Health Literacy as a Moderator in the Relationship Between Diabetes Knowledge and Diabetes Outcomes

Jameshyia Ballard Thompson
University of Southern Mississippi

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HEALTH LITERACY AS A MODERATOR IN THE RELATIONSHIP BETWEEN
DIABETES KNOWLEDGE AND DIABETES OUTCOMES

by

Jameshyia Ballard Thompson

A Dissertation
Submitted to the Graduate School
and the Department of Educational Studies and Research
at The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

Approved:

________________________________
Dr. Lilian Hill, Committee Chair
Professor, Educational Studies and Research

________________________________
Dr. Thomas Lipscomb, Committee Member
Professor, Educational Studies and Research

________________________________
Dr. Richard Mohn, Committee Member
Associate Professor, Educational Studies and Research

________________________________
Dr. Kyna Shelley, Committee Member
Professor, Educational Studies and Research

________________________________
Dr. Karen S. Coats
Dean of the Graduate School

August 2016
ABSTRACT

HEALTH LITERACY AS A MODERATOR IN THE RELATIONSHIP BETWEEN DIABETES KNOWLEDGE AND DIABETES OUTCOMES

by Jameshyia Ballard Thompson

August 2016

The purpose of this research was to determine if health literacy was a moderator in the relationship between diabetes knowledge and diabetes outcomes, and explore the relationship between diabetes knowledge and health literacy. The target population included adults living in Mississippi with a diagnosis of diabetes at any point in life.

A pilot study was performed to determine if the Functional Communicative Critical Health Literacy scales (FCCHL) and the Spoken Knowledge in Low Literacy in Diabetes scale (SKILLD) were appropriate for use in a population of adults in Mississippi with a diagnosis of diabetes. Participants for the pilot study were recruited via Facebook pages belonging to diabetes-related organizations in Mississippi. Internal consistency was measured using Kuder Richardson coefficient and coefficient alpha to determine if FCCHL and SKILLD were reliable. Bivariate correlations were used to determine if FCCHL and SKILLD were valid. The pilot study revealed SKILLD and FCCHL were valid and reliable methods of measuring diabetes knowledge and health literacy.

In the research study, participants were recruited for the research study via recognized and accredited diabetes self-management programs in Mississippi. In the research study, validation and reliability testing were performed for FCCHL and SKILLD using Kuder Richardson coefficient, coefficient alpha, and bivariate correlations.
Hierarchical linear regression followed by structure coefficients were used to determine if health literacy was a moderator in the relationship between diabetes knowledge and health literacy, and explore relationships between diabetes knowledge, health literacy, and diabetes outcomes. FCCHL was determined to be a valid and reliable method of measuring health literacy, and SKILLD was determined to be a valid but not reliable method of measuring diabetes knowledge. It was determined that health literacy was not a moderator in the relationship between diabetes knowledge and diabetes outcomes. When predicting diabetes outcomes using total health literacy, diabetes knowledge, and an interaction variable (diabetes knowledge*total health literacy), it was determined that total health literacy was the strongest predictor in the model. When predicting diabetes outcomes using functional health literacy, communicative health literacy, critical health literacy, and diabetes knowledge, among these variables critical health literacy was the strongest predictor in the model. Findings of this research imply total health literacy and critical health literacy are important predictors for diabetes outcomes.
ACKNOWLEDGMENTS

I would like to express my deepest gratitude to my committee chair, Dr. Lilian Hill. Without her dedication and encouragement, the production of this work would not have been possible. I would also like to thank my committee members, Dr. Thomas Lipscomb, Dr. Richard Mohn, and Dr. Kyna Shelley who have selflessly dedicated their time and experience to ensure this work was one of perfection.
DEDICATION

This body of work is dedicated to my parents and siblings who have believed in me my entire life. Without the thoughts, prayers, and guidance of Lula Ballard, Jackie Ballard, Nathaniel Shenall, Gladys Shenall, Jakeshyia Ballard, Jakeveyon Ballard, Ja’Donnesha Ballard, Ja’Donnieka Ballard, Ja’Donnia Ballard, and Alanis Shenall this work would not have been possible.

Thank you to my husband, Terrance Thompson, and family who selflessly sacrificed time and resources for me to fulfill a lifelong goal. Special thanks to Ebenezer Baptist Church, The Bridge Church, and Dr. Jonathan Bines for providing financial support, spiritual guidance, and education-related resources throughout this dissertation process.

Every moment I wanted to give up, you all reminded me that God had preordained me to do great things and that my light must shine bright before all of mankind. You all reminded me that my dedication and perseverance were not in vain. There are no words that could express my gratitude. Thank you all so much.
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<table>
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<tr>
<td>FCCHL</td>
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Diabetes mellitus is a chronic disease characterized by hyperglycemia, or elevated blood glucose, due to complete or partial deficiency of insulin production (Shrivastava, Shrivastava, & Ramsey, 2013). According to the National Diabetes Education Program (2011), there are three known types of diabetes. Type 1 diabetes is characterized by a complete deficiency in insulin production, and accounts for approximately 5% of all cases. Type 2 diabetes is characterized by partial deficiency in insulin production, and accounts for 90-95% of all diagnosed cases. Gestational diabetes is characterized by a partial deficiency in insulin production and occurs in 2-10% of pregnant women. Women diagnosed with gestational diabetes have a 35-60% chance of developing type 2 diabetes (National Diabetes Education Program, 2011). In 2012, 29.1 million people and 9.3% of the United States population had diabetes (CDC, 2014b). The present research focuses on type 2 diabetes, due to its high prevalence and ability to be managed by the individual with appropriate lifestyle modifications.

Diabetes is a medical condition that can have serious consequences when not properly managed. Uncontrolled diabetes can lead to blindness, kidney failure, and non-traumatic lower limb amputations (CDC, 2011). Because management of diabetes is a day-to-day process, it is important that people diagnosed with diabetes are capable of self-management strategies, including eating in a healthy manner, incorporating physical activity, monitoring blood glucose, taking prescribed medications, solving issues of hyperglycemia or hypoglycemia, and dealing with the emotions and lifestyle changes of diabetes (Haas et al., 2012; Shrivastava et al., 2013).
Knowledge of diabetes self-management techniques is an important part of diabetes management, considering the need for self-management strategies (Haas et al., 2012). To self-manage a chronic disease means one is able to manage the day-to-day disease process using his or her own knowledge and skills. It may be extremely difficult for an individual to manage diabetes without self-management knowledge because of the specific nature of disease management. For instance, an individual diagnosed with diabetes may experience lightheadedness if he or she performs manual labor at the workplace. Lightheadedness may be a symptom of hypoglycemia (low blood glucose), meaning the individual’s blood glucose is low. In other chronic diseases, experience of symptoms usually means medication is needed. However, if the individual responds to the lightheadedness with insulin or glucose-lowering medication, the result may be fatal.

In the case of hypoglycemia, glucose is needed. The individual would need to know he or she should stop what he or she is doing, and check blood glucose. If blood glucose is less than 70, the individual will need to consume a food containing fast acting glucose, such as hard candy or juice. In this example, the individual would need to know how to identify symptoms of changing blood glucose, understand that action is needed, be knowledgeable of the normal blood glucose range, be capable of checking blood glucose with a blood glucose meter, keep the blood glucose monitor nearby in case of instances like this one, and be knowledgeable of the treatment for low blood glucose.

This is why the provision of diabetes education by the healthcare provider, and the understanding of diabetes education by the individual with diabetes is an integral part of diabetes management. Evidence suggests diabetes education may lead to improved diabetes outcomes, such as improvement of hemoglobin A1C (Adachi et al., 2013;
Karakurt & Kasikci, 2012), reduced weight (Rickheim, Weaver, Flader, & Kendall, 2002), and reduced blood pressure (Karakurt & Kasikci, 2012).

Self-management of diabetes requires an individual to follow a specific diet, monitor blood glucose, manage symptoms, and provide accurate information to health care providers (American Dietetic Association, 2008; Kulkarni, 2005; McNabb, 1997). In order to provide accurate information to healthcare providers, individuals with diabetes may be expected to answer questions regarding symptoms, relay information about effectiveness (or lack thereof) of treatment, keep a blood glucose log, maintain a food diary, and provide other information that may affect the treatment of the chronic disease. For an individual with low health literacy, this may present challenges. An individual with inadequate health literacy may have trouble seeking, understanding, and utilizing diabetes self-management education, such as written instructions in education pamphlets, directions on prescription inserts, and verbal instructions regarding monitoring blood glucose. It is no surprise that individuals with low health literacy tend to be older adults with low formal education attainment and low income (Kutner, Greenberg, Jin, Paulson, & White, 2006). These individuals may pretend to understand because they have experience coping with inadequate literacy or do not view themselves as poor readers (Colter, 2012).

Adequate health literacy is an important part of being active in one’s own health care. Having adequate health literacy has been associated with understanding of diabetes care, self-efficacy of diabetes management, social support (Inoue, Takahashi, & Kai, 2013), diabetes self-management (Lai, Ishikawa, Kiuchi, Mooppil, & Griva, 2013) and diabetes knowledge (Ishikawa, Takeuchi, & Yano, 2008). As informed by critical social
theory, knowledge has an emancipatory function (Leonardo, 2004). Individuals with a diagnosis of diabetes, accompanied by adequate health literacy may be able to properly seek, understand, and utilize diabetes knowledge in order to manage self-care.

Mississippi has a population at unique risk for developing diabetes and having inadequate health literacy. The diagnosis of diabetes is associated with several risk factors including family history, being overweight, lack of a healthy diet, and lack of physical activity (International Federation of Diabetes, 2014). Mississippian are at increased risk for diabetes due to the large number of obese and overweight individuals (CDC Prevalence, 2014a), low consumption of fruits and vegetables, (CDC, 2013) and low amounts of physical activity (CDC, 2015).

Having adequate health literacy is associated with certain socioeconomic classifications. Being non-White, older, having less education than a high school diploma, and low income are associated with inadequate health literacy (Kutner et al., 2006). This puts Mississippi at further disadvantage with a population that is 40.8% non-White, 18.5% without a high school diploma, and 48.4% unemployed (U.S. Census Bureau, 2014). It is clear that diabetes is a serious medical condition that may require adequate health literacy for proper self-management. Mississippian may be at further disadvantage for inadequate health literacy due to the population and environment. As informed by The Chronic Care Model, the current healthcare system may not provide adequate support for individuals with chronic diseases, such as diabetes, and in order for an individual with a chronic disease to be successful in their disease management adequate professional support is needed (Bodenheimer, Wagner, & Grumbach, 2002). Given the uniqueness of this population, it is important to utilize the lens of The Chronic
Care Model and critical social theory to explore the function of health literacy accompanied by diabetes knowledge, as it relates to diabetes outcomes.

The current study aims to explore the relationship between diabetes self-management knowledge, health literacy, and diabetes outcomes; and determine if health literacy is a moderator in the relationship between diabetes knowledge and diabetes outcomes in a population of adults with type 2 diabetes in Mississippi.

Purpose of the Study

This research study is performed to determine if health literacy is a moderator in the relationship between diabetes knowledge and diabetes outcomes. Diabetes knowledge is positively related to diabetes outcomes (Rickheim et al., 2002). Individuals with a diagnosis of diabetes who have greater diabetes knowledge tend to experience better diabetes outcomes. However, this relationship may be more complex than receiving diabetes education or not receiving diabetes education. An individual with diabetes requires the ability to seek, understand, and utilize health information. This is where health literacy begins to play a role in determining outcomes. Having knowledge and resources is not useful if one is unable to properly use them. As informed by critical social theory, it can be hypothesized that health literacy in combination with diabetes knowledge is related to diabetes outcomes, because diabetes knowledge determines if a person possesses skills needed to manage diabetes, and health literacy determines if individuals are capable of seeking, processing and utilizing these skills.

Research Questions

R1: What is the relationship among diabetes knowledge, health literacy and diabetes outcomes?
R2: Is health literacy a moderator in the relationship between diabetes knowledge and diabetes outcomes?

Assumptions

Assumptions of this study include the following: (1) Study participants are current residents of Mississippi, (2) Study participants will answer honestly, (3) Study participants will complete all instruments, and (4) Study participants will understand the content of the instruments.

Delimitations

1) This study will be limited to adults who self-report having diabetes.

2) This study will be limited to those who speak English.

3) This study will be limited to those who attend recognized/accredited diabetes self-management training programs in Mississippi.

4) Individuals who are not comfortable participating in this research study may choose not to participate due to the voluntary nature of this study.

Definition of Terms

1) Chronic care model: A concrete guide used to improve the quality of care provided to individuals with chronic disease in the healthcare setting (Bodenheimer et al., 2002).

2) Communicative health literacy: A skill higher than functional health literacy but lower than critical health literacy that allows a person to gain access to, discover meaning from, use, and apply healthcare information to changing conditions (Inoue et al., 2013, p. 2).
3) Critical health literacy: A skill higher than functional and communicative health literacy that allows a person to investigate and evaluate health information and use this information to achieve a greater amount of control of changing conditions (Inoue et al., 2013, p. 2).

4) Diabetes mellitus: An incurable disease that causes blood glucose to be elevated (Mississippi State Department of Health, Diabetes, 2012a).

5) Flesch-Kincaid Grade Level Readability tool: A tool designed to determine the reading level of documents, by determining the grade level (Microsoft Office, 2007).

6) Food desert: Areas of limited food availability (U. S. Department of Agriculture, 2015).

7) Food insecurity: Inconsistent access to adequate food source or supply due to lack of resources (U. S. Department of Agriculture, 2014).

8) Functional health literacy: A skill that allows a patient to read, and understand health information (Inoue et al., 2013, p. 2).

9) Glucose: A simple sugar used by living organisms as an energy source.

10) Glycemic control: Also referred to as blood glucose control; Keeping blood glucose levels as close to normal as possible (American Diabetes Association, 2013).

11) HDL cholesterol: High density lipoprotein cholesterol, often referred to as good cholesterol because it helps remove LDL cholesterol from the arteries (American Heart Association, 2014).
12) Health care access: Entry or acceptance of an individual to utilize the healthcare system (Agency for Healthcare Research and Quality, 2015, p. 6).

