracy are associated with their self-management outcomes. Due to these delimitations, caution should be exercised generalizing findings outside of this population.

Assumptions were also made within the study. It was assumed participants are answering questions truthfully and accurately. The survey was self-report presenting the possibility of response bias. Self-report data is subject to challenges in critical self-assessment, differences in perception of taking care of one's health, and diabetic knowledge. Respondents may have had concerns about data confidentiality, or may not want their diabetes literacy and numeracy, cognitive function, and self-management outcomes to be known.

The study has limitations including the possibility of a confounding factor such as self-efficacy or depressive and anxiety symptoms influencing Type 2 Diabetes Mellitus self-management outcomes rather than the three factors studied (diabetes health literacy, diabetes

numeracy, and cognitive function). There is a history threat present given the study is being conducted post-COVID and the Anxiety & Depression Association of America has identified higher post-COVID anxiety and depression in individuals as a result of COVID-19. Numerous people experienced separation from loved ones throughout the pandemic due to social distancing; studies have discovered a lonely person's immune system reacts differently, making them more likely to contract an inflection or disease (Solomon, 2020). A further limitation is survey drop off rates; some participants may be more unlikely to have completed the entire questionnaire and they may be less inclined to have participated without an incentive or compensation. Finally, the scarcity of previous studies to validate the findings of this research inquiry may have had an impact on the evaluation and interpretation of the data.

Summary

Chapter 3 laid out the framework of the present study's inquiry to answer the research questions posed in Chapter 1. The research study design, participants and recruitment methods, scales of measurement, variables, data analysis techniques, and the delimitations, assumptions, and limitations of the study have been presented. Briefly put, the research design was quantitative in nature employing convenience sampling. The sample was comprised of people who were readily available the during the 2-month duration the researcher was recruiting participants, meaning the study did not include a range of people who did not come across the survey during that time period. The study was conducted online with participants filling out a questionnaire comprised of gathering demographic and diabetes history along with 4 scales assessing diabetes health literacy and numeracy, cognitive function, and T2DM self-management outcomes. As the study is aimed at older adults, the study was developed in mind to keep the survey short, concise, and easy to read and navigate. Since correlational designs look at the

direction and strength of a relationship amongst variables it was suitable to answer research questions 1, 2, and 3. Hierarchical regression analysis of research questions 4 and 5 elucidated the interrelationships between the variables at hand (Guenther & Falk, 2019). In sum, the present study was designed to explore and uncover the relationships that could lead to better Type 2 Diabetes Mellitus outcomes in older adults and highlight the importance of diabetes health literacy and numeracy as well as cognitive function.

CHAPTER 4: RESULTS

Overview

The purpose of this study was to assess the relationships between diabetes health literacy, diabetes numeracy, and cognitive function with Type 2 Diabetes Mellitus self-management outcomes in adults over 45 years old. The primary objective of this research was to ascertain whether this population exhibited a relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes and if diabetes numeracy as well as cognitive function moderated this relationship such that greater scores in these meant better self-management outcomes regardless of diabetes health literacy levels.

A quantitative correlational design was implemented to collect and assess the data. This chapter reviews the research questions, hypotheses, and presents the results of the study at hand. Descriptive statistics defining and characterizing the population will be addressed first, preceded by the results of the analyses.

Research Questions

RQ 1: What is the association of diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes in older adults?

RQ 2: What is the association of diabetes numeracy and Type 2 Diabetes Mellitus self-management outcomes?

RQ 3: What is the association of cognitive function and Type 2 Diabetes Mellitus self-management outcomes in older adults?

RQ 4: How does diabetes numeracy moderate the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes?

RQ 5: How does cognitive function moderate the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes?

Data Preparation

The data from 173 surveys were exported from the Qualtrics platform into IBM SPSS Version 29. Participants who did not give survey consent or left 4 or more questions blank were removed from the survey. Thus, the total sample of the study became 88 participants after cleaning which exceeded the number of participants needed according to the G*Power Analysis version 3.1.9.7 calculation; 74 participants was determined a proper sample size to obtain 80% statistical power at an alpha level of .05 and medium effect size of 0.15. For questions with missing answers, it was decided to conduct mean imputation since the scales have several items.

Descriptive Results

The study sample was comprised of 88 eligible respondents who are above 45 years old and diagnosed with Type 2 Diabetes Mellitus. Of these participants, the largest percentages were between the ages of 45-55 (45.5%), female (54.5%), White or Caucasian (63.6%), reside in North America (84.1%), graduate degree as highest level of education completed (45.5%), diagnosed with Type 2 Diabetes under 20 years (36.4%), family members are also diagnosed with Type 2 Diabetes (69.3%), most recent HbA1c level as 6.5% to 7.5% (35.2%), with comorbidities (51.1%). See Table 1 and 2 below for a detailed breakdown of the study participants demographics and T2DM specific characteristics of participants respectively.

Table 1

Sociodemographic Characteristics of Survey Participants

Demographics		
	n	%
Age		
45-55	40	45.5
56-64	33	37.5
65-75	13	14.8
76-85	2	2.3
Gender		
Male	40	45.5
Female	48	54.5
Race		
White or Caucasion	56	60.9
Black or African American	5	5.4
American Indian or Alaska Native	1	1.1
Asian	25	27.2
Other	3	3.3
Prefer Not to Say	2	2.2
Current Residence		
North America	74	84.1
Africa	1	1.1
South America	1	1.1
Asia	5	5.7
Other	7	8.0
Marital Status		
Married	62	70.5
Living with a partner	3	3.4
Widowed	5	5.7
Divorced/Separated	11	12.5
Never been married	7	8.0
Education		
Some high school or less	2	2.3
High school diploma or GED	5	5.7
Some college, but no degree	16	18.2
Associates or technical degree	6	6.8
Bachelor's degree	18	20.5
Grad or professional degree (MA, MS, MBA, PhD, JD, MD, DDS)	40	45.5
Prefer not to say	1	1.1