13) Health disparity: A particular type of health difference that is closely linked with social, economic, and/or environmental disadvantage (Healthy People 2020, 2015).

14) Health equity: Fair or equal treatment of individuals and groups that leads to the avoidance of disparities in good health and longevity (Baker, Metzler, & Galea, 2005, p. 553).

15) Health literacy: A person’s ability to use skills obtained in order to understand health information, and make informed healthcare decisions (Baker, 2006, p. 878).

16) Hemoglobin A1C: Glycated hemoglobin test; blood test that provides an average blood glucose from previous 1-3 months (American Diabetes Association, 2014).

17) Insulin: A hormone secreted in the pancreas that assists with the control of blood glucose.

18) LDL cholesterol: Low density lipoprotein cholesterol, often referred to as bad cholesterol, because it contributes to the clogging of arteries (American Heart Association, 2014).

19) Public health: A field of study that seeks to ensure individuals and groups are able to be healthy (Baker et al., 2005, p.553).

20) Self-efficacy: One’s belief in one’s own ability to reach goals (Consumer Health Informatics Resource Research, 2015).
21) Social determinants of health: “Social, economic, and political resources and structures that influence health outcomes” (Baker et al., 2005, p.553).

22) Socio-cultural status: Societal position based on social and cultural factors.


24) Total cholesterol: A measure of all cholesterol levels in the blood.

Justification

Diabetes mellitus is a serious medical condition that may result in serious complications such as blindness, kidney failure, and non-traumatic lower limb amputations (CDC, 2011). Compared to other states in the United States, Mississippi has the second highest prevalence of diagnosed cases of diabetes in the United States. Self-management of diabetes is a day-to-day process requiring knowledge of healthy eating, physical activity, monitoring blood glucose, taking prescribed medications, solving hyperglycemic and hypoglycemic episodes, handling lifestyle changes attached to diabetes diagnosis, and reducing risks of complications (Shrivastava et al., 2013). Diabetes self-management education has been shown to be effective in improving hemoglobin A1C, total cholesterol, low density lipoprotein (LDL) cholesterol, blood pressure, and triglycerides in patients with diabetes (Karakurt, & Kasikci, 2012). Increased diabetes knowledge has been associated with non-Black race, and high health literacy (Jeppensen, Hull, Raine, & Miser, 2011). As income and formal education level increase, so does health literacy (Jeppensen et al., 2011; Rothman et al., 2005). Individuals with inadequate health literacy may be at increased risk for diabetes-related complications (Kim, Love, Quistberg, & Shea, 2004).
Adequate health literacy is necessary for the use and acquisition of health-related information. Inadequate health literacy has been linked to decreased compliance with prescribed treatment and self-care regimens (Weiss, 1999), and increased self-reported complications with diabetes (Kim et al., 2004). High health literacy has been associated with White race, higher income, and higher education (Kutner et al., 2006) compared to non-White, lower income, and those with less than a high school diploma.

In 2012, the United States population was 77.7% non-Hispanic White, 13.2% non-Hispanic Black, and 17.1% Hispanic/Latino. The Mississippi population in 2012 was 59.8% non-Hispanic White, 37.4% non-Hispanic Black, and 2.9% Hispanic/Latino (U. S. Census Bureau, 2014). From 2008-2012, 85.7% of the United States population age 25 or greater had a high school diploma or higher, 28% had a Bachelor’s degree or higher, and the median income was $53,046. The education and median income during this same time frame for this same age group in Mississippi was 81% with high school diploma or higher, 20% with Bachelor’s degree or higher, and $38,882 median income (U. S. Census Bureau, 2014). Mississippi has fewer adults with high school diplomas and Bachelor’s degrees and a lower median income than the national average. Mississippians are at higher risk of low diabetes knowledge, low health literacy, and high incidence of diabetes complications due to its large minority population, low median income, and low percentage of population with a high school diploma compared to other states. Considering the serious risks associated with uncontrolled diabetes, the relationship between health literacy, diabetes knowledge, and diabetes outcomes should be assessed on a general population in Mississippi. Research findings may help practitioners better
understand the limitations of the population they serve, and assist them to prepare to educate the population they serve.
CHAPTER II – REVIEW OF THE LITERATURE

The present research study is informed by critical social theory and the chronic care model. Critical theory is a school of thought that describes society as having inequalities that should be corrected. This was best described by Marcuse (1969) when he depicted the human world as being unable to have freedom for all classes of people because class struggles will always create a lower class of people who are there to meet the needs of the higher class of people. Critical theory is considered critical because it aims to free individuals or groups from situations or circumstances that bind them (Horkheimer, 2002). Critical theory has been found most often in the research regarding works involving critical race theory, feminist theory, and queer theory, all focused on groups who have experienced inequalities for not being members of the dominant culture.

Critical social theory emerged from critical theory. According to Ngwenyama (1991), critical social theory can be explained in 5 assumptions. The social world, created by people, is capable of being changed by people. Because knowledge of the social world is created by the social world, it is subject to be assigned value according to systems within the social world. Understanding of the social world and critique of the social world coincide. Theory and practice should always be intertwined. Reason and critique must be informed by and inclusive of practice. According to Dutta (2010), knowledge is power. This means possession of knowledge may contribute to a societal separation between those who have knowledge and those who do not have knowledge. It is well documented that individuals with less education often have lower income, poorer management of chronic disease (Schillinger, Barton, Karter, Wang & Adler, 2006), and
lower health literacy (Kutner et al., 2006). Meanwhile, their well-educated counterparts typically experience more income, better management of chronic disease, and higher health literacy.

Similar to critical social theory in that it seeks to make changes to a system that omits certain populations from fair treatment is the chronic care model. The chronic care model was designed as a concrete guide to assist in the improvement of the current healthcare system. The current healthcare system is designed to meet needs of acute disease care and not chronic disease management. This system is characterized by brief patient-physician interactions and little planning dedicated to instructing patients on the management of chronic disease (Bodenheimer et al., 2002). The chronic care model includes six components, interconnected to provide comprehensive health management. Self-management support involves a collaboration of patient, family, and friends to assist individuals with acquiring the skills and confidence needed to manage and improve chronic illness. Clinical information systems include a computerized information system capable of reminding the healthcare team of compliance goals for patients, providing physician feedback on chronic disease indicators (such as hemoglobin A1C for individuals with diabetes), and providing a registry of patients along with chronic disease (Bodenheimer et al., 2002). Delivery system redesign involves physicians intervening to treat acute symptoms, and non-physicians (i.e. nurse, dietitian, patient educator, etc.) assisting with provision of education and management of routine tasks such as appointments, diet instruction, and laboratory tests. Decision support includes specialized care from professionals available and easily accessible to patients with a chronic disease. The health care
organization includes “the structure, goals, and values of a provider organization, and its relationship with purchasers, insurers, and other providers” (Bodenheimer et al., 2002, p. 1776). Community resources include a linkage between community organizations (i.e. clinic based group education class, case management provided by home-based care agencies), and community-based resources (i.e. support groups for chronic diseases, weight loss programs). While designed to be a concrete, implementable guide for healthcare practice, the chronic care model is also capable of informing research by providing a framework that suggests current healthcare system is inefficient in adequately assisting individuals with chronic disease, and is in need of improvement. Individuals with diabetes can benefit from all six components of the chronic care model, and a healthcare system utilizing the chronic care model will have individuals with greater chronic disease management skills and health literacy due to the provision of education and interaction with healthcare professionals.

Chronic disease can be defined as illnesses that persist over extended periods of time and are not likely to be cured (Knyahnytska, 2014). In the United States, chronic disease has become a part of life for many individuals. According to results from the 2011 Behavioral Risk Factor Surveillance System, states within the United States have a median of 27.7% people with obesity, 9.5% with diabetes, 11.2% with cancer, 9.1% with arthritis, 31.6% with high blood pressure, 38.9% with elevated cholesterol, and 10.9% with heart disease (Xu et al., 2014). In order for people diagnosed with chronic disease(s) to have adequate quality of life and longevity, chronic disease management is required. Per the chronic care model, chronic disease management requires knowledge and skill to incorporate disease management tools into everyday life and situations. From the
perspective of critical social theory, acquisition and use of knowledge cannot be separated from the individual and his or her social context. (Xu et al., 2014). Knowledge creation is mediated by socially and historically created power structures (Xu et al., 2014). As it relates to chronic disease self-management, power structures within society determine who receives resources, what resources are given, and where resources are provided. This ensures inequalities. For example, a low-income family with lack of transportation in search of diabetes education resources may be forced to receive care only from a local health department within walking distance of their home. This local health department is funded by the State government, and its resources are limited to what the State government is capable of funding or willing to fund. The State and Federal governments allow only education materials they have approved at sponsored facilities. Therefore the State and Federal governments control what resources a low income family has access to.

The dominant culture exerts power and control in the amount of attention brought to specific health concerns and in the development of solutions to these concerns. Critical social theory has been used to provide a rational for deconstructing the dominant culture’s attempt at risk framing, allowing alternative observation of risks, alternative explanations, and alternative resolutions to be used regarding issues of health communication (Dutta, 2010). This interruption of the status quo allows issues regarding participation, equity, and social justice to be viewed in rationales regarding health communications and health disparities (Dutta, 2010). Social class, identified as an individual’s level of formal education, occupation, and income, is a determining factor in disease outcomes and quality of life. (Stephens, Markus, & Fryberg, 2012). While the
individual is very much responsible for personal health care, environment plays an important role in determining health outcomes by determining material resources and environmental conditions (Stephens et al., 2012). It cannot be ruled as a coincidence that adults with lower income and education have higher rates of cancer, heart disease, hypertension (Lutsey et al., 2008), and lower perceived well-being (Johnson & Kruger, 2006), compared to adults with higher income and education.

A clear division exists in the healthcare realm between individuals capable of managing care and those who are not, partly due to socio-cultural circumstances. Social determinants of health, such as access to adequate amounts of affordable nutritious foods, drinkable water, secure housing, and supportive social communities are linked to health outcomes (Baker et al., 2005). The unequal distribution of social determinants of health leads to health disparities and health inequalities. In 2012, individuals in poor households experienced worse health care access, and less quality of health care, compared to individuals with high incomes (Agency for Healthcare Research and Quality, 2015). While socioeconomic disparities may be the most fundamental cause of health disparities, this relationship is complex (Adler & Newman, 2002). Socioeconomic indicators, such as income, education, and occupation may not directly affect health status, but are the underlying determinants by contributing to behavior and lifestyle, environmental exposure, and health care (Lee & Paxman, 1997). Education is capable of determining occupational opportunities, earning potential, knowledge and life skills. As an individual gains education, they are likely to gain the ability to access information and tools to inform health decisions. Income provides the means to purchase health-related devices, such as insurance, prescriptions, and specialized health professional visits.
Adequate income can also provide access to adequate nutrition, secure housing, satisfactory schooling, and ample recreation (Adler & Newman, 2002). Employment is directly related to income, and provides an opportunity to access health insurance. While occupations differ in terms of status, credentials, rewards, and responsibilities (Adler & Newman, 2002), employed persons have better health status than the unemployed (Ross & Mirovsky, 1995). Socioeconomic inequalities originate from social inequalities (Mackenbach, 2012). These social inequalities are a function of social mobility creating differences between social class, resource distribution, and resource benefits.

The present research identifies residents of Mississippi as a critical population in need of investigation via critical social theory and the chronic care model. Mississippians are at unique risk for development of chronic disease, poor management of chronic disease, and inadequate health literacy to assist with chronic disease management, compared to the rest of the nation due to increased incidence of diabetes (Mississippi State Department of Health, 2012a), poor nutrition and physical fitness (International Federation for Diabetes, 2014), decreased education, increased unemployment rates, and decreased annual income (U. S. Census Bureau, 2014). This research study is designed to explore the relationship between diabetes knowledge, health literacy and diabetes outcomes, using critical social theory and the chronic care model.

Mississippi as an At-Risk Population

The International Federation for Diabetes (2014) identifies several risk factors for diabetes, including family history of diabetes, weight status above normal, unhealthy diet, lack of physical activity, increasing age, and ethnicity. This puts Mississippi at a critical disadvantage due to its unique population. About 12.5% of Mississippians have been
diagnosed with diabetes (Mississippi Department of Health, 2012a). Approximately 35% of Mississippians self-report being obese (CDC, 2014a). Among adults in Mississippi, 49.9% eat less than one fruit daily, and 30.6% eat less than one vegetable daily. (CDC, 2013). About 38.1% of Mississippians participate in no leisure time physical activity, and only 25.9% are physically active daily (CDC, 2015).

Mississippi has a cocktail of environmental concerns that prevent healthy eating and physical activity, and in turn increases risk of chronic disease development. Food deserts are prevalent in non-metropolitan areas in Mississippi, and prevent access to nutritious food options (Blanchard & Lyson, 2005). Mississippi is a rural area where sidewalks are not always prevalent, especially in rural areas. The lack of sidewalks and prevalence of traffic may prevent safe and cost-effective exercise within neighborhoods (McGinn, Evenson, Herring, Huston, & Rodriguez, 2007). Annual income in Mississippi is well below national averages. Meanwhile, increased costs of lean meats, whole grains, fresh fruits, and fresh vegetables force families to choose between eating healthy and being unable to provide food for the entire family (Drewnowski & Darmon, 2005). Increased food insecurity combined with obesity masks the plight of the hungry (Dinour, Bergen, & Yeh, 2007). It would be assumed that if a family suffered from food insecurity, the lack of food would be related to underweight instead of overweight. However, in Mississippi, low income families make unhealthy nutrition choices leading to excess caloric intake without nutritional adequacy. This leads to individuals who are overweight but still do not have an adequate amount of nutritious foods available. Traditional family soul food recipes passed down generations are usually high in fat and sodium, and individuals assume giving up the traditional methods of cooking equates to
giving up flavor (James, 2004). Inaccurate estimations of health status cause adults to feel healthier than they actually are. Among women in Mississippi who had children receiving free lunches, only 13.9% accurately estimated weight status (Lofton, 2007). About 76.6% of obese mothers estimated weight status as overweight and about 45.4% of overweight women estimated weight status as normal (Lofton, 2007).