Table 2

T2DM Characteristics of Survey Participants

T2DM Demographics		
	n	%
Years of T2DM Diagnosis		
Under 5 years	27	30.7
Under 10 years	18	20.5
Under 20 years	32	36.4
Under 30 years	11	12.5
Family Member T2DM Diagnosis		
Yes	61	69.3
No	27	30.7
Recent HbA1c level		
Below 5.7%	17	19.3
5.7% to 6.4%	18	20.5
6.5% to 7.5%	31	35.2
7.6% to 8.5%	13	14.8
8.6% to 9.5%	4	4.5
9.6% to 9.9%	1	1.1
10% plus	3	3.4
I don't know	1	1.1
Comorbidities		
Chronic Kidney Disease	2	2.8
Nerve Damage	14	19.4
Vision Loss	10	13.9
Hearing Loss	11	15.3
Gum Disease	10	13.9
Mental Health Condition	15	20.8
Other	10	13.9

Study Findings

Assumption and Hypothesis Testing

For Hypotheses 1 through 3, which were addressed with Pearson's correlation, scatterplots with LOESS lines were used to assess roughly linear relationships, along with checking for bivariate outliers. There were a few bivariate outliers, but excluding

and re-running the correlations did not conceptually change the directions, general sizes, and significance levels.

For Hypotheses 4 and 5, which are regression-based, additional assumptions checked were normal residuals based on histograms, the homoscedasticity and linear relationship of all variables when adjusting for each other based on a scatterplot of residuals on predicted values, no multicollinearity based on the variance inflation factor (VIF < 4) and no overly influential points through Cook's distance that is greater than 4/n and sticks out. Cook's distance was a slight issue due to one outlier, however when excluding this point and re-running the regression, the overall patterns were the same. The R^2 was a bit smaller, but the direction and significance levels of coefficients were largely consistent. All other assumptions were met.

Hypotheses 4 and 5 were addressed with hierarchical linear regression with main effects in model 1 to provide more interpretable coefficients that are not lower order terms when there is no significant interaction in model 2. All predictors were mean centered.

Table 3

Descriptive Statistics for Study Variables

	Reliability	Mean	Median	SD	Skew	Min	Max
T2DM Self-Management	0.872	6.8	6.8	1.7	-0.5	2.3	10.0
Cognitive Function	0.925	64.5	65.5	14.2	-0.5	24.0	95.0
Diabetes Health Literacy	0.901	3.3	3.5	0.7	-1.7	0.3	4.0
Diabetes Numeracy	N/A	4.0	4.0	0.9	-0.9	1.0	5.0

Findings by Research Question

Research Question #1

RQ 1: What is the association of diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes in older adults?

Hypothesis 1: Diabetes health literacy is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults

A Pearson's correlation was conducted to assess the relationship between diabetes health literacy as measured by the DHLS (Lee et al., 2018) and Type 2 Diabetes self-management outcomes as measured by Schmitt and colleagues (2022) DSMQ-R Scale. The hypothesis was found to have a significant positive relationship and medium effect size, as higher levels of health literacy were associated with T2DM self-management outcomes ($r = .404$, $p < .001$).

Research Question #2

RQ 2: What is the association of diabetes numeracy and Type 2 Diabetes Mellitus self-management outcomes?

Hypothesis 2: Diabetes numeracy is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults

A Pearson's Correlation was conducted to examine the relationship between diabetes numeracy as measured by Huizinga and colleagues (2011) DNT-5 scale and T2DM self-management outcomes using the DSMQ-R (Schmitt et al., 2022). There was not significant support for the hypothesis, ($r = .205$, $p = .055$) however, the relationship was marginally significant and in the direction of a small positive relationship.

Research Question #3

RQ 3: What is the association of cognitive function and Type 2 Diabetes Mellitus self-management outcomes in older adults?

Hypothesis 3: Cognitive function is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults

A Pearson's correlation was conducted to assess the relationship between cognitive function as measured by the CAQ created by Broadbent and colleagues (2008) and Type 2 Diabetes self-management outcomes as measured by Schmitt and colleagues (2022) DSMQ-R Scale. In support of the hypothesis there was a positive, medium-sized significant relationship with higher levels of cognitive function associated with greater T2DM self-management outcomes ($r = .382$, $p < .001$).

Research Question #4

RQ 4: How does diabetes numeracy moderate the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes?

Hypothesis 4: Increased diabetes numeracy moderates the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes

Hierarchical regression was used to assess if diabetes numeracy and diabetes health literacy predicted T2DM self-management outcomes. The overall interaction model is significant $F(_{3,84})= 5.83$, $p = .001$ and explains 17.3% ($R^2 = .173$) of the variability in T2DM self-management outcomes. However, as seen in the coefficients in Table 4 in the second model, the interaction term between diabetes numeracy and T2DM self-management outcomes was not a significant predictor of the effect of diabetes health literacy on T2DM self-management outcomes by diabetes numeracy ($B = .157$, $p = .616$). As there was no significant interaction, we turn our attention to the main effects and it is

noted that adjusting for each other diabetes health literacy does still predict greater self-management, but diabetes numeracy does not predict any difference in T2DM self-management outcomes.

Table 4

Hierarchical Regression Coefficients for Diabetes Numeracy Moderation of the Diabetes Health Literacy - T2DM Self-Management Relationship

						95% CI	
		B	*SE*	*Beta*	*p*	Lower	Upper
Main Effect Model	Intercept	6.84	0.16		<.001	6.51	7.17
	Diabetes Health Literacy	0.96	0.27	0.38	<.001	0.43	1.49
	Diabetes Numeracy	0.15	0.19	0.09	.414	-0.22	0.52
Interaction Model	Intercept	6.81	0.18		<.001	6.46	7.16
	Diabetes Health Literacy	1.01	0.28	0.39	<.001	0.45	1.56
	Diabetes Numeracy	0.17	0.19	0.09	.380	-0.21	0.54
	Diabetes Health Literacy x Diabetes Numeracy	0.16	0.31	0.05	.616	-0.46	0.78

Research Question #5

RQ 5: How does cognitive function moderate the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes?