The uniqueness of the Mississippi population puts Mississippians at a disadvantage as it relates to preventing chronic disease and being able to properly manage chronic disease. The Chronic Care Model implies that without an effective and efficient healthcare system that is patient-focused, outcomes for these individuals will be negative. One specific chronic disease Mississippians are currently leading the nation in acquiring is diabetes.

Prevalence and Implications of Diabetes

In 2010, 8.3% (25.8 million) of all Americans were diagnosed with diabetes (CDC, 2011). In 2012, this number rose to 9.3% (29.1 million) (CDC, 2014b). From 2007 to 2009, 7.1% of Whites, 8.4% of Asian Americans, 11.8% of Hispanics, and 12.6% of Blacks ages 20 or greater were diagnosed with diabetes in the United States (CDC, 2011). From 2010 to 2012, these percentages rose for each racial group to 7.6% of Non-Hispanic Whites, 9% of Asian Americans, 12.8% of Hispanics, and 13.2% of Non-Hispanic Blacks (CDC, 2014a). The increasing prevalence of diabetes in the United States is alarming, and the prevalence is even higher for Mississippians.

In 2010, over 270,000 (12%) of adult Mississippians were diagnosed with diabetes, the highest prevalence in the United States (Mississippi Department of Health, 2012b). That same year, diabetes was related to the deaths of 926 (3.2%) Mississippians
(Mississippi Department of Health, 2010). In 2012, over 276,000 (12.5%) adult Mississippians were reported to have a diagnosis of diabetes (Mississippi Department of Health, 2012a), the second highest prevalence in the United States. That same year, diabetes was found to be related to the deaths of 1039 (3.5%) Mississippians (Mississippi Department of Health, 2012b). The increased prevalence of diabetes is a serious issue in the United States, specifically Mississippi, considering the serious implications associated with diabetes.

Diabetic complications include retinopathy, kidney disease, limb amputations, heart disease, and death. In 2007, diabetes was the seventh leading cause of death in the United States (CDC, 2011). From 2005 to 2008, 28.5% (4.2 million) of adults with diabetes ages 40 and older had diabetic retinopathy (CDC, 2011). In 2011, diabetes was the primary cause of 44% of renal failure cases (CDC, 2014b). In 2010, 60% of non-traumatic lower limb amputations of people 20 years of age or older occurred in people with diabetes (CDC, 2014b). In 2004, heart disease was noted on 68% of diabetes-related death certificates, and stroke was noted on 16% of diabetes-related death certificates among people 65 years of age or older (CDC, 2011). From 2009 to 2012, 65% of adults diagnosed with diabetes had elevated LDL cholesterol and used cholesterol-lowering medications (CDC, 2014b). From 2009 to 2012, 71% of adults with diagnosed diabetes had elevated blood pressures (CDC, 2014b), a rise from 67% from 2005 to 2008 (CDC, 2011). Diabetes self-management presents a method to help combat complications with diabetes.
Diabetes Self-Management

Diagnosis of diabetes requires individuals to be hands-on with care, and receive extensive education to manage this disease. Patients with diabetes need to be skilled in daily maintenance of crisis-management skills because uncontrolled diabetes can ultimately lead to coma and death. Considering the serious implications of uncontrolled diabetes, it is imperative that practitioners understand ways to assist patients in the management of diabetes. Self-management skills such as healthy eating, being physically active, monitoring blood glucose, compliance with medications, problem-solving skills, coping skills, and risk reduction behaviors have been identified as being positively related to optimal glycemic control, reduction of complications, and improved quality of life (Haas et al., 2012; Shrivastava et al., 2013). Knowledge of diabetes is an important part of diabetes management, considering the need for self-management (Haas et al., 2012). Diabetes self-management education may lead to improved diabetes outcomes, such as improvement of hemoglobin A1C (Adachi et al., 2013; Karakurt, & Kasikci, 2012).

Knowledge of diabetes self-management strategies is an important part of managing type 2 diabetes. National Standards of Diabetes Self-Management Educators found diabetes education, in the form of diabetes self-management strategies, effective in helping to improve hemoglobin A1C, weight, body mass index and increasing diabetes knowledge (Rickheim, et al., 2002). An intensive lifestyle intervention consisting of a 16 lesson curriculum based on diet, exercise and behavior modification proved more effective than standard lifestyle changes and standard lifestyle changes combined with glucophage in reducing incidence of diabetes (Diabetes Prevention Program Research
This implies diabetes self-management knowledge may be more effective than a well-known prescription medication for managing blood glucose. Education on self-management of diabetes was found to be effective in reducing hemoglobin A1C and blood pressure ($p<0.001$) in a pretest-posttest experiment (Karakurt & Kasikci, 2012). An individual lifestyle education based on basic information for blood glucose control, actions for blood glucose control, daily activities of blood glucose control, and management of stress for blood glucose control was also effective in reducing hemoglobin A1C (Adachi et al., 2013). These experimental research studies provide strong evidence of the effectiveness of education as a means of improving diabetes outcomes, specifically reducing hemoglobin A1C and blood pressure.

Diabetes Education and Outcomes

The Association of Diabetes Educators restricts a diabetes education program to any structured delivery of education occurring in a practice setting (Martin et al., 2008). The relationship between diabetes education and outcomes has been well-established in previous research. Low education level (some high school or less) among patients with a diagnosis of diabetes has been linked to poorer glycemic control when compared to that of individuals with a high school diploma or higher (Schillinger et al., 2006). Increased diabetes knowledge has been associated with improved outcomes (Fenwick, Xie, Rees, Finger, & Lamoureaux, 2013).

Receipt of diabetes education, regardless of format, has been associated with improvements in hemoglobin A1C ($p<0.05$), systolic and diastolic blood pressure ($p<0.001$), and LDL cholesterol ($p<0.001$) (Gagliardino et al., 2011). Using a pharmacy-led diabetes education program, receiving diabetes education resulted in significant
reductions in blood pressure, blood glucose and hemoglobin A1C (p<.05) and an increase in medication compliance, health status, and diabetes knowledge (Ali et al., 2012). In a pretest-posttest design, self-care diabetes education was associated with improvements in hemoglobin A1C, total cholesterol, HDL cholesterol, LDL cholesterol, and blood pressure (Karakurt & Kasikci, 2012). An electronic diabetes education intervention using a website and chat room was associated with improvement in hemoglobin A1C (p<.001), LDL cholesterol (p<.04), and HDL cholesterol (p<.029) (Moattari, Hashemi, & Dabbaghmanesh, 2012). Using a web-based diabetes education program based on the Critical Care Model, participants saw improved hemoglobin A1C, LDL cholesterol, and blood pressure (Morrow et al., 2013). Using a provider-based diabetes education model, participants were significantly less likely to use insulin (p=.009) and had significant improvements in hemoglobin A1C (p=.09) and LDL cholesterol (p=.01) (Piatt et al., 2010). A local group-based diabetes self-management intervention was associated with improved hemoglobin A1C (p=.032), higher levels of diabetes knowledge (p<.001), higher self-inspection of feet (p=.002), avoidance of fatty foods (p=.027), and increased self-monitoring of blood glucose (p=.027) (Rygg, Rise, Gronning, & Steinsbekk, 2012).

From pharmacy-based to web-based, several methods have been established to provide diabetes education. However, outcomes are very similar. Diabetes education is associated with improved hemoglobin A1C, cholesterol, blood pressure, and self-management of disease condition. However, these improvements are not equally distributed within the population.
Diabetes Knowledge and Socioeconomic Status

Socioeconomic status has been found to have a negative relationship with diabetes knowledge. The use of critical social theory may suggest that income, employment, and education may affect an individual’s risk of chronic disease, management of chronic disease and outcomes related to chronic disease. This seems obvious given the fact that the environment may determine the type and amount of resources readily available to individuals and socioeconomic status may determine knowledge of and access to resources beyond one’s immediate environment.

In an attempt to determine factors associated with inadequate diabetes knowledge, Fenwick et al. (2013) found that having increased diabetes knowledge was related to higher income, higher formal education, being employed, and younger age (p<0.001). Diabetes knowledge was also higher among individuals who had sought assistance from healthcare providers, such as ophthalmologist (for diabetes eye exam), diabetes educator, counselor, and diabetes support group (p<0.001). This implies that individuals with employment, increased education and increased income have higher diabetes knowledge and are more likely to seek assistance for managing diabetes.

In the development of a tool designed to measure diabetes knowledge in low literacy populations, it was found that increased diabetes knowledge was associated with higher income, higher education, and higher literacy status (Rothman et al., 2015). While validating this same tool for low literacy populations, Jeppensen et al. (2011) found that individuals with greater diabetes knowledge were members of non-Black race, and experienced higher income, higher formal education, and higher functional health.
literacy. While validating a short diabetes knowledge test, Fitzgerald et al. (1998) found that diabetes knowledge increased as years of formal education increased.

According to current research, diabetes knowledge has an identifiable effect on diabetes outcomes. However, diabetes knowledge alone may not be effective in ensuring proper management of chronic disease. An individual may require more than the experience of diabetes knowledge. An individual may need to combine diabetes knowledge with health literacy to ensure positive diabetes outcomes.

Defining Health Literacy

Literacy, in its simplest form, may be defined as the ability to read and write. Health literacy is an addition to this and could be defined as the ability to read and write health-related material. However, health literacy may mean different things to different audiences. The Institute of Medicine and the American Medical Association’s Ad Hoc Committee on Health Literacy view health literacy as a set of individual abilities that allow a person to obtain and use new information related to health. The American College of Physicians Foundation view health literacy as an achieved level of knowledge depending on the capacity of an individual and the resources health care systems provide. For the purposes of this research study, overall health literacy will be defined as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Baker, 2006, p. 878). Health literacy has evolved over that past decade and currently goes beyond an individual’s ability to simply read and write health information and includes an individual’s ability to listen, analyze, apply knowledge learned, and make decisions based on information given.
The above definition does not completely encompass the current understanding of health literacy. Nutbeam (2000) identifies health literacy in three levels including functional, interactive, and critical that progressively allow for greater autonomy and personal empowerment of the individual. Functional health literacy reflects communication of healthcare information between provider and patient and ability to use the healthcare system. This may include an individual reading and understanding educational pamphlets from a nurse after a diagnosis of diabetes. Interactive or communicative health literacy reflects the individual’s ability to act independently and apply knowledge gained. This may include an individual monitoring blood glucose daily before taking insulin because he or she understands the relationship between blood glucose and insulin. Critical health literacy reflects an individual’s ability to use cognitive ability and skills developed to support effective social and political action. This may include an individual starting a diabetes support group at a local community center to help neighbors in need of information related to diabetes.

Most research exploring the relationship between health literacy and chronic disease self-management focuses on functional health literacy (Heijmans, Waverjin, Rademakers, & van der Vaart, 2015) and suggests self-management may not rely solely on an individual’s ability to read and understand health information (Easton, Entwistle, & Williams, 2010). However, the need to assess functional, communicative, and critical health literacy is evident in the limited research available. Functional health literacy has been associated with understanding of diabetes care and self-efficacy for diabetes management (Inoue et al., 2013). Communicative health literacy has been associated with patient-physician communications, social support (Inoue et al., 2013), and diabetes self-
management (Lai et al., 2013). Critical health literacy has been associated with a patient’s knowledge, having an active role in health care, self-management, and confidence in medical consultation (Heijmans et al., 2015). The current research will be used to assess functional, communicative, and critical health literacy.

**Prevalence of Low Health Literacy**

Having adequate health literacy is an important part of being active in one’s health care. In order to properly navigate the current health care system and ensure good health, patients need adequate health literacy. From insurance applications to nutrition instructions in brochures, at some point patients are expected to understand health information (Vernon, Trujillo, Rosenbaum & DeBuono, 2007). In 2003, the National Assessment of Adult Literacy was performed, directly measuring health literacy in the forms of prose literacy, document literacy and quantitative literacy. Of the 19,000 adults aged 16 or greater in this nationally representative sample, 14% scored below basic, 22% scored basic, 53% scored intermediate, and 12% scored proficient (Kutner et al., 2006).

In a primary care setting in London, the All Aspects of Health Literacy Scale was used to assess health functional, communicative and critical health literacy. It was found that 22% reported they “often” and 24% reported they “sometimes” need help reading health information (Chinn & McCarthy, 2013, p. 249) suggesting inadequate functional health literacy. In the same study, 64% reported “wider social and economic factors were more important than individual behaviors for influencing overall health” (Chinn & McCarthy, 2013, p. 251) implying inadequate critical health literacy.

The Functional Communicative Critical Health Literacy scale has been used in several countries to assess functional, communicative, and critical health literacy.
Originally designed by Ishikawa et al. (2008), it uses 4 point scales with 1 corresponding with never and 4 corresponding with often. In Japan, using the Functional Communicative and Critical Health Literacy scales, participants scored an average 3.39±0.75 for overall health literacy, 3.19±1.12 for functional health literacy, 2.43±1.04 for communicative health literacy, and 1.96±0.63 for critical health literacy (Ishikawa et al., 2008). In Singapore, using the Functional Communicative and Critical Health Literacy scales, participants scored 2.99±0.5 for overall health literacy, 2.79±0.8 for functional health literacy, 3.04±0.7 for communicative health literacy, and 3.17±0.6 for critical health literacy (Lai et al., 2013). Although cut-offs for adequate health literacy have not been established for instruments that measure functional, communicative and critical health literacy, it may be assumed that a large number of individuals may be at risk for inadequate functional, communicative, and critical health literacy due to increased number of people in need of assistance and average scores not exceeding 3.17 respectively.

In the Netherlands, the Functional Communicative and Critical Health Literacy scales was translated in Dutch and revised for use to assess health literacy in the population. Some questions were changed for clarity in the Dutch language. The scale was changed to reflect 1 to 4 corresponding with never to often for functional health literacy, and easy to rather difficult for communicative health literacy and critical health literacy. Mean scores ranged from 1 (low health literacy) to 4 (high health literacy). Average patient scores were highest for functional health literacy (3.2±0.7), followed by communicative health literacy (3.10±0.7), total health literacy (3.0±0.6), then critical health literacy (2.7±0.8) (Heijman et al., 2015). Low health literacy is a serious situation
considering the implications of inadequate health literacy, and benefits of adequate health literacy.