Hypothesis 5: Increased cognitive function moderates the relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes

Hierarchical regression was utilized to test this hypothesis. The overall model is significant, $F(_{3,84}) = 9.08$, $p < .001$ and explains 24.5% ($R^2 = .245$) of the variability in T2DM self-management outcomes. However, as seen in the coefficients in Table 5 of the

second model, the interaction of cognitive function and diabetes health literacy is not significant (B = -.001, p = .933). As there was no significant interaction, we turn our attention to the main effects and it is noted that adjusting for each other diabetes health literacy does still predict greater self-management, and cognitive function also predicts significantly greater T2DM self-management outcomes.

Table 5

Hierarchical Regression Coefficients Cognitive Function Moderation of the Diabetes Health Literacy - T2DM Self-Management Relationship

						95% CI	
		B	*SE*	*Beta*	*p*	Lower	Upper
Main Effect Model	Intercept	6.84	0.16		<.001	6.53	7.15
	Diabetes Health Literacy	0.83	0.25	0.33	.001	0.34	1.33
	Cognitive Function	0.04	0.01	0.30	.003	0.01	0.06
Interaction Model	Intercept	6.84	0.16		<.001	6.52	7.16
	Diabetes Health Literacy	0.82	0.27	0.32	.003	0.30	1.35
	Cognitive Function	0.04	0.01	0.30	.004	0.01	0.06
	Diabetes Health Literacy x Cognitive Function	0.00	0.01	-0.01	.933	-0.03	0.03

Summary

The purpose of this study was to assess the relationships between factors diabetes health literacy, diabetes numeracy, and cognitive function on Type 2 Diabetes Mellitus self-management outcomes in adults over 45 years old diagnosed with T2DM. The hypotheses included: (1) the expectation that diabetes health literacy would be positively correlated with T2DM self-management outcomes, (2) diabetes numeracy would be

positively associated with T2DM self-management outcomes, (3) cognitive function would be positively associated with T2DM self-management outcomes, (4) increased diabetes numeracy would moderate the relationship between diabetes health literacy and T2DM self-management outcomes, such that those who demonstrate greater diabetes numeracy levels will have higher T2DM self-management outcomes, regardless of diabetes health literacy levels, and (5) increased cognitive function would moderate the relationship between diabetes health literacy and T2DM self-management outcomes, such that those who demonstrate greater cognitive function will have higher T2DM self-management outcomes, regardless of diabetes health literacy levels.

Using 88 completed surveys, the first and third hypotheses were supported by a statistically significant positive correlation between diabetes health literacy, cognitive function, and T2DM self-management outcomes respectively. The second hypothesis of diabetes numeracy being positively associated with T2DM self-management outcomes was not supported; however, the relationship was marginally significant and in the direction of a small positive relationship. For hypothesis 4 hierarchical regression analyses was conducted and the overall model was found to be significant but the interaction term between diabetes numeracy and T2DM self-management outcomes was not a significant predictor of the effect of diabetes health literacy on T2DM self-management outcomes by diabetes numeracy. Similarly for hypothesis 5, hierarchical regression analyses exhibited the overall model is significant, and both cognitive function and diabetes health literacy are significant predictors independently, however when the interaction is added the model does not significantly improve. The following chapter will delve comprehensively into the findings, discuss what these findings mean and how they

compare to the research literature, as well as discuss the implications for theory and future practice.

CHAPTER 5: DISCUSSION

Overview

The purpose of this quantitative correlational study was to examine the associations between diabetes health literacy, diabetes numeracy, and cognitive function on Type 2 Diabetes Mellitus self-management outcomes in older adults (≥ 45 years old). The primary objective of this research was to ascertain whether this population exhibited a relationship between diabetes health literacy and Type 2 Diabetes Mellitus self-management outcomes and if diabetes numeracy as well as cognitive function moderated this relationship such that greater scores in these meant better T2DM self-management outcomes regardless of diabetes health literacy levels.

Conducting research in this arena has been vital as diabetes has become a major public health concern globally; currently it is understood as growing at an epidemic rate according to researchers (Saffari et al., 2019). Healthcare providers and researchers both purport 95% of diabetes care is through self-management of the disease, making diabetes health literacy and numeracy essential to individuals' skillset in making health-related decisions and taking care of their health (Tefera et al., 2020; Abdullah et al., 2019). This study was designed to uncover potential relationships helpful in calling attention to and growing the literature on diabetes self-management outcomes as studies have not looked at these factors (diabetes health literacy, diabetes numeracy, and cognitive function levels) together in older adults. The present study can also aid in informing aspects of clinical practice, implementing routine health literacy and numeracy assessments, and in the creation of health education initiatives.

The present chapter will summarize the findings of the study, discuss what these findings mean and how they compare to the research literature, delve into the implications for theory as well as practice, including a biblical interpretation of the outcomes. The implications and limitations of this study will also be discussed, and recommendations for future research in this field will be made based on this information.

Summary of Findings

The hypotheses driving the study included: (1) the expectation that diabetes health literacy would be positively correlated with T2DM self-management outcomes, (2) diabetes numeracy would be positively associated with T2DM self-management outcomes, (3) cognitive function would be positively associated with T2DM self-management outcomes, (4) increased diabetes numeracy would moderate the relationship between diabetes health literacy and T2DM self-management outcomes, such that those who demonstrate greater diabetes numeracy levels will have higher T2DM self-management outcomes, regardless of diabetes health literacy levels, and (5) increased cognitive function would moderate the relationship between diabetes health literacy and T2DM self-management outcomes, such that those who demonstrate greater cognitive function will have higher T2DM self-management outcomes, regardless of diabetes health literacy levels.

Using 88 completed surveys from adults above 45 years old, diagnosed with T2DM, the first and third hypotheses were supported by a statistically significant positive correlation between diabetes health literacy, cognitive function, and T2DM self-management outcomes respectively; demonstrating that when either diabetes health literacy or cognitive function increases, T2DM self-management outcomes also

increases. The second hypothesis of diabetes numeracy being positively associated with T2DM self-management outcomes was not supported; however, the relationship was marginally significant and in the direction of a small positive relationship. For hypothesis 4 hierarchical regression analyses was conducted and it was only partially supported. Adjusting for numeracy, health literacy predicts significantly greater T2DM self-management, though adjusting for health literacy, numeracy does not predict a significant difference in T2DM self-management outcomes. When excluding an outlier, the overall conclusions were still generally the same. Hence, the model is significant, diabetes health literacy is predicting better self-management than numeracy, however with the added interaction, it does not significantly improve the model.