Implications of Health Literacy

Low health literacy has been linked to poorer health status (Nielsen-Bohlman, Panzer & Kindig, 2004), increased hospitalization (Baker et al., 2002), increased in-patient spending (Howard, Gazmararian, & Parker, 2005), increased mortality rates (Baker et al., 2007), and decreased compliance to prescribed treatment and self-care regimens (Weiss, 1999). Increased functional health literacy has been associated with better methods of coping with chronic disease, increased knowledge of chronic disease, increased confidence during consultations with professionals (Heijmans et al., 2015), understanding of diabetes care (Inoue et al., 2013), and diabetes knowledge (Ishikawa et al., 2008). Communicative health literacy has been associated with patient-physician communications, social support, understanding of diabetes care, self-efficacy of diabetes management (Inoue et al., 2013), diabetes self-management (Lai et al., 2013), and diabetes knowledge (Ishikawa et al., 2008). Critical health literacy has been found to be correlated with a patient’s perceived knowledge, having an active role in health care, self-management of chronic disease, confidence in medical consultation (Heijmans et al., 2015), understanding of diabetes care, self-efficacy of diabetes management, social support (Inoue et al., 2013), diabetes self-management (Lai et al., 2013), and diabetes knowledge (Ishikawa et al., 2008).

There is a clear correlation between increased functional, communicative, and critical health literacy and positive health outcomes. However, as with the improvements
seen with diabetes knowledge, these improvements are not equally disbursed within the population.

Health Literacy and Socioeconomic Status

Findings from the 2003 National Assessment of Adult Literacy suggest Whites had higher average health literacy than other races, Hispanics had lower health literacy than other races, older adults (65 and older) had lower average health literacy than younger adults, adults who had not attended or finished high school had lower health literacy than higher education groups, and as income increased health literacy increased (Kutner et al, 2006). At a university hospital in Pennsylvania, it was found that low literacy was associated with being older, having less education, and lower annual income (Kim et al., 2004). Among patients in primary care facilities in Tower Hamlets London, lower functional, communicative, and total health literacy scores were associated with belonging to Black and minority ethnic groups (Chinn & McCarthy, 2013). Lower critical health literacy was associated with greater age; and higher functional, communicative, critical, and total health literacy were associated with higher education level (Chinn & McCarthy, 2013). In a nationwide study in the Netherlands, lower levels of functional, communicative, and critical health literacy were associated with greater age, lower education, and lower income (Heijmans et al., 2015). These findings suggest having lower education, lower income, and greater age may be related to lower health literacy.

Summary

Critical social theory implies socioeconomic and environmental factors may be capable of determining an individual’s ability to seek and access healthcare systems. Mississippians are thus a critical population due to low income, low education level, and
low rates of employment, compared to national statistics, combined with a mixture of conditions that put them at increased risk of developing and/or improperly managing chronic disease, such as inadequate fruit intake, inadequate vegetable intake and inadequate physical activity. The Chronic Care Model implies the current healthcare system was designed to manage acute disease, and not chronic disease. In order to effectively and efficiently manage chronic disease, the healthcare system should provide education and support so patients are capable of managing self-care after leaving the doctor’s office. This may be a difficult task for the unique population in Mississippi. Mississippians with diabetes are in need of self-management education to manage this chronic disease. However, individuals with inadequate health literacy may be unable to seek, understand and process health-related information. This research study aims to explore the relationship between diabetes knowledge, health literacy and diabetes outcomes. More specifically, this research seeks to determine if health literacy is a moderator in the relationship between diabetes knowledge and diabetes education.
CHAPTER III - METHODOLOGY

A non-experimental design was used to examine if a relationship existed between health literacy, diabetes knowledge, and diabetes outcomes. The target population for this research project was adult residents of Mississippi diagnosed with type 2 diabetes mellitus. Participants eligible for inclusion met the following criteria: 18 years of age or older, English speaking, and self-reported diagnosis of type 2 diabetes by a hemoglobin A1C of 6.5 at any point in life. Patients were excluded from this research project if they did not speak English, were under the age of 18 years, self-reported taking anti-psychotics or anti-epilepsy drugs, were pregnant or breastfeeding, or had a diagnosis of end stage renal disease. This study was conducted in two phases, including a pilot and study.

Sampling

For the pilot study, targeted convenience sampling was used to identify a population in Mississippi, according to the following inclusion criteria: English-speaking, 18 years of age or older, current Mississippi resident, and self-report a diagnosis of diabetes. A total of 20 participants were needed for the pilot study. Background information, self-reported hemoglobin A1C, the Spoken Knowledge in Low Literacy Diabetes (SKILLD), and the Functional Communicative Critical Health Literacy (FCCHL) scales were administered electronically via questionnaire. A link to the questionnaire was posted on Facebook pages belonging to Diabetes Coalition of Mississippi, Diabetes Foundation of Mississippi, and American Diabetes Association-Mississippi.
For the study, participants were recruited via recognized/accredited diabetes self-management training programs in Mississippi. Any person participating in the pilot study was not allowed to participate in the study. Participants who participated in the pilot study were identified in the screening process and allowed to complete all measures but information was not included in analyses. A total of 120 participants were needed for this research project. This number was calculated using 12 participants per independent variable used in the hierarchical linear regression.

Setting

The pilot study took place online using Qualtrics. The research study took place at six recognized/ accredited diabetes self-management training programs in Mississippi.

Ethical Considerations

Permission to perform this research project was granted by The University of Southern Mississippi Institutional Review Board. Permission was also granted by the health care facilities’ chief executive officer or clinic manager at each diabetes self-management training program. These permissions were granted prior to the beginning of this research project.

Procedures

For the pilot study, a link to the anonymous electronic questionnaire was posted by the researcher on Facebook pages belonging to Diabetes Coalition of Mississippi, Diabetes Foundation of Mississippi, and American Diabetes Association- Mississippi. This link was active for a period of 15 days. Participants completed background information, self-report most current hemoglobin A1C, the SKILLD, and the FCCHL scales online.
For the research study, a list of recognized/ accredited diabetes self-management training programs in Mississippi was obtained from the Mississippi State Department of Health (MSDH) website. Each of the 36 programs identified by MSDH were contacted and offered the opportunity to participate in the research project. Upon receipt of letter of permission, the researcher attended up to three regular diabetes education meetings at each recognized/ accredited self-management program that agreed to participate.

Enrollment in this research study took place at existing diabetes education program sites. During this time, all participants signed informed consent documentation and completed a background questionnaire. The researcher measured the participants’ hemoglobin A1C, diabetes knowledge, and health literacy.

Upon data collection, consent forms, demographic information, hemoglobin A1C results, the SKILLD, and the FCCHL scales were numbered for each participant. Each participant was assigned a unique number. An identity key was created linking a patient’s name to his or her data. Consent forms and the identity key were kept in a locked box. Demographic information, the SKILLD, and the FCCHL scales were kept in a separate location. Any information stored electronically on laptop or personal computer was password protected. Only individuals directly involved in the data analysis process were allowed access to secure or password protected information.

Hemoglobin A1C is a blood test requiring a finger stick. Finger sticks were done by a licensed registered dietitian. Sanitary procedures were used. Sanitary procedures included use of use of latex gloves by licensed professionals, alcohol preps to clean finger before stick, disposal of sharps in hospital grade sharps containers, and use of cotton swabs and bandages after stick. Patients with a hemoglobin A1C above 9 were
told to seek immediate medical attention, and given a written copy of results. A hemoglobin A1C of 9 corresponds to an approximate blood glucose greater than 360 (American Diabetes Association, 2011). This is considered a high value and medical attention may be needed.

Selection of Measurement Tools

*Measuring Health Literacy*

Four methods of measuring functional health literacy have been used regularly in the literature. The Adult Test of Functional Health Literacy assesses a patient's comprehension level of health-related material. It is available in a full format (approximately 22 minute, 50 reading comprehension items, and 17 numeracy items), an abbreviated format (approximately 12 minute, 36 reading comprehension items and 4 numeracy items), and a short format (approximately 7 minute, 36 reading comprehension items) (Baker, 2006). Scores range from 0 to 100 and correlate to 3 levels: inadequate (0-53), marginal (54-66) and adequate (67-100). The Rapid Estimation of Adult Literacy in Medicine (REALM) assesses a patient’s health literacy by assessing a patient’s ability to read medical words. A score of 0-66 is correlated to four levels: 3rd grade or below (will not be able to read most low literacy materials and will need repeated oral instruction), 4th to 6th grade (will need low literacy materials and may not be able to read prescriptions), 7th to 8th grade (will struggle with most patient education materials), or high school (will be able to understand most patient education materials) (Davis et al., 1991). The Newest Vital Signs (NVS) was developed to be a quick and easy method to accurately assess patient literacy (Weiss et al., 2005). Prose literacy, numeracy, and document literacy are examined. NVS has 6 items, scored correct or incorrect, corresponding to the following:
0-1 (high likelihood of limited literacy), 2-3 (possibility of limited literacy) and 4-6 (adequate literacy). Chew et al. (2008) developed a system of assessing health literacy by examining “help reading”, “problems reading” and “confidence with completing forms” (p. 562), using three questions. “How often do you have someone (like a family member, friend, hospital/clinic worker or caregiver) help you read hospital materials? How often do you have problems learning about your medical condition because of difficulty understanding written information? How confident are you filling out forms by yourself?” (Chew et al., 2008, p. 562) Answer choices are ‘always, often, sometimes, occasionally, or never’. Several studies have been performed to demonstrate the validity and reliability of S-TOFHL (Baker, Williams, Parker, Gazmararian, & Nurss, 1999), REALM (Bass, Wilson & Griffith, 2003), NVS (Weiss et al., 2005; Shah, West, Bremmeyr, & Savoy-Moore, 2010) and Chew’s questionnaire (Chew et al., 2008; Wallace, Rogers, Roskos, Holiday & Weiss, 2006).

Measuring functional, communicative, and critical health literacy has not been as thoroughly examined in the literature. Only two methods have been identified in the literature. The All Aspects of Health Literacy Scale (AAHLS) was developed as a tool to measure functional, communicative, and critical health literacy in primary care settings (Chinn & McCarthy, 2013). Functional health literacy is measured via four items, communicative health literacy via three items, and critical health literacy via seven items. Chinn and McCarthy (2013) assessed a population in London, and internal consistency was measured yielding a Cronbach’s alpha of 0.75. Content validity was assessed yielding four factors and 59% of variance explained. Construct validity was also assessed. Functional health literacy was significantly associated with communicative
(r=0.393, p<0.001) and critical (r=0.59, p=0.036) health literacy. Communicative and critical health literacy were also significantly associated (r=0.186, p=0.017). The Functional Communicative Critical Health Literacy (FCCHL) scales by Ishikawa were also developed to measure functional, communicative, and critical health literacy. The FCCHL uses five items to measure functional health literacy, five items to measure communicative health literacy, and four items to measure critical health literacy. Responses range from 1 (never) to 4 (often). In Japan, internal consistency, content validity, and construct validity were assessed (Ishikawa et al., 2008). Cronbach’s alpha was 0.84 for functional, 0.77 for communicative, and 0.65 for critical health literacy. Content validity was assessed with all five functional items loading on component one, all five communicative items loading on component two, and three of four critical components loading on component three, explaining 67% of variance. In terms of construct validity, communicative health literacy was significantly associated with critical health literacy (r=0.52, p<0.001) (Ishikawa et al., 2008). Diabetes knowledge showed a positive association with total health literacy scores (r=0.37, p<0.001), functional health literacy (r=0.20, p=0.017), communicative health literacy (r=0.31, p<0.01), and critical health literacy (r=0.26, p=0.002). Functional health literacy was associated with having no diabetes complications (p=0.083), and communicative health literacy was associated with lower hemoglobin A1C (r=−0.20, p=0.020). The FCCHL will be used to assess functional, communicative, critical, and total health literacy for this research project due to its ability to assess multiple types of health literacy and previous associations with diabetes knowledge.

*Measuring Diabetes Knowledge*
Several tests used to measure diabetes knowledge were identified in the literature. The most widely used was the Diabetes Knowledge Test (DKT) designed by researchers at the Michigan Diabetes Research and Training Center. The DKT aims to measure the level of diabetes knowledge in patients with a diagnosis of diabetes. The test has 2 sections containing 23 multiple choice questions. The general section consists of 14 items and the insulin subscale consists of 9 questions. Reliability and validity were assessed in a community sample in Michigan (Fitzgerald et al., 1997). The general test had a coefficient alpha of 0.71 and the insulin subscale had a coefficient alpha of 0.75, indicating both are reasonably reliable. Criterion-related validity was assessed, and scores on each subscale increased as years of formal education and receipt of diabetes education increased (Fitzgerald et al., 1997). The Short Diabetes Knowledge Instrument (SDKI) was designed by Hodge and colleagues and aims to measure diabetes knowledge (Quandt et al., 2014). The test consists of 16 multiple choice questions. Reliability and validity were assessed in eight counties in North Carolina. Internal consistency was assessed using Cronbach’s alpha, and an alpha of 0.73 was obtained. Criterion-related validity was assessed, resulting in higher scores being related to White race, higher levels of education, and incomes exceeding the federal poverty level (Quandt et al., 2014).

The Spoken Knowledge in Low Literacy in Diabetes (SKILLD) scales was developed at The University of North Carolina and is used to “assess core patient knowledge about diabetes self-care issues, including glucose self-management, appropriate lifestyle modifications, recognition and treatment of acute complications, and appropriate activities to prevent long-term consequences of uncontrolled diabetes” (Rothman et al., 2005, p. 216). Questions are written at a 5th grade reading level as
assessed using the Flesch-Kincaid Grade Level Readability tool. The SKILLD consists of 10 open-ended questions with prompts to aid with comprehension and is administered by reading aloud. Reliability and validity were assessed in a population in North Carolina (Rothman et al., 2005). Kuder Richardson coefficient was used to assess internal consistency, and a coefficient of 0.72 was obtained. Criterion-related validity was assessed using correlation, and higher scores were related to higher levels of education, higher income, and longer duration of diabetes (Rothman et al., 2005). The SKILLD was used to assess diabetes knowledge in this research study due to its ability to assess diabetes knowledge in populations with low and adequate literacy levels.