In regard to hypothesis 5, hierarchical regression analyses exhibited the overall model is significant, and both cognitive function and diabetes health literacy are significant predictors independently, however there is no significant interaction of diabetes health literacy on T2DM self-management by cognitive function. As cognitive function levels increase, T2DM self-management increases. Also, as diabetes health literacy increases, T2DM self-management increases but there is no significant interaction, providing partial support for the moderation hypotheses.

Discussion of Findings

The findings of the present study and how they compare to research literature reviewed in Chapter 2 will be discussed in this section. Additionally, how this study contributes to the understanding of the theories of the constructs and how it fits into the biblical foundations are presented.

The theoretical framework driving this study is the Health Belief Model. This model allowed for the study of T2DM self-management through the lens of six key constructs and highlights that a person's health-related behavior is dependent on: perceived barriers (barriers to taking action), perceived benefits (beneficial effects of taking preventative action), self-efficacy (individual's confidence to perform an action), perceived susceptibility (vulnerability to that illness), perceived severity (severity of a potential sickness), and cues to action (information, events, people, or various other factors that can trigger people to modify their behavior). The six areas all critically impact the probability of engaging in health-promoting behaviors. These constructs are key to better learn about how people view their perceived diabetes-related risks and what encourages or discourages them from practicing healthier habits or complying to treatment. When using the Health Belief Model in this context, it is possible that individuals who scored higher on the DHLS, DNT-5, CAQ, and DSMQ-R would also be high in constructs such as perceived benefits, self-efficacy, and cues to action. Conversely, those who scored lower in the present study may experience greater perceived barriers and lower cues to action, perceived benefits, and self-efficacy.

Relationship with Diabetes Health Literacy

In regard to Hypothesis 1 (Diabetes health literacy is positively associated with Type 2 Diabetes Mellitus self-management outcomes in older adults) there is scant literature on diabetes specific health literacy in people diagnosed with diabetes, however there is much knowledge on general health literacy in individuals with diabetes.

The findings are in line with the existing literature on health literacy in people diagnosed with diabetes. For instance, studies have shown health literacy to be an

indicator of how well people recognize diabetic symptoms and self-manage their diabetes, and it has shown to improve knowledge of diabetes, quality of life, and self-efficiency (Asharani et al., 2021; Rachmawati et al., 2019). Adding on to this, respondents experiencing difficulties understanding health information and connecting with healthcare providers, had higher odds of engaging in unhealthy behaviors (Friis et al., 2016).

Relationship with Diabetes Numeracy

Numbers aid in giving meaning to information to assist people in making well-informed decisions, though research has shown not everyone is able to effectively use numbers. Particularly, individuals vary in numeracy skills. There is limited research in diabetes numeracy specifically, yet it is important to assess because older adults have an increased risk of declining cognitive function which can play a role in worsening self-management of diabetes yielding in less attentiveness to daily activities such as administering the accurate insulin dose and correct nutritional serving sizes.

The present study did not have a significant positive relationship of diabetes numeracy and T2DM self-management outcomes however, it was marginally significant and in the direction of a small positive relationship. Peters and colleagues (2014) found health numeracy to be more strongly correlated with health outcomes than health literacy, contrastingly the present study found health literacy to be stronger. Additionally, the moderation model of the present study had found that diabetes numeracy does not moderate the relationship between diabetes health literacy and T2DM self-management outcomes. This may be the case due to research participation, as $p = .055$, the sample size or outliers may have affected the results.

Relationship with Cognitive Function

There is some research on self-management of diabetes that has focused on older adults and factors specific to their management of the disease. The prevalence of several chronic diseases rises with age and diabetes itself has shown to be a risk factor for impairments and decline in cognitive function (Nematzad et al., 2023; Bruce et al., 2003). Crespo and colleagues (2020) have purported cognitive function to be a pertinent component associated with health literacy in older adults with diabetes, for all components associated with self-management such as medication adherence, diet, and physical activity. The current study is partially reflective of these findings and demonstrates that cognitive function is associated with T2DM self-management outcomes. However, the moderation model of the present study had found that cognitive function does not moderate the relationship between diabetes health literacy and T2DM self-management outcomes. This may be the case due to sample size, typically for moderation hypotheses and conducting hierarchical regression analyses, a greater sample size is preferred.

Biblical Perspective on Findings

From a biblical perspective, engaging in religion can offer solace when experiencing adversities and aid in coping with uncertainty; religiosity has been shown to influence health related quality of life in patients (Dewi et al., 2022; Saffari et al., 2019). Research has also shown older adults are likelier to engage in spiritual and religious coping than those who are younger as they experience a growing number of familial or social losses, as well as decline in health.

The practice of faith and religion indeed bears a relationship to health (Bentley-Edwards et al., 2020). In times of sickness, people often turn to prayer, and call upon God to heal and restore one's health. From a biblical perspective, the belief is the ultimate source of health and healing comes from God. For instance, Jeremiah 30:17 purports "For I will restore Health to you and heal you of your wounds" (King James Version, 1997). This outlook highlights the significance of taking care of one's health as a means of honoring God and encourages people to adopt healthy behaviors and lifestyles that promote overall well-being.

In relation to the study findings, it has been found that religious coping and religious problem-solving are both avenues that can support chronic diabetes self-management (Saffari et al., 2019). According to Dewi and authors (2022) religiosity is vital as it provides a foundation for sustaining quality of life in patients. People may seek comfort in a higher divine power during tough life events and cope through prayer which can promote self-management of diabetes. Biblically, religious participation has been shown to influence physical health, specifically diabetes and obesity are major health outcomes in which religion plays a role according to research (Bentley-Edwards et al., 2020). This is so because religion functions as a protective factor to detrimental behaviors by inspiring people to practice self-control, positive thinking, and confidence (Dewi et al., 2022).