*Measuring Glycemic Control*

Glycemic control can be measured via blood glucose or hemoglobin A1C. Blood glucose measures the level of blood sugar in the bloodstream at any one point in time (American Diabetes Association, 2015). Normal range for blood glucose is dependent on the timing of meals eaten that day. The American Diabetes Association (2015) suggests target blood glucose levels of 80-130mg/dL before meals, and less than 180mg/dL after meals. Hemoglobin A1C measures average blood glucose over a 1 to 3 month period. Hemoglobin A1C is strongly associated with risks for developing microvascular and nerve damage, which are adverse effects of uncontrolled diabetes (Michigan Diabetes Research and Training Center, 2013). The American Diabetes Association recommends a target hemoglobin A1C of 7% (American Diabetes Association, 2015). Hemoglobin A1C was used to measure glycemic control due to its non-reliance on recent meals and ability to measure glycemic control over a 1 to 3 month period. Hemoglobin A1C was measured using the A1C Now tool because it measures hemoglobin A1C with only a finger stick
and results were available in approximately 5 minutes. Patients received hemoglobin A1C results the same day it was measured.

**Self-Reported Measures**

Height, weight, income, and years with diabetes were self-reported. Height and weight were used to calculate a current BMI.

**Data Analysis**

Alpha was set at p<0.05 for all statistical analysis. Prior to performing statistical tests, presence of invalid data, presence and pattern of outliers, and amount and pattern of missing data were assessed. Assumptions of hierarchical linear regression and correlation were performed, including testing for linearity, normality, multicollinearity, and homoscedasticity. Descriptive statistics were obtained for age, race, income, education, calculated BMI, hemoglobin A1C, diabetes knowledge scores, total health literacy scores, functional health literacy scores, communicative health literacy scores, and critical health literacy scores.

The SKILLD and the FCCHL scales had not been used with a population in Mississippi. Therefore the instruments were pilot tested. Internal consistency was measured for the SKILLD using the Kuder Richardson coefficient. A score of 0.70, similar to 0.72 found in previous research was considered adequate. Internal consistency for the health literacy scale was measured using coefficient alpha. A score of 0.70 for total, functional, communicative, and critical literacy was considered adequate. This score is similar to 0.78, 0.84, 0.77, and 0.65 found for total, functional, communicative and critical health literacy respectively in previous research (Heijmans et al., 2015).

Criterion-related validity for SKILLD was assessed using bivariate correlations expecting
diabetes knowledge to be positively related to highest level of education, household income, and years with diabetes as found in previous literature (Rothman et al., 2015). Criterion-related validity for FCCHL scales was assessed using bivariate correlations expecting positive relationships with level of education and income, and a negative relationship with age as found in previous research (Heijmans et al., 2015; Kim at al., 2004).

For the research study internal consistency was measured for the SKILLD using Kuder Richardson coefficient, and internal consistency for functional health literacy, communicative health literacy, critical health literacy, and total health literacy was measured using coefficient alpha. Hierarchical linear regression was used to determine if health literacy was a moderator in the relationship between diabetes knowledge and diabetes outcomes. Assumptions for hierarchical linear regression were assessed prior to performing analysis. For the purposes of hierarchical linear regression, education was re-categorized into high school diploma or below, and greater than high school diploma; and race will be re-categorized into White and Non-White. Continuous variables were centered prior to creating interaction variable and running analyses. In Block 1 main effects for age, race, education, income, years with diabetes, and BMI were entered. In Block 2 main effects for total health literacy and diabetes knowledge were entered. In Block 3 interaction variable (total health literacy * diabetes knowledge) was entered. If interaction terms significantly added to variance explained in Block 1, significant moderation was assumed. Hierarchical linear regression was followed by structure coefficients to determine the amount of variance each independent variable explained.
To explore the relationship between functional health literacy, communicative health literacy, critical health literacy, diabetes knowledge, and diabetes outcomes, hierarchical linear regression was used. In Block 1 main effects for age, race, education, income, years with diabetes, and BMI were entered. In Block 2 main effects for functional health literacy, communicative health literacy, critical health literacy, and diabetes knowledge were entered. Hierarchical linear regression was followed by structure coefficients to determine the amount of variance each independent variable explained.
CHAPTER IV – RESULTS

The purpose of this research study was to determine if health literacy was a moderator in the relationship between diabetes knowledge and diabetes outcomes, and explore the relationships between diabetes knowledge, health literacy, and diabetes outcomes. Because the instruments used to measure diabetes knowledge and health literacy had not been used with a population in Mississippi, a pilot test was performed to determine if the instruments were valid and reliable for use with a population of adults in Mississippi with a diagnosis of diabetes. Validation and reliability testing were performed on the research data. Hierarchical linear regression was used to determine if health literacy was a moderator in the relationship among diabetes knowledge and diabetes outcomes, and to explore the relationships between functional health literacy, communicative health literacy, critical health literacy, diabetes knowledge, and diabetes outcomes.

Pilot Study

Thirty participants completed the pilot study. Data from 21 participants were used for data analysis. A total of nine participants were excluded from the pilot study because of the following reasons. Three participants did not currently reside in Mississippi. Three participants did not have a diagnosis of diabetes at any point in life. One participant reported taking anti-psychotic or anti-epileptic drugs. Two participants reported having end stage renal disease or were currently on dialysis.

All items on the functional health literacy scale were negatively worded and therefore reverse coded so the highest number reflected a higher level of functional health literacy. Frequencies were reviewed for the following variables to determine if invalid
data existed: age, race, ethnicity, highest level of education, number of years with diabetes, household income, body mass index (BMI), diabetes knowledge, total health literacy, functional health literacy total, communicative health literacy total, critical health literacy total, and most current hemoglobin A1C. Diabetes knowledge was measured using Spoken Knowledge in Low Literacy in Diabetes (SKILLD). Total health literacy was measured using Functional Communicative Critical Health Literacy (FCCHL) scales. It was determined there were no invalid values present. To determine the presence of outliers, standardized scores for age, number of years with diabetes, household income, BMI, diabetes knowledge, total health literacy, functional health literacy total, communicative health literacy total, critical health literacy total, and most current hemoglobin A1C were reviewed. It was determined all variables contained standardized scores not greater than +3 or less than -3 and there were no outliers. After omitting the data from the 9 participants who did not meet inclusion criteria there was no missing data. To determine normality of data, skewness and kurtosis values for age, number of years with diabetes, household income, BMI, diabetes knowledge, total health literacy, functional health literacy total, communicative health literacy total, critical health literacy total, and most current hemoglobin A1C were reviewed. Normality was assessed using descriptive statistics. It was determined that household income was positively skewed, age and functional health literacy scores were negatively kurtotic, and household income and total health literacy scores were positively kurtotic. See Table 1 for further details. It was determined that skewness was acceptable and no transformations were performed. Linearity of hemoglobin A1C was assessed using Q-Q plot, and hemoglobin A1C scores were assumed normal. See Figure 1 for details.
Figure 1. Pilot Study Linearity of Hemoglobin A1C

The majority of participants were African American with highest level of education of high school diploma or higher. Mean age for participants was 47.7 years (SD=16.25). Mean household income was $40,038 (SD=30,121). See Table 2 for demographic information pertaining to race and highest level of education.
Table 1

*Pilot Study Descriptive Statistics (n=21)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean Statistic</th>
<th>Std. Deviation Statistic</th>
<th>Skewness Statistic</th>
<th>Kurtosis Statistic</th>
<th>Std. Error Statistic</th>
<th>Kurtosis Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>47.71</td>
<td>16.25</td>
<td>.096</td>
<td>.50</td>
<td>-1.29</td>
<td>.97</td>
</tr>
<tr>
<td>Years with Diabetes</td>
<td>9.57</td>
<td>7.45</td>
<td>.77</td>
<td>.50</td>
<td>-.12</td>
<td>.97</td>
</tr>
<tr>
<td>Household Income</td>
<td>40,038.09</td>
<td>30,121.41</td>
<td>1.61</td>
<td>.50</td>
<td>3.33</td>
<td>.97</td>
</tr>
<tr>
<td>BMI</td>
<td>37.22</td>
<td>11.36</td>
<td>.71</td>
<td>.50</td>
<td>-.51</td>
<td>.97</td>
</tr>
<tr>
<td>Diabetes Knowledge</td>
<td>6.04</td>
<td>3.18</td>
<td>-.28</td>
<td>.50</td>
<td>-.95</td>
<td>.97</td>
</tr>
<tr>
<td>Total Health Literacy</td>
<td>2.64</td>
<td>.50</td>
<td>-.90</td>
<td>.50</td>
<td>1.14</td>
<td>.97</td>
</tr>
<tr>
<td>Functional Health Literacy</td>
<td>2.43</td>
<td>1.21</td>
<td>.27</td>
<td>.50</td>
<td>-1.69</td>
<td>.97</td>
</tr>
<tr>
<td>Communicative Health Literacy</td>
<td>2.73</td>
<td>.86</td>
<td>-.18</td>
<td>.50</td>
<td>-.33</td>
<td>.97</td>
</tr>
<tr>
<td>Critical Health Literacy</td>
<td>2.63</td>
<td>1.03</td>
<td>-.48</td>
<td>.50</td>
<td>-1.04</td>
<td>.97</td>
</tr>
<tr>
<td>Hemoglobin A1C</td>
<td>7.81</td>
<td>1.78</td>
<td>.87</td>
<td>.50</td>
<td>.10</td>
<td>.97</td>
</tr>
</tbody>
</table>
Table 2

Pilot Study Demographics (n=21)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subgroup</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race</td>
<td>White</td>
<td>7</td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td>Black or African American</td>
<td>13</td>
<td>61.9</td>
</tr>
<tr>
<td></td>
<td>American Indian or Alaskan Native</td>
<td>1</td>
<td>4.8</td>
</tr>
<tr>
<td>Highest Level of Education</td>
<td>Less than high school diploma</td>
<td>2</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td>High school diploma or equivalent</td>
<td>6</td>
<td>28.6</td>
</tr>
<tr>
<td></td>
<td>Associate’s degree or trade</td>
<td>4</td>
<td>19.0</td>
</tr>
<tr>
<td></td>
<td>Bachelor’s degree</td>
<td>5</td>
<td>23.8</td>
</tr>
<tr>
<td></td>
<td>Master’s degree or higher</td>
<td>19</td>
<td>19.0</td>
</tr>
</tbody>
</table>

Reliability testing for diabetes knowledge and total health literacy scales was performed. The diabetes knowledge scale revealed a Kuder Richardson coefficient of 0.86. This exceeded the Kuder Richardson coefficient cutoff of 0.70, and the 0.72 found in previous research (Rothman et al., 2005). Coefficient alpha for the total health literacy scale was 0.93. Coefficient alpha for functional health literacy scale was 0.96. Coefficient alpha for communicative health literacy scale was 0.86. Coefficient alpha for critical health literacy scale was 0.948. The total health literacy, functional health literacy, communicative health literacy, and critical health literacy scales exceeded the coefficient alpha cutoff of 0.70, and the scores of 0.78, 0.84, 0.77, and 0.65 found by Heijmans et al. (2015).

Validation for diabetes knowledge scale and total health literacy scale was performed. Positive relationships existed between diabetes knowledge and household income (p=0.040, r²=0.20), diabetes knowledge and highest level of education (p<0.01,
$r^2=0.53$), diabetes knowledge and number of years with diabetes ($p=0.07$, $r^2=0.006$), total health literacy and household income ($p=0.012$, $r^2=0.11$), and total health literacy and highest level of education ($p=0.07$, $r^2=0.15$). A negative relationship existed between total health literacy and age ($p=0.06$, $r^2=0.16$). See Table 3 for details.
### Table 3

**Pilot Study Bivariate Correlations (n=21)**

<table>
<thead>
<tr>
<th></th>
<th>Diabetes Knowledge</th>
<th>Total Health Literacy</th>
<th>Age</th>
<th>Household Income</th>
<th>BMI</th>
<th>Highest Level of Education</th>
<th>Years with Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes Knowledge</td>
<td>r²</td>
<td>.23*</td>
<td>.46**</td>
<td>.20*</td>
<td>.11</td>
<td>.53**</td>
<td>.006</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.02</td>
<td>.001</td>
<td>.04</td>
<td>.13</td>
<td>.000</td>
<td>.70</td>
</tr>
<tr>
<td>Total Health Literacy</td>
<td>r²</td>
<td>.23*</td>
<td>.16</td>
<td>.11</td>
<td>.01</td>
<td>.15</td>
<td>.09</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.02</td>
<td>.06</td>
<td>.123</td>
<td>.63</td>
<td>.07</td>
<td>.18</td>
</tr>
<tr>
<td>Age</td>
<td>r²</td>
<td>.46**</td>
<td>.16</td>
<td>.25*</td>
<td>.21*</td>
<td>.49**</td>
<td>.00</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.001</td>
<td>.06</td>
<td>.020</td>
<td>.03</td>
<td>&lt;.01</td>
<td>.98</td>
</tr>
<tr>
<td>Household Income</td>
<td>r²</td>
<td>.20*</td>
<td>.11</td>
<td>.25*</td>
<td>.10</td>
<td>.37**</td>
<td>.004</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.04</td>
<td>.12</td>
<td>.02</td>
<td>.13</td>
<td>.003</td>
<td>.74</td>
</tr>
<tr>
<td>BMI</td>
<td>r²</td>
<td>.11</td>
<td>.01</td>
<td>.21*</td>
<td>.10</td>
<td>.09</td>
<td>.02</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>.13</td>
<td>.63</td>
<td>.03</td>
<td>.13</td>
<td>.15</td>
<td>.0004</td>
</tr>
<tr>
<td>Highest Level of Education</td>
<td>r²</td>
<td>.53**</td>
<td>.15</td>
<td>.49**</td>
<td>.37**</td>
<td>.09</td>
<td>.02</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td>&lt;.01</td>
<td>.07</td>
<td>&lt;.001</td>
<td>.003</td>
<td>.15</td>
<td>.48</td>
</tr>
</tbody>
</table>

Note: * denotes correlation is significant at the 0.05 level (2-tailed). ** denotes correlation is significant at the 0.01 level (2-tailed). BMI is body mass index.
Research Study

Thirty-six recognized and accredited diabetes self-management training programs were contacted and invited to participate in this research study. Seven of these sites agreed to participate and were included in data analysis. Twenty sites were contacted via telephone and email a total of 5 times but did not respond. One site did not have group classes. Two sites no longer had a diabetes self-management program. Six sites declined participation.