Implications

The findings of this research illustrate several areas where organizations could impact diabetes education and self-management behaviors through their actions or inactions. This idea aligns with research purporting that 95% of diabetes care is through

self-management of the disease, and the results of this study exhibit that diabetes health literacy, numeracy, and cognitive function are positively associated with T2DM self-management outcomes. These results can be discussed with those in healthcare management, doctors, and to those diagnosed with Type 2 Diabetes Mellitus to not only emphasize the importance of health education but also create initiatives to increase general and disease specific health literacy and numeracy. On a societal level, this study highlights the need for health positive behaviors and emphasizes the importance of health literacy and numeracy as findings emphasize the positive associations of diabetes health literacy and numeracy with T2DM self-management. This can inspire communities to take action towards attaining equitable health education. If there are institutional and structural changes ameliorating health education disparities, such as community health education sessions and health-literacy focused classes in school curriculum, then there will be a decrease in chronic illnesses such as Type 2 Diabetes Mellitus. These changes will empower individuals to set the course for lifelong habits, and aid in their health decision making, ultimately influencing greater community health (Auld et al., 2020).

The findings also have key clinical implications as health literacy assessments are not performed in healthcare settings, thus patients' levels of health literacy and numeracy are unknown. Routine and brief health literacy and numeracy assessments should be incorporated into medical visits (Asharani et al., 2021). Educational materials and communication strategies can then be modified accordingly as patients may experience difficulty in understanding the medical information communicated to them. Some physicians may also view T2DM as a lifestyle choice and treat their patients with disdain. Hence, greater reflection on personal biases within a provider care context should be

discussed. Empathic one-on-one interactions with healthcare providers during appointments can be influential in patients' healthcare education.

Search engines and social media can also be a powerful tool in health promotion, both positively and negatively. There is misinformation and conspiracy theories present on the web that may create distrust in the healthcare system. However, the web can also provide access to many educational materials and information benefitting one's health. Healthcare associations and organizations should be at the frontlines of disseminating healthcare information on social networking platforms, mobile applications, websites, printed media, as well as television and radio (Aremu et al., 2022). When individuals pick up their prescriptions from pharmacies or visit healthcare product stores, printed media such as flyers, pamphlets, and posters should be viewable and accessible to consumers as this is another avenue to increase health education.

Research has shown families listen to messages from organizations within their community as well as religious and spiritual leaders (Aremu et al., 2022). Faith-based leaders are known to be members of the community who are trusted and offer support and guidance. Health organizations can seek to cultivate a partnership with local faith-based organizations as it can aid in improving health literacy amongst its members. Different from many health conditions, diabetes is primarily managed by oneself with support from one's family, social supports, community, and health care team (primary care doctor, pharmacist, nutritionist, diabetes educator, foot doctor, eye doctor, and more) (Centers for Disease Control and Prevention, 2023).

Limitations

As addressed in prior chapters, there are certain limitations in the present study and further limitations were discovered in the completion of the study as well. As there are multiple types of diabetes, people may not be cognizant of the difference between Type 1, Type 2, or even gestational diabetes. Potential participants may have clicked they do not have Type 2 Diabetes Mellitus when in fact they do but are not aware of the medical term. Another limitation to the study is whether the outcomes in Type 2 Diabetes Mellitus self-management are specifically caused by the three factors (diabetes health literacy, diabetes numeracy, and cognitive function) or a confounding factor such as self-efficacy or depressive and anxiety symptoms. A further limitation is participants may be less inclined to actively participate without an incentive or compensation.

There is also a history threat present given the study was conducted post-COVID and the Anxiety & Depression Association of America has identified higher post-COVID anxiety and depression in individuals as a result of COVID-19. Numerous people experienced separation from loved ones throughout the pandemic due to social distancing; studies have discovered a lonely person's immune system reacts differently, making them more likely to contract an inflection or disease (Solomon, 2020).

Assumptions were made within the study as well. It was assumed participants are accurately recalling diabetic history and health details. As this study is directed toward older adults there is a greater likelihood of decline in cognitive function and they may misremember information such as the age they were diagnosed, average HbA1C levels over the past year, or experience reluctance in disclosing their medical condition history. Respondents may have had concerns about data confidentiality or may not have wanted

their diabetes literacy and numeracy, cognitive function, and self-management outcomes to be known. Utilization of self-report assessments introduces the possibility of response bias. Self-report data in this context is subject to challenges in critical self-assessment, differences in perception of proper nutrition, and diabetic knowledge. This impacts the internal validity of the study and can influence the results from the study; however, it was assumed participants are answering questions truthfully and accurately.

A threat to external validity is the findings generalizability to people with T2DM internationally. Outside of the United States, health resources and information could be more or less accessible, paired with varying cultural norms around physical exercise and nutrition. The sample was recruited through social media outreach and is not representative of those who may not utilize social media as well. Finally, the shortage of existing studies to validate the findings of this research investigation may have had an impact on the analysis and interpretation of the results. Due to these limitations, caution should be exercised generalizing findings outside of this population.

Recommendations for Future Research

The first set of recommendations for future research would be for studies to correct some of the limitations mentioned in the preceding section such as diversified recruiting methods, doctor assessments, greater sample size, and research compensation. Second, implementing the Health Belief Model at the forefront of an intervention would be effective in increasing T2DM self-management behaviors. Regarding the study at hand, the Health Belief Model provided a helpful lens on how people view their Type 2 Diabetes Mellitus, what motivates and hinders them in being treatment compliant, making healthier lifestyle changes, and self-managing this chronic condition. However,

integrating HBM-based educational interventions would be effective at improving and providing greater insight into the promotion of T2DM self-management behaviors in older adults (Tehrani et al., 2019).

Finally, while there is a biblical lens discussed, employing a community-based approach and partnering with churches to improve health remains to need more involvement to fill in these evidence gaps (Bentley-Edwards et al., 2020). In a review conducted by Dahal & Hosseinzadeh (2019) health literacy interventions led in a community setting were more effective than patient-focused health literacy interventions. Researchers recognizing the centrality of religion in health should opt to design interventions and initiatives through the church for health education and promotion amongst church members (Bentley-Edwards et al., 2020). Conducting future studies in a religious or spiritual setting can provide added context into the contributions of protective factors in older adults with T2DM and their self-management outcomes.