Data Screening

All items on the functional health literacy scale were negatively worded and therefore reverse coded so the highest number reflected a higher level of functional health literacy. Using frequencies, minimum scores, and maximum scores for all study variables it was determined there were no invalid data present. To determine the presence of outliers standardized scores for number of years with diabetes, age, household income, hemoglobin A1C, BMI, diabetes knowledge, functional health literacy, communicative health literacy, critical health literacy, and total health literacy were reviewed. It was determined that age, highest level of education, SKILLD total, functional health literacy total, communicative health literacy total, critical health literacy total, and FCCHL total contained standardized scores not greater than +3 or less than -3. For number of years with diabetes, 4 participants were identified as having standardized scores greater than +3. Upon review of the data, it was determined these participants had diabetes for 30 (Z-score=3.04) to 35 (Z-score=3.69) years and the data was representative of the population. For household income, 2 scores were identified as having standardized scores greater than +3. It was determined that these participants had incomes of $144,000 (Z-
score=3.07) and $150,000 (Z-score=3.27) and were not representative of the population.

Data for these two participants was not included in any further data analysis. For hemoglobin A1C, 4 scores were identified as having standardized scores greater than +3. It was determined that these participants had hemoglobin A1Cs ranging from 11.7 (Z-score=3.28) to 12.7 (Z-score=3.96) and were representative of the population. For BMI, 2 participants were identified as having standardized scores greater than +3. Upon review of the data set, it was determined these 2 participants had BMIs of 58 (Z-score=3.31) and were not representative of the population. Data for these 2 participants was not included in any further data analysis.

Assumptions of hierarchical linear regression were tested. There was no missing data. Normality was assessed using descriptive statistics. It was determined that diabetes knowledge scores, functional health literacy scores, communicative health literacy scores, critical health literacy scores, and total health literacy scores were normally distributed due to the absence of skewness and kurtosis values greater than +1 and less than -1. Hemoglobin A1C and years with diabetes were positively skewed. Hemoglobin A1C and years with diabetes were positively kurtotic. No transformations were performed. See Table 5 for details. Linearity of hemoglobin A1C was assessed using Q-Q plot, and hemoglobin A1C scores were assumed normal. See Figure 2 for details.
A total of 127 participants completed the research project. As previously discussed, data from 4 participants were excluded from the analysis for having an income or BMI that was not being representative of the data set. Data from 123 participants was used for data analysis. Among participants, 68% were female, 99.2% were non-Hispanic, 69% were non-Hispanic White, 7.3% had less than a high school education, and 44% had a high school education or equivalent. See Table 4 for demographic information pertaining to sex, ethnicity, race, highest level of education, and hemoglobin A1C. Mean age was 58.61 (SD=14.10) and mean household income was $50,725.26 (SD=27,465.81).
Table 4

Demographics (n=123)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subgroup</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>66</td>
<td>44.7</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>68</td>
<td>55.3</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Non-Hispanic</td>
<td>122</td>
<td>99.2</td>
</tr>
<tr>
<td></td>
<td>Hispanic</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Race</td>
<td>White</td>
<td>69</td>
<td>56.1</td>
</tr>
<tr>
<td></td>
<td>Black or African</td>
<td>52</td>
<td>42.3</td>
</tr>
<tr>
<td></td>
<td>American</td>
<td>2</td>
<td>1.6</td>
</tr>
<tr>
<td>Highest Level of</td>
<td>Less than high</td>
<td>9</td>
<td>7.3</td>
</tr>
<tr>
<td>Education</td>
<td>school diploma</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High school diploma or equivalent</td>
<td>44</td>
<td>35.8</td>
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<tr>
<td></td>
<td>Associate’s degree or trade</td>
<td>34</td>
<td>27.6</td>
</tr>
<tr>
<td></td>
<td>Bachelor’s degree</td>
<td>20</td>
<td>16.3</td>
</tr>
<tr>
<td></td>
<td>Master’s degree or higher</td>
<td>16</td>
<td>13.0</td>
</tr>
<tr>
<td>Hemoglobin A1C</td>
<td>Optimal (≤7)</td>
<td>85</td>
<td>69.1</td>
</tr>
<tr>
<td></td>
<td>Elevated (&gt;7)</td>
<td>38</td>
<td>30.9</td>
</tr>
</tbody>
</table>

Study Variables

Mean years with diabetes was 6.38 (SD=7.14). Mean hemoglobin A1C was 6.81 (SD=1.42). Mean BMI was 32.93 (SD=7.01). Mean diabetes knowledge score was 6.56 (SD=2.08). Mean total health literacy score was 2.91 (SD=0.60). Mean functional health literacy score was 3.05 (SD=0.76). Mean communicative health literacy score was 2.90 (SD=0.72). Mean critical health literacy score was 2.74 (SD=0.75). See Table 6 for bivariate correlations among independent and dependent variables.
Table 5

**Descriptive Statistics (n=123)**

<table>
<thead>
<tr>
<th></th>
<th>Mean Statistic</th>
<th>Std. Deviation Statistic</th>
<th>Skewness Statistic</th>
<th>Std. Error Statistic</th>
<th>Kurtosis Statistic</th>
<th>Std. Error Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years with Diabetes</td>
<td>6.38</td>
<td>7.14</td>
<td>1.50</td>
<td>.21</td>
<td>2.91</td>
<td>.43</td>
</tr>
<tr>
<td>Age</td>
<td>58.61</td>
<td>14.10</td>
<td>-.44</td>
<td>.21</td>
<td>-.267</td>
<td>.43</td>
</tr>
<tr>
<td>Household Income</td>
<td>50,725.26</td>
<td>27,465.81</td>
<td>.21</td>
<td>.21</td>
<td>-1.03</td>
<td>.43</td>
</tr>
<tr>
<td>Hemoglobin A1C</td>
<td>6.81</td>
<td>1.42</td>
<td>1.56</td>
<td>.21</td>
<td>3.65</td>
<td>.43</td>
</tr>
<tr>
<td>BMI</td>
<td>32.93</td>
<td>7.01</td>
<td>.28</td>
<td>.21</td>
<td>-.80</td>
<td>.43</td>
</tr>
<tr>
<td>Diabetes Knowledge</td>
<td>6.56</td>
<td>2.08</td>
<td>-.98</td>
<td>.21</td>
<td>.86</td>
<td>.43</td>
</tr>
<tr>
<td>Functional total</td>
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<td>.76</td>
<td>-.92</td>
<td>.21</td>
<td>.62</td>
<td>.43</td>
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<tr>
<td>Communicative total</td>
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<td>.72</td>
<td>-.07</td>
<td>.21</td>
<td>-.68</td>
<td>.43</td>
</tr>
<tr>
<td>Critical total</td>
<td>2.74</td>
<td>.75</td>
<td>-.19</td>
<td>.21</td>
<td>-.35</td>
<td>.43</td>
</tr>
<tr>
<td>Total Health Literacy</td>
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<td>.21</td>
<td>-.43</td>
<td>.43</td>
</tr>
</tbody>
</table>

Note: BMI is body mass index.
Table 6

Bivariate Correlations Among Variables, $r^2$ (n=123)

<table>
<thead>
<tr>
<th></th>
<th>Race</th>
<th>Education</th>
<th>Age</th>
<th>Income</th>
<th>Years with Diabetes</th>
<th>BMI</th>
<th>Total Health Literacy</th>
<th>Diabetes Knowledge</th>
<th>Functional Health Literacy</th>
<th>Communicative Health Literacy</th>
<th>Critical Health Literacy</th>
<th>Hemoglobin A1C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race</td>
<td>&lt;.001</td>
<td>.10**</td>
<td>.03*</td>
<td>.04*</td>
<td>.05**</td>
<td>.01</td>
<td>.01</td>
<td>&lt;.001</td>
<td>.03*</td>
<td>.06**</td>
<td>.06**</td>
<td>.005</td>
</tr>
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<td>Education</td>
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<td>.11**</td>
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</tr>
<tr>
<td>Age</td>
<td>.10**</td>
<td>.01</td>
<td>.02</td>
<td>.09**</td>
<td>.06**</td>
<td>.04*</td>
<td>.03*</td>
<td>.07**</td>
<td>.001</td>
<td>.05*</td>
<td>&lt;.001</td>
<td>.02</td>
</tr>
<tr>
<td>Income</td>
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<td>.11**</td>
<td>.02</td>
<td>.03*</td>
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<td>.06**</td>
<td>.11**</td>
<td>.14**</td>
<td>.008</td>
<td>.01</td>
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<td>.02</td>
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<td>.05**</td>
<td>.09**</td>
<td>.032*</td>
<td>.01</td>
<td>.03*</td>
<td>.001</td>
<td>&lt;.01</td>
<td>.06**</td>
<td>.05*</td>
<td>.02</td>
<td>.02</td>
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<td>.05**</td>
<td>&lt;.01</td>
<td>&lt;.01</td>
<td>&lt;.01</td>
<td>.02</td>
</tr>
<tr>
<td>Total Health Literacy</td>
<td>.01</td>
<td>.13**</td>
<td>.04*</td>
<td>.06**</td>
<td>.03*</td>
<td>.009</td>
<td>.20**</td>
<td>.54**</td>
<td>.71**</td>
<td>.71**</td>
<td>.99**</td>
<td>.02</td>
</tr>
<tr>
<td>Diabetes Knowledge</td>
<td>.02</td>
<td>.04*</td>
<td>.03*</td>
<td>.11**</td>
<td>.001</td>
<td>&lt;.01</td>
<td>.20**</td>
<td>.15**</td>
<td>.13**</td>
<td>.11**</td>
<td>.08**</td>
<td>.03</td>
</tr>
<tr>
<td>Interaction Variable</td>
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<td>.005</td>
<td>&lt;.01</td>
<td>.09**</td>
<td>.07**</td>
<td>&lt;.01</td>
<td>.02</td>
<td>.15**</td>
<td>.09**</td>
<td>&lt;.01</td>
<td>.002</td>
<td>.04*</td>
</tr>
<tr>
<td>Functional Health Literacy</td>
<td>&lt;.001</td>
<td>.13**</td>
<td>.07**</td>
<td>.14**</td>
<td>&lt;.01</td>
<td>.05**</td>
<td>.54**</td>
<td>.15**</td>
<td>.11**</td>
<td>.13**</td>
<td>.99**</td>
<td></td>
</tr>
<tr>
<td>Communicative Health Literacy</td>
<td>.03*</td>
<td>.06**</td>
<td>.001</td>
<td>.008</td>
<td>.06**</td>
<td>&lt;.01</td>
<td>.71**</td>
<td>.13**</td>
<td>.11**</td>
<td>.54**</td>
<td>.03*</td>
<td></td>
</tr>
<tr>
<td>Critical Health Literacy</td>
<td>.01</td>
<td>.06**</td>
<td>.05*</td>
<td>.01</td>
<td>.05*</td>
<td>&lt;.01</td>
<td>.71**</td>
<td>.11**</td>
<td>.13**</td>
<td>.54**</td>
<td>.05*</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin A1C</td>
<td>.005</td>
<td>.06**</td>
<td>&lt;.01</td>
<td>.05**</td>
<td>.02</td>
<td>.02</td>
<td>.09**</td>
<td>.08**</td>
<td>.09**</td>
<td>.03*</td>
<td>.05*</td>
<td></td>
</tr>
</tbody>
</table>

Note: * denotes correlation is significant at the 0.05 level (2-tailed). ** denotes correlation is significant at the 0.01 level (2-tailed). BMI is body mass index.
Validity and Reliability Testing

Validity was assessed using bivariate correlations. Statistically significant positive relationships existed between diabetes knowledge and total health literacy (p<0.01), diabetes knowledge and household income (p<0.01), diabetes knowledge and highest level of education (p=0.01), total health literacy and household income (p=0.004), and total health literacy and highest level of education (p<0.01). Statistically significant negative relationships existed between diabetes knowledge and age (p=0.04) and total health literacy and age (p=0.01). A negative relationship existed between total health literacy and BMI (p=0.28) but this relationship was not statistically significant. See Table 7 for details.
Table 7

**Bivariate Correlations**

<table>
<thead>
<tr>
<th></th>
<th>Diabetes knowledge</th>
<th>Total health literacy</th>
<th>Household Income</th>
<th>Highest Level of Education</th>
<th>Age</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes knowledge</td>
<td>r²</td>
<td>.20**</td>
<td>.11**</td>
<td>.04*</td>
<td>.03*</td>
<td>.0004</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>&lt;.01</td>
<td>&lt;.01</td>
<td>.01</td>
<td>.04</td>
<td>.79</td>
</tr>
<tr>
<td>Total health literacy</td>
<td>r²</td>
<td>.20**</td>
<td>.06**</td>
<td>.12**</td>
<td>.04*</td>
<td>.008</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>&lt;.01</td>
<td>.004</td>
<td>&lt;.01</td>
<td>.01</td>
<td>.28</td>
</tr>
<tr>
<td>Household Income</td>
<td>r²</td>
<td>.11**</td>
<td>.06**</td>
<td>.11**</td>
<td>.02</td>
<td>.003</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>&lt;.01</td>
<td>.004</td>
<td>&lt;.01</td>
<td>.06</td>
<td>.47</td>
</tr>
<tr>
<td>Highest Level of</td>
<td>r²</td>
<td>.04*</td>
<td>.12**</td>
<td>.11**</td>
<td>.01</td>
<td>.003</td>
</tr>
<tr>
<td>Education</td>
<td>Sig. (2-tailed)</td>
<td>.01</td>
<td>&lt;.01</td>
<td>&lt;.01</td>
<td>.17</td>
<td>.46</td>
</tr>
<tr>
<td>Age</td>
<td>r²</td>
<td>.03*</td>
<td>.04*</td>
<td>.02</td>
<td>.01</td>
<td>.06**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.041</td>
<td>.06</td>
<td>.17</td>
<td>.003</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>r²</td>
<td>.0004</td>
<td>.008</td>
<td>.003</td>
<td>.003</td>
<td>.06**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.79</td>
<td>.28</td>
<td>.47</td>
<td>.46</td>
<td>.003</td>
</tr>
</tbody>
</table>

Note: * denotes correlation is significant at the 0.05 level (2-tailed). ** denotes correlation is significant at the 0.01 level (2-tailed). BMI is body mass index.
Reliability was measured via internal consistency. The diabetes knowledge scale revealed a Kuder Richardson coefficient of 0.58. Coefficient alpha for the total health literacy scale was 0.89. Coefficient alpha for functional health literacy scale was 0.86. Coefficient alpha for communicative health literacy scale was 0.83. Coefficient alpha for critical health literacy scale was 0.84. See Table 8 for further details.

Table 8

<table>
<thead>
<tr>
<th>Scale</th>
<th>Coefficient Alpha</th>
<th>Kuder Richardson Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes knowledge</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>Total health literacy</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>Functional health literacy</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>Communicative health literacy</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Critical health literacy</td>
<td></td>
<td>0.84</td>
</tr>
</tbody>
</table>

Health Literacy as a Moderator

A hierarchical linear regression was performed to determine if health literacy was a moderator in the relationship between diabetes knowledge and diabetes outcomes. A three stage hierarchical linear regression was used to predict hemoglobin A1C. Highest level of education was recoded into high school diploma or below and greater than high school education. Race was recoded into White and non-White. Hemoglobin A1C was recoded into optimal (≤7) and elevated (>7). The reference groups for highest level of education and race were high school diploma or below and White. Using a scatterplot of
residual and predicted values, homoscedasticity was assumed. See Figure 3 for details. Using a histogram of residual values, normality of residuals was assumed. See Figure 4 for details. The following variables were centered to reduce multicollinearity: age, income, years with diabetes, BMI, FCCHL total, and SKILLD total. Multicollinearity was assessed by reviewing Tolerance scores. Absence of multicollinearity was assumed due to lack of scores at or below 0.60. An interaction term was created by multiplying FCCHL total by SKILLD total. Ages, income, years with diabetes, BMI, race, and education were entered as covariates in block 1. Total health literacy (FCCHL total) and diabetes knowledge (SKILLD total) were entered in block 2. The interaction variable (health literacy * diabetes knowledge) was entered in block 3.
Figure 3. Homoscedasticity
Results of the hierarchical linear regression analysis are shown in Tables 10 and 11. Age, income, years with diabetes, BMI, race, and education entered into block 1 were statistically significant covariates, $F(6, 116) = 4.30$, $p=.001$. When health literacy and diabetes knowledge were added to block 2, the change in $r^2$ was statistically significant, $F(2, 114) = 16.09$, $p<.001$. For block 3, when the interaction variable was added, the change in $r^2$ was not statistically significant, $F(1, 113) = .00$, $p=.963$. See Table 9 for details. In block 3, the strongest predictors of hemoglobin A1C were total health literacy, followed by years with diabetes and diabetes knowledge. Total health literacy was associated with a standardized coefficient of -0.42, meaning every point increase in
total health literacy score was associated with a predicted 0.42 decrease in hemoglobin A1C. Years with diabetes was associated with a standardized coefficient of 0.39 meaning each year increase in number of years with diabetes was associated with a predicted 0.39 increase in hemoglobin A1C. Diabetes knowledge was associated with a standardized coefficient of -0.14, meaning every point increase in diabetes knowledge scores was associated with a predicted 0.14 decrease in hemoglobin A1C. See Table 10 for standardized coefficients for all variables.

Table 9

*Model Summary (n=123)*

<table>
<thead>
<tr>
<th>Block</th>
<th>R Square</th>
<th>R Square Change</th>
<th>F Change</th>
<th>Sig F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.18</td>
<td>.18</td>
<td>4.30</td>
<td>.001</td>
</tr>
<tr>
<td>2</td>
<td>.36</td>
<td>.18</td>
<td>16.09</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>3</td>
<td>.36</td>
<td>.00</td>
<td>.00</td>
<td>.963</td>
</tr>
</tbody>
</table>
Table 10

Coefficients (n=123)

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficient (B)</th>
<th>Standardized Coefficient (Beta)</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>.33</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Age</td>
<td>.003</td>
<td>.07</td>
<td>.42</td>
</tr>
<tr>
<td>Income</td>
<td>-3.30</td>
<td>-.19</td>
<td>.04</td>
</tr>
<tr>
<td>Years with Diabetes</td>
<td>.01</td>
<td>.28</td>
<td>.003</td>
</tr>
<tr>
<td>BMI</td>
<td>.01</td>
<td>.18</td>
<td>.04</td>
</tr>
<tr>
<td>Race</td>
<td>.06</td>
<td>.06</td>
<td>.51</td>
</tr>
<tr>
<td>Education</td>
<td>-.10</td>
<td>-.10</td>
<td>.23</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>.30</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Age</td>
<td>-.004</td>
<td>-.12</td>
<td>.20</td>
</tr>
<tr>
<td>Income</td>
<td>-1.46</td>
<td>-.08</td>
<td>.32</td>
</tr>
<tr>
<td>Years with Diabetes</td>
<td>.02</td>
<td>.39</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>BMI</td>
<td>.008</td>
<td>.12</td>
<td>.12</td>
</tr>
<tr>
<td>Race</td>
<td>-.01</td>
<td>-.01</td>
<td>.89</td>
</tr>
<tr>
<td>Education</td>
<td>.01</td>
<td>.01</td>
<td>.84</td>
</tr>
<tr>
<td>Total Health Literacy</td>
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<td>-.42</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Diabetes Knowledge</td>
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<td>-.14</td>
<td>.11</td>
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<td>(Constant)</td>
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<td>&lt;.01</td>
</tr>
<tr>
<td>Age</td>
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<td>-.12</td>
<td>.21</td>
</tr>
<tr>
<td>Income</td>
<td>-1.47</td>
<td>-.08</td>
<td>.32</td>
</tr>
<tr>
<td>Years with Diabetes</td>
<td>.02</td>
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</tr>
<tr>
<td>BMI</td>
<td>.008</td>
<td>.12</td>
<td>.12</td>
</tr>
<tr>
<td>Race</td>
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<td>-.01</td>
<td>.90</td>
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<tr>
<td>Education</td>
<td>.01</td>
<td>.01</td>
<td>.84</td>
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<tr>
<td>Total Health Literacy</td>
<td>-.33</td>
<td>-.42</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Diabetes Knowledge</td>
<td>-.03</td>
<td>-.14</td>
<td>.13</td>
</tr>
<tr>
<td>Interaction Variable</td>
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<td>-.004</td>
<td>.96</td>
</tr>
</tbody>
</table>

Note: * denotes correlation is significant at the 0.05 level (2-tailed). ** denotes correlation is significant at the 0.01 level (2-tailed).

BMI is body mass index.
Structure coefficients were performed to determine the amount of variance each independent variable explained in hemoglobin A1C scores. Bivariate correlations were performed between unstandardized predicted variables and age, income, years with diabetes, BMI, total health literacy, and diabetes knowledge. The greatest amount of variance in hemoglobin A1C scores was explained by total health literacy ($r^2=0.49$), followed by diabetes knowledge ($r^2=0.28$), income ($r^2=0.22$), years with diabetes ($r^2=0.21$), and the income ($r^2=0.22$). See Table 11 for details.

Table 11

**Structure Coefficients (n=123)**

<table>
<thead>
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<th>Variable</th>
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<tbody>
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</tr>
<tr>
<td>Income</td>
<td>0.22**</td>
</tr>
<tr>
<td>Years with Diabetes</td>
<td>0.21**</td>
</tr>
<tr>
<td>Race</td>
<td>0.01</td>
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<tr>
<td>BMI</td>
<td>0.04*</td>
</tr>
<tr>
<td>Highest Level of Education</td>
<td>0.02</td>
</tr>
<tr>
<td>Total Health Literacy</td>
<td>0.49**</td>
</tr>
<tr>
<td>Diabetes Knowledge</td>
<td>0.28**</td>
</tr>
<tr>
<td>Health Literacy * Diabetes Knowledge</td>
<td>0.16**</td>
</tr>
<tr>
<td>Unstandardized Predicted Value</td>
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</tr>
</tbody>
</table>

Note: * denotes correlation is significant at the 0.05 level (2-tailed). ** denotes correlation is significant at the 0.01 level (2-tailed).

BMI is body mass index.

Functional, Communicative, and Critical Health Literacy

A hierarchical linear regression was performed to explore the relationship between functional health literacy, communicative health literacy, critical health literacy, diabetes knowledge, and diabetes outcomes. Functional health literacy, communicative health literacy, critical health literacy, and diabetes knowledge were used to predict diabetes outcomes in the form of hemoglobin A1C. Functional health literacy,
communicative health literacy, and critical health literacy were centered to reduce multicollinearity. Age, income, years with diabetes, race, and education were entered as covariates in block 1. Functional health literacy, communicative health literacy, critical health literacy, and diabetes knowledge were entered in block 2.

Age, income, years with diabetes, race, and education entered into block 1 were statistically significant covariates, F(6, 116) = 4.30, p=.001. When functional health literacy, communicative health literacy, critical health literacy, and diabetes knowledge were added to the second block the change in $r^2$ was statistically significant, F(4,112)=8.60, p<.001. The model explained a total 37% of variance, and the weighted combination of the predictor variables in block 2 explained 19% of total variance in hemoglobin A1C ($r^2=0.37$, $r^2$ change= 0.19). See Table 12 for the model summary. The standardized regression coefficients are shown in Table 13. Hemoglobin A1C was primarily predicted by years with diabetes followed by critical health literacy, BMI, and diabetes knowledge. Years with diabetes was associated with a partial regression coefficient of 0.42 meaning every point increase in the number of years a participant had diabetes was associated with a predicted 0.42 increase in hemoglobin A1C. Critical health literacy was associated with a partial regression coefficient of -0.28 meaning every point increase in critical health literacy scores was associated with a predicted 0.28 decrease in hemoglobin A1C scores. BMI was associated with a partial regression coefficient of 0.16 meaning every point increase in BMI was associated with a predicted 0.16 increase in hemoglobin A1C. Diabetes knowledge was associated with a
standardized coefficient of -.15 meaning every point increase in diabetes knowledge scores was associated with a .15 decrease in hemoglobin A1C.

Table 12

*Model Summary (n=123)*

<table>
<thead>
<tr>
<th>Block</th>
<th>R Square</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R Square Change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F Change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sig F Change</td>
</tr>
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<td>.18</td>
<td>.18</td>
</tr>
<tr>
<td></td>
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<tr>
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<td></td>
<td>.001</td>
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<td>.19</td>
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<tr>
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</tr>
</tbody>
</table>

Table 13

*Coefficients (n=123)*

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficient (B)</th>
<th>Standardized Coefficient (Beta)</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>1</td>
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<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>Age -.003 -.07 .42</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Income -3.30 -.19 .04</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Years with Diabetes .01 .28 .003</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BMI .01 .18 .04</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Race .06 .06 .51</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Education -.100 -.10 .23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(Constant) .33</td>
<td></td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>Age -.004 -.12 .19</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Income -1.98 -.11 .20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Years with Diabetes .02 .42 .01</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BMI .01 .16 .06</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Race -.04 -.04 .60</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Education -.01 -.01 .85</td>
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</tr>
<tr>
<td></td>
<td>Diabetes Knowledge -.03 -.15 .08</td>
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</tr>
<tr>
<td></td>
<td>Functional Health Literacy -.04-.07 .48</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Communicative Health Literacy -.09-.14 .23</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Critical Health Literacy -.17-.28 .02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Structure coefficients were used to determine the amount of variance functional health literacy, communicative health literacy, and critical health literacy explained.

Bivariate correlations were performed between unstandardized predicted variables and age, income, years with diabetes, BMI, functional health literacy, communicative health literacy, critical health literacy, and diabetes knowledge. The greatest amount of variance in the model was explained by functional health literacy ($r^2=.45$), followed by diabetes knowledge ($r^2=.28$), communicative health literacy ($r^2=.26$), and critical health literacy ($r^2=.24$). See Table 14 for details.

Table 14

*Structure Coefficients (n=123)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.03*</td>
</tr>
<tr>
<td>Income</td>
<td>.22**</td>
</tr>
<tr>
<td>Years with Diabetes</td>
<td>.21**</td>
</tr>
<tr>
<td>BMI</td>
<td>.04*</td>
</tr>
<tr>
<td>Race</td>
<td>.01</td>
</tr>
<tr>
<td>Highest Level of Education</td>
<td>.02</td>
</tr>
<tr>
<td>Diabetes Knowledge</td>
<td>.28**</td>
</tr>
<tr>
<td>Functional Health Literacy</td>
<td>.45**</td>
</tr>
<tr>
<td>Communicative Health Literacy</td>
<td>.26**</td>
</tr>
<tr>
<td>Critical Health Literacy</td>
<td>.24**</td>
</tr>
</tbody>
</table>

Summary

A pilot test was performed to determine if SKILLD and FCCHL were valid and reliable tools capable of measuring diabetes knowledge and health literacy in a population of adults in Mississippi with a diagnosis of diabetes. Kuder Richardson coefficient was used to measure internal consistency of SKILLD. Coefficient alpha was
used to measure internal consistency of FCCHL. Bivariate correlations were used to determine criterion-related validity for both instruments.