Summary

This study was designed to uncover potential relationships that could be helpful in the self-management of T2DM in older adults. The importance of diabetes health literacy, diabetes numeracy, and adequate cognitive function was demonstrated in this study, whereby significant positive associations were found between diabetes health literacy and T2DM self-management outcomes and cognitive function and T2DM self-management outcomes. Diabetes numeracy and T2DM self-management outcomes also showed a marginally significant positive relationship. In addition, the moderation effect between diabetes numeracy and diabetes health literacy and T2DM self-management outcomes was partially supported. The model is significant, diabetes health literacy is predicting

better self-management than numeracy, however with the added interaction, it does not significantly improve the model. In the second moderation model, the moderation effect between cognitive function and diabetes health literacy and T2DM self-management outcomes, was partially supported and found to be overall significant but had no significant interaction. Adjusting for each other, diabetes health literacy still predicts greater self-management, and cognitive function also predicts significantly greater T2DM self-management outcomes.

The significance of this research is the contribution to call attention to and grow the literature on T2DM self-management outcomes within the context of diabetes health literacy, diabetes numeracy, and current cognitive function, studies have not looked at these factors together in older adults. The present study can also inform other aspects of clinical practice such as the identification of specific needs of older adults to enhance their self-management abilities, this can lead to improved health and quality of life for individuals facing challenges with managing chronic conditions. Future researchers should further explore avenues of mitigating the limited diabetic health literacy and numeracy in individuals and implement interventions likely to produce improved results such as those embedded in the Health Belief Model which are community-based (Dahal & Hosseinzadeh, 2019). The present results can be presented to those in healthcare management, doctors, and to those diagnosed with Type 2 Diabetes Mellitus to not only emphasize the importance of health education but also create initiatives to increase general and disease specific health literacy and numeracy. This research is a call to action for collaboration amongst leaders of the healthcare system, schools, communities, and more. By presenting tools, interventions, and initiatives to ameliorate health disparities

and increase health education, individuals can be positively impacted personally, community-wide, institutionally, nationally, and internationally for time.

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APPENDIX A: IRB-APPROVED RECRUITING MATERIALS

1. Recruitment Letter

Dear Potential Participant,

As a graduate student in the Psychology Department at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy degree. The purpose of my research is to better understand management of Type 2 Diabetes in adults, and I am writing to invite you to join my study.

Participants must be 45 years of age or older and diagnosed with Type 2 Diabetes. Participants will be asked to take an anonymous, online survey. It should take approximately 20 minutes to complete the procedure listed. Participation will be completely anonymous, and no personal, identifying information will be collected.

To participate, please click here to complete the study survey: https://qualtricsxmy8xq56c3g.az1.qualtrics.com/jfe/preview/previewId/8e13a4c8-ef94-4a99-b3c1-6d1a8120e0ab/SV_bjwMr1LVea8NFJk?Q_CHL=preview&Q_SurveyVersionID=current

A consent document is provided as the first page of the survey. The consent document contains additional information about my research.

Because participation is anonymous, you do not need to sign and return the consent document unless you would prefer to do so. After you have read the consent form, please click the button to proceed to the survey. Doing so will indicate that you have read the consent information and would like to take part in the study.

2. Recruitment Letter Follow-Up

Dear Potential Participant,

As a graduate student in the Psychology Department at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy degree. Last week an email was sent to you inviting you to participate in a research study. This follow-up email is being sent to remind you to complete the survey if you would like to participate and have not already done so. The deadline for participation is April 12th, 2024.

Participants must be 45 years of age or older and diagnosed with Type 2 Diabetes. Participants will be asked to take an anonymous, online survey. It should take approximately 20 minutes to complete the procedure listed. Participation will be completely anonymous, and no personal, identifying information will be collected.

To participate, please click here to complete the study survey: https://qualtricsxmy8xq56c3g.az1.qualtrics.com/jfe/preview/previewId/8e13a4c8-ef94-4a99-b3c1-6d1a8120e0ab/SV_bjwMr1LVea8NFJk?Q_CHL=preview&Q_SurveyVersionID=current

A consent document is provided as the first page of the survey. The consent document contains additional information about my research.

Because participation is anonymous, you do not need to sign and return the consent document unless you would prefer to do so. After you have read the consent form, please click the button to proceed to the survey. Doing so will indicate that you have read the consent information and would like to take part in the study.

3. Recruitment Social Media

ATTENTION FACEBOOK FRIENDS: I am conducting research as part of the requirements for a Doctor of Philosophy degree at Liberty University. The purpose of my research is to examine how adults' diabetic knowledge, basic mathematical skills, and cognitive function influences their management of diabetes. To participate, you must be 45 years of age or older and be diagnosed with Type 2 Diabetes. Participants will be asked to complete an online questionnaire, which should take about 20 minutes to complete. If you would like to participate and meet the study criteria, please click here: https://qualtricsxmy8xq56c3g.qualtrics.com/jfe/form/SV_bjwMr1LVea8NFJk

A consent document is provided as the first page of the survey. Please review this page, and if you agree to participate, click the "proceed to survey" button at the end.

To take the survey, click here: https://qualtricsxmy8xq56c3g.qualtrics.com/jfe/form/SV_bjwMr1LVea8NFJk

Twitter/X:

Are you diagnosed with Type 2 Diabetes and are 45 years of age or older? Click here for information about a research study on diabetes self-management: https://qualtricsxmy8xq56c3g.qualtrics.com/jfe/form/SV_bjwMr1LVea8NFJk

4. Recruitment Verbal

Hello,

As a graduate student in the Psychology Department at Liberty University, I am conducting research as part of the requirements for a Doctor of Philosophy degree. The purpose of my research is to better understand management of Type 2 Diabetes in adults, and if you meet my participant criteria and are interested, I would like to invite you to join my study.

Participants must be 45 years of age or older and diagnosed with Type 2 Diabetes. Participants, if willing, will be asked to answer an online survey. It should take approximately 20 minutes to complete the procedure listed. Participation will be completely anonymous, and no personal, identifying information will be collected.

Would you like to participate?
[Yes] Great, could I get your email address so I can send you the link to the survey?
[No] I understand. Thank you for your time.

A consent document is provided as the first page of the survey. The consent document contains additional information about my research. Because participation is anonymous, you do not need to sign and return the consent document unless you would prefer to do so. After you have read the consent form, please complete and return the survey. Doing so will indicate that you have read the consent information and would like to take part in the study.

Thank you for your time. Do you have any questions?

5. Permission Request

[Date]

[Address]

Dear [Name],

As a graduate student in the Psychology Department at Liberty University, conducting research as part of the requirements for a Doctor of Philosophy degree. The title of my research project is Type 2 Diabetes Management in Adults and the purpose of my research is to examine how adults' diabetic knowledge, basic mathematical skills, and cognitive function influences management of their diabetes. Within the context of this study, diabetes management encompasses factors such as medication and treatment compliance, physical activity, diet, and HbA1c levels.

I am writing to request your permission to utilize your membership list to recruit participants for my research.

Participants will be asked to complete the attached survey. Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission, please provide a signed statement on official letterhead indicating your approval. A permission letter document is attached for your convenience.

6. Recruitment Flyer

Research Participants Needed

Type 2 Diabetes Management in Adults

- Are you 45 years of age or older?
- Are you diagnosed with Type 2 Diabetes?

If you answered **yes** to both of the questions listed above, you may be eligible to participate in a research study.

The purpose of this research study is to examine how adults' diabetic knowledge, basic mathematical skills, and cognitive function influences management of their diabetes.

Participants, if willing, will be asked to answer an online survey. It should take approximately 20 minutes. Participation will be completely anonymous, and no personal, identifying information will be collected.

If you would like to participate, please click here and complete the survey.
https://qualtricsxmy8xq56c3g.qualtrics.com/jfe/form/SV_bjwMr1LVea8NFJk

A consent document is provided as the first page of the survey at the time the survey link is accessed.

Twinkle Gupta, a doctoral candidate in the Psychology Department at Liberty University, is conducting this study.

Please contact Twinkle Gupta at [redacted] for more information.

APPENDIX B: INFORMED CONSENT

Welcome to the research study!
Title of the Project: Diabetes Health Literacy, Diabetes Numeracy, and Cognitive Function as Predictors of Type 2 Diabetes Mellitus Self-Management
Principal Investigator: Twinkle Gupta, Doctoral Candidate, Psychology Department, Liberty University

Invitation to be Part of a Research Study
You are invited to participate in a research study. To participate, you must be 45 years of age or older and diagnosed with Type 2 Diabetes. Taking part in this research project is voluntary. Please take time to read this entire form and ask questions before deciding whether to take part in this research.

What is the study about and why is it being done?
The purpose of this study is to examine how adults' diabetic knowledge, basic mathematical skills, and cognitive function influences their management of diabetes. Diabetes management encompasses factors such as medication and treatment compliance, physical activity, diet, and HbA1c levels.

What will happen if you take part in this study?
If you agree to be in this study, I will ask you to do the following:
Complete an online questionnaire about your Type 2 Diabetes that will take no more than 20 minutes to complete.

How could you or others benefit from this study?
Participants should not expect to receive a direct benefit from taking part in this study.

What risks might you experience from being in this study?
The expected risks from participating in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

How will personal information be protected?
The records of this study will be kept private. Research records will be stored securely, and only the researchers will have access to the records.

-Participant responses to the online survey will be anonymous
-Data will be stored on a password-locked computer. After five years, all electronic records will be deleted.

Is study participation voluntary?
Participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time prior to submitting the survey without affecting those relationships.

What should you do if you decide to withdraw from the study?
If you choose to withdraw from the study, please exit the survey and close your internet browser. Your responses will not be recorded or included in the study.

Whom do you contact if you have questions or concerns about the study?
The researcher conducting this study is Twinkle Gupta. You may ask any questions you have now. If you have questions later, you are encouraged to contact her at tkgupta@liberty.edu. You may also contact the researcher's faculty sponsor, Dr. Rachel Piferi, at rpiferi@liberty.edu.

Whom do you contact if you have questions about your rights as a research participant?
If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the IRB. Our physical address is Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA, 24515; our phone number is 434-592-5530, and our email address is irb@liberty.edu.

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University.

Your Consent
Before agreeing to be part of the research, please be sure that you understand what the study is about. You can print a copy of the document for your records. If you have any questions about the study later, you can contact the researcher using the information provided above.

☐ Yes, I am diagnosed with Type 2 Diabetes and am 45 years of age or older

☐ I do not meet the eligibility criteria

APPENDIX C: SURVEY INSTRUMENTS

Cognitive Assessment Questionnaire (CAQ) (Broadbent et al., 2008)

The Cognitive Assessment Questionnaire

The following questions are about minor mistakes, which everyone makes from time to time, but some of which happen more often than others. We want to know how often these things have happened to your in the past 6 months. Please circle the appropriate number.

		Very often	Quite often	Occasion-ally	Very rarely	Never
1.	Do you read something and find you haven't been thinking about it and must read it again?	4	3	2	1	0
2.	Do you find you forget why you went from one part of the house to the other?	4	3	2	1	0
3.	Do you fail to notice signposts on the road?	4	3	2	1	0
4.	Do you find you confuse right and left when giving directions?	4	3	2	1	0
5.	Do you bump into people?	4	3	2	1	0
6.	Do you find you forget whether you've turned off a light or a fire or locked the door?	4	3	2	1	0
7.	Do you fail to listen to people's names when you are meeting them?	4	3	2	1	0
8.	Do you say something and realize afterwards that it might be taken as insulting?	4	3	2	1	0
9.	Do you fail to hear people speaking to you when you are doing something else?	4	3	2	1	0
10.	Do you lose your temper and regret it?	4	3	2	1	0
11.	Do you leave important letters unanswered for days?	4	3	2	1	0
12.	Do you find you forget which way to turn on a road you know well but rarely use?	4	3	2	1	0
13.	Do you fail to see what you want in a supermarket (although it's there)?	4	3	2	1	0
14.	Do you find yourself suddenly wondering whether you've used a word correctly?	4	3	2	1	0

		Very often	Quite often	Occasion-ally	Very rarely	Never
15.	Do you have trouble making up your mind?	4	3	2	1	0
16.	Do you find you forget appointments?	4	3	2	1	0
17.	Do you forget where you put something like a newspaper or a book?	4	3	2	1	0
18.	Do you find you accidentally throw away the thing you want and keep what you meant to throw away – as in the example of throwing away the matchbox and putting the used match in your pocket?	4	3	2	1	0
19.	Do you daydream when you ought to be listening to something?	4	3	2	1	0
20.	Do you find you forget people's names?	4	3	2	1	0
21.	Do you start doing one thing at home and get distracted into doing something else (unintentionally)?	4	3	2	1	0
22.	Do you find you can't quite remember something although it's "on the tip of your tongue"?	4	3	2	1	0
23.	Do you find you forget what you came to the shops to buy?	4	3	2	1	0
24.	Do you drop things?	4	3	2	1	0
25.	Do you find you can't think of anything to say?	4	3	2	1	0

Diabetes Health Literacy Scale (DHLS) (Lee et al., 2018)

Diabetes Health Literacy Scale (English Version)

Please read each of the following items and mark V in the space that most closely indicates how much you agree with it (note that there is no correct answer for any of the items).

	Item	Not really	Slightly	Moderately	Quite a lot	Very much
1	I can read and understand the educational materials and booklets on diabetes.					
2	I understand the written information provided at an appointment for diabetes treatment or an examination.					
3	I comprehend the information I sought on diabetes.					
4	I understand the information on diabetes management provided by the health-care provider.					
5	I can judge if diabetes-related information is reliable.					
6	I can print out my prescription from an automated prescription machine at the hospital.					
7	When a change occurs in my personal schedule, I can alter the appointment date or time for a medical checkup.					
8	I can calculate the next time to take diabetes medication.					
9	I can determine the carbohydrate content per serving from the nutrition label on food packaging.					
10	I can interpret if my blood-glucose level is within the normal range.					
11	I can understand information on diabetes presented as probabilities, ratios, or on graphs.					
12	When I have a question about diabetes, I usually ask a health-care provider.					
13	I can explain my diabetes condition to a health-care provider.					

14	When eating out with colleagues or friends, I can convey the reason why I should have a diabetic diet.					

Diabetes Self-Management Questionnaire-Revised (DSMQ-R) (Schmitt et al., 2022)

Revised version with 27 items

No.	Item
1	I check my glucose levels with care and attention. (gm)[2]
2	The foods I choose to eat make it easy for me to achieve good glucose levels. (eb)
3	I regularly see the doctor (/diabetes specialist) regarding my diabetes. (cdt)
4	I take my diabetes medication (e.g. insulin, tablets) consistently and reliably. (mt)[3]
5	I occasionally eat large amounts of sweets or other foods rich in carbohydrates. (eb)[r]
6	I keep a diary/log of my glucose levels to inform and improve my diabetes management. (gm)[2]
7	I tend to avoid seeing the doctor (/diabetes specialist) regarding my diabetes. (cdt)[r]
8	I am regularly physically active to improve my diabetes and health. (pa)
9	I follow the current dietary recommendations for people with diabetes (e.g. given to me by my doctor or diabetes specialist). (eb)
10	I do not check my glucose levels frequently enough for achieving good blood glucose control. (gm)[2r]
11	I avoid physical activity although it would be good for my diabetes. (pa)[r]
12	I tend to forget or skip taking my diabetes medication (e.g. insulin, tablets). (mt)[3r]
13	Sometimes I have real 'food binges' (not triggered by hypoglycemia). (eb)[r]
14	Regarding my diabetes, I should see my doctor (/diabetes specialist) more often. (cdt)[r]
15	I am less physically active than would be good for my diabetes. (pa)[r]
20	(see below)
16	I could improve my diabetes self-care considerably. (ts)[r]
17	I estimate the carbohydrate content of my meals/foods (to improve my diabetes control). (eb)
18	I eat without regard to my diabetes. (eb)[r]
19	I check and discuss my diabetes treatment with the doctor (/diabetes specialist) regularly. (cdt)
20	My diabetes self-care is poor. (ts)[r]
21	I check my glucose levels before each meal.*
22	I adjust my insulin doses to the carbohydrate content of my meals.*
23	I adjust the timing of my insulin injections to the start of my meals.*
24	I adjust my insulin doses according to the current glucose levels and preceding or planned activities.*
25	I correct elevated glucose levels consistently whenever necessary.*
26	I carry fast carbohydrates to enable quick treatment of low blood glucose.*
27	In case of low blood glucose, I take appropriate amounts of carbohydrates to avoid causing high blood glucose.*

Diabetes Numeracy Test (DNT-5) (Huizinga et al., 2011)

1. 1/2 cup of potatoes counts as 1 carbohydrate choice. How many choices does 2 cups of potatoes count as?

1. ANSWER _____choices

2. You ate 1 and 1/2 cups from the food labeled below. How many grams of carbohydrate did you eat?

Nutrition Facts
Serving size: ¾ cup Servings per container 10
Amount per Serving **Calories** 150 Calories
Total Fat 7g **Total Carbohydrates** 18 grams Dietary Fiber 3g Sugars 3g **Protein** 3g

2. ANSWER _____grams

3. You have to eat 6 grams of carbohydrate for each 30 minutes you plan to walk. You are planning to walk for one hour. You have a bag with 12 crackers. Each cracker contains 10 grams of carbohydrate. How many crackers do you need to eat before your walk?

3. ANSWER _____crackers

4. You test your blood sugar 3 times a day. You purchase a prescription of 50 strips on March 5th. Of the dates below, by when will you need to buy new strips?

Please circle your answer:

March 21st
April 21st
May 21st
June 21st

5. Please <u>round down</u> to the nearest whole number.

You are given the following instructions: “Take 1 unit of insulin for every 7 grams of carbohydrate you eat.” How much insulin do you take:

When you eat 98 grams at supper?

98 g

5. ANSWER _____units