In the research study, Kuder Richardson coefficient κ was used to determine internal consistency for SKILLD, and coefficient alpha was used to determine internal consistency for FCCHL. Bivariate correlations were used to determine criterion-related validity for both instruments. Hierarchical linear regression was used to determine if health literacy was a moderator in the relationship between diabetes knowledge and diabetes outcomes. Hierarchical linear regression revealed covariates within Block 1 including age, income, years with diabetes, BMI, race, and highest level of education explained 18% of the variance in the model and was statistically significant (p=.001). In Block 2 when total health literacy and diabetes knowledge was added to the model, an added 18% of variance was added and the model remained statistically significant (p<.01). In Block 3 when the intervention term was added to the model, no further variance was explained and the model was no longer statistically significant (p=.96). Structure coefficients were performed to determine the amount of variance each variable explained in the model. Hierarchical linear regression was performed to determine the relationship between functional health literacy, communicative health literacy, critical health literacy, diabetes knowledge, and diabetes outcomes. Structure coefficients were performed to determine the amount of variance explained by each variable in the model. The following chapter will discuss the results found and relationships to previous research and theoretical foundations.
CHAPTER V – DISCUSSION

The purpose of this research study was to determine if health literacy was a moderator in the relationship between diabetes knowledge and diabetes outcomes and explore the relationship between diabetes knowledge, health literacy, and diabetes outcomes. A pilot test was performed to determine if the instruments were valid and reliable for use with a population of adults in Mississippi with a diagnosis of diabetes. In the research study, validation and reliability testing were performed. Hierarchical linear regression was used to determine if health literacy was a moderator in the relationship between diabetes knowledge and diabetes outcomes, and to explore the relationships between functional health literacy, communicative health literacy, critical health literacy, diabetes knowledge, and diabetes outcomes. The current chapter will be used to discuss the results mentioned in Chapter IV.

Pilot Study

Reliability and validity estimates for the diabetes knowledge scale and total health literacy scales were performed via pilot study to ensure these tools were capable of measuring diabetes knowledge and health literacy in a population of Mississippi adults with diabetes. The diabetes knowledge scale revealed a Kudar Richardson coefficient of 0.865 which exceeded the threshold of 0.70, and was higher than the Kudar Richardson of 0.72 found by Rothman et al. (2005). This implies SKILLD may be a reliable method of measuring diabetes knowledge in a population of adults in Mississippi with diabetes. Criterion-related validity for the diabetes knowledge scale was assessed using bivariate correlations expecting diabetes knowledge to be positively related to highest level of
education, income, and years with diabetes as found by Rothman et al. (2005). Positive relationships were found between the diabetes knowledge scale and the following variables: household income, highest level of education, and years with diabetes. These findings were similar to those of Rothman et al. (2005) in which higher scores were related to higher levels of education and higher income. This implies SKILLD may be a valid method of measuring diabetes knowledge in a population of adults in Mississippi with diabetes.

The FCCHL scales received a coefficient alpha of 0.94 which exceeded the threshold of 0.70, and was higher than the coefficient alpha of 0.78 found by Heijmans et al. (2015). The functional health literacy, communicative health literacy, and critical health literacy scales received coefficient alphas of 0.96, 0.86, and 0.94, exceeding the threshold of 0.70. The functional health literacy, communicative health literacy, and critical health literacy scales exceeded the scores of 0.84, 0.77, and 0.65 found by Heijmans et al. (2015). This implied FCCHL may be a reliable method of measuring total health literacy, functional health literacy, communicative health literacy, and critical health literacy for a population of adults in Mississippi with diabetes. Criterion-related validity for total health literacy was assessed using bivariate correlations expecting positive relationships with highest level of education and income, and a negative relationship with age. Positive relationships were found between total health literacy and household income and highest level of education, and a negative relationship was found between total health literacy and age. These findings were similar to those found in previous literature (Heijmans et al., 2015; Kim et al., 2004).
Validation and Reliability Testing of Instruments in Actual Research Study

In order to ensure the instruments used to measure diabetes knowledge and health literacy were valid and reliable for the population being measured, validation and reliability testing were performed. Criterion-related validity was tested using bivariate correlations. As found in previous research (Fenwick et al., 2013; Rothman et al., 2005), diabetes knowledge measured using SKILLD scale was positively associated with household income and highest level of education. This implied SKILLD may be a valid method of measuring diabetes knowledge in a population of adult Mississippians with diabetes. Total health literacy measured using FCCHL total was positively associated with household income and highest level of education, and negatively associated with age. Previous research by Kim et al. (2004) and Heijmans et al. (2015) found similar results. This implied FCCHL may be a valid method of measuring health literacy in a population of adult Mississippians with diabetes.

Internal consistency was used to determine if the instruments used to measure diabetes knowledge and health literacy were reliable. Using Kuder Richardson coefficient, SKILLD scored 0.58 which was lower than the cutoff score of 0.70 and lower than a score of 0.72 (Rothman et al., 2005) found in previous research. This implied SKILLD may not be a reliable method of measuring diabetes knowledge in a population of adult Mississippians with a diagnosis of diabetes. However findings from Garcia, Zuniga, Reynolds, Cairampoma, and Sumlin (2015) revealed a Kuder Richardson coefficient of 0.64 which was similar to findings of this research study, implying the SKILLD may be reliable in measuring diabetes knowledge in a population of adult
Mississippians with a diagnosis of diabetes. The relatively low Kuder Richardson coefficient may be the result of the study population having relatively high diabetes knowledge. Mean diabetes knowledge score for the current research study was 6.56 compared to 6.08 and 5.20 found in previous research (Jeppensen et al., 2011; Garcia et al., 2015). Using coefficient alpha, FCCHL total scored 0.89, functional health literacy scored 0.86, communicative health literacy scored 0.83, and critical health literacy scored 0.84. These scores exceeded the cutoff of 0.70 and were higher than scores of 0.78, 0.84, 0.77, and 0.65 found in previous research (Heijmans et al., 2015). This implied FCCHL may be a reliable method of measuring total health literacy, functional health literacy, communicative health literacy, and critical health literacy in a population of adult Mississippians with a diagnosis of diabetes.

Determining Adequate Levels of Diabetes Knowledge and Health Literacy

Cutoff scores that determine adequate or inadequate diabetes knowledge and health literacy have not been established for the SKILLD or FCCHL scales. Therefore it is imperative to compare findings to scores found in previous research. Mean diabetes knowledge score for the current research study was 6.56 (SD=2.08). This is higher than the means of 6.08 (SD=1.08) found by Jeppensen et al. (2011) in Ohio, and 5.20 (SD=2.18) found by Garcia et al. (2015) in Texas. This presents evidence suggesting adults in Mississippi with a diagnosis of diabetes may have adequate levels of diabetes knowledge.

In the current research study mean total health literacy score was 2.91 (SD=0.60), mean functional health literacy score was 3.05 (SD=0.76), mean communicative health
literacy score was 2.90 (SD=0.72), and mean critical health literacy score was 2.74 (SD=0.75). In Japan, mean total health literacy score was 3.39 (SD=0.75), mean functional health literacy score was 3.19 (SD=1.12), mean communicative health literacy was 2.43 (SD=1.04), and mean critical health literacy score was 1.96 (SD=0.63) (Ishikawa et al., 2008). In Singapore, mean total health literacy score was 2.99 (SD=0.5), mean functional health literacy score was 2.79 (SD=0.8), mean communicative health literacy score was 3.04 (SD=0.7), and mean critical health literacy score was 3.17 (SD=0.6) (Lai et al., 2013). In the Netherlands, mean total health literacy score was 3.0 (SD=0.6), mean functional health literacy score was 3.2 (SD=0.7), mean communicative health literacy score was 3.10 (SD=0.7), and mean critical health literacy score was 2.7 (SD=0.8) (Heijman et al., 2015). This implies that total health literacy among Mississippians with diabetes is less than levels found in other countries. Functional health literacy, communicative health literacy, and critical health literacy among Mississippians with diabetes is similar to levels found in other countries.

Health Literacy as a Moderator

Hierarchical linear regression was used to determine if health literacy was a moderator in the relationship between diabetes knowledge and diabetes outcomes. In Block 1, the covariates age, income, years with diabetes, race, and education were statistically significant meaning a relationship existed between the independent and dependent variables. In Block 2, the predictor variables total health literacy and diabetes knowledge were statistically significant meaning a relationship existed between the dependent and independent variables. In Block 3, the interaction variable was not
statistically significant meaning a relationship did not exist between the independent and dependent variables. Because an adequate amount of statistical or practical significance did not exist when the interaction variable was added to the model, it is assumed that health literacy is not a moderator in the relationship between diabetes knowledge and diabetes outcomes. While health literacy was not a moderator in the relationship between diabetes knowledge and diabetes outcomes, further analysis revealed the importance of health literacy as an independent predictor for diabetes outcomes in the form of hemoglobin A1C.

Exploring Diabetes Outcomes

When predicting diabetes outcomes using total health literacy, diabetes knowledge, and an interaction variable (health literacy * diabetes knowledge), the strongest predictor in the regression model was total health literacy, followed by years with diabetes, diabetes knowledge, age and BMI, income, race and education, and finally health literacy * diabetes knowledge. Structure coefficients were used to determine the amount of variance each independent variable explained in diabetes outcomes in the form of hemoglobin A1C scores. The greatest amount of variance was explained by total health literacy ($r^2=.49$), followed by diabetes knowledge ($r^2=.28$), income ($r^2=.22$), years with diabetes ($r^2=.21$), health literacy * diabetes knowledge ($r^2=.17$), BMI ($r^2=.04$), age ($r^2=.03$), highest level of education ($r^2=.02$), and race ($r^2=.03$). This implies that of the variables in the model, total health literacy played the most vital role in determining a participant’s diabetes outcomes, followed by diabetes knowledge. Of the socioeconomic
variables, income played the largest role in determining diabetes outcomes followed by age and race.

In order to determine the relationship between functional health literacy, communicative health literacy, critical health literacy, diabetes knowledge, and diabetes outcomes a hierarchical linear regression was performed. In Block 1 the covariates age, income, years with diabetes, race, and education were statistically significant meaning a relationship existed between the independent and dependent variables. In Block 2 the predictor variables functional health literacy, communicative health literacy, critical health literacy, and diabetes knowledge were statistically significant meaning a relationship existed between the independent and dependent variables. The strongest predictor in the regression model was years with diabetes, followed by critical health literacy, BMI, diabetes knowledge, communicative health literacy, age, income, functional health literacy, race, and education. Structure coefficients were used to determine the amount of variance each independent variable explained in hemoglobin A1C scores. The greatest amount of variance was explained by functional health literacy ($r^2=.45$), followed by diabetes knowledge ($r^2=0.28$), communicative health literacy ($r^2=.26$), critical health literacy ($r^2=.24$), income ($r^2=.22$), years with diabetes ($r^2=.21$), BMI ($r^2=.04$), age ($r^2=.03$), highest level of education ($r^2=.02$), and race ($r^2=.01$). This implies that of the variables in the model, functional health literacy played the largest role in determining diabetes outcomes. This was followed by diabetes knowledge, communicative health literacy, and critical health literacy.
Exploring Diabetes Knowledge

Review of the structure coefficients from hierarchical linear regression models revealed diabetes knowledge explained a statistically and practically significant ($p<.01$, $r^2=.28$) amount of variance in diabetes outcomes. The SKILLD tool has been used in previous research to assess diabetes knowledge. Guler and Oguz (2011) found a statistically significant relationship between diabetes knowledge and education level ($p<.0001$). Rothman et al. (2005) found statistically significant positive relationships between diabetes knowledge and income ($p<.05$) and education level ($p<.0001$). Garcia et al. (2014) found statistically and practically significant relationships between diabetes knowledge and hemoglobin A1C ($p=.03$, $r^2=.08$) and years with diabetes ($p<.001$, $r^2=.22$).

In the current research study, diabetes knowledge had statistically and practically significant relationships with several variables within the model. Upon examination of bivariate correlations, it was determined diabetes knowledge had statistically and practically significant positive relationships with total health literacy ($p<.01$, $r^2=.20$), functional health literacy ($p<.01$, $r^2=.15$), communicative health literacy ($p<.01$, $r^2=.13$), critical health literacy ($p<.001$, $r^2=.08$), household income ($p<.01$, $r^2=.11$), and highest level of education ($p=.01$, $r^2=.04$). A statistically and practically significant negative relationship existed between diabetes knowledge and the following variables: age ($p=.04$, $r^2=.03$) and hemoglobin A1C ($p=.002$, $r^2=.08$). This implies that as total health literacy, functional health literacy, communicative health literacy, critical health literacy, household income, and highest level of education increase diabetes knowledge increases.
This also implies that as age and hemoglobin A1C increases diabetes knowledge decreases.

Exploring Total Health Literacy

Review of the structure coefficients from hierarchical linear regression models revealed total health literacy explained a statistically and practically significant (p<.01, r²=.28) amount of variance in diabetes outcome scores. The FCCHL tool has been used in previous research to measure total health literacy. Lai et al. (2013) found a statistically significant relationship between total health literacy and education. Ishakawa et al. (2008) found a statistically and practically significant relationship between total health literacy and diabetes knowledge (p<.001, r²=.13), and statistically significant relationships between total health literacy and education (p=.006) and economic status (p=.01). Heijman et al. (2015) found statistically and practically significant relationship between total health literacy and age (p<.001), r²=.08) and illness duration (p<.01, r²=.01), and statistically significant relationships between total health literacy and education level (p<.001) and income (p<.001).

In the current research study total health literacy was related to several other variables. Upon examination of bivariate correlations total health literacy had a statistically and practically significant relationship with diabetes knowledge (p<.01, r²=.20), functional health literacy (p<.01, r²=.54), communicative health literacy (p<.01, r²=.71), and critical health literacy (p<.01, r²=.71), highest level of education (p<.01, r²=.13), income (p=004, r²=.06), and years with diabetes (p=.04, r²=.030). Statistically and practically significant negative relationships existed between total health literacy and
the following variables: age (p=.01, r²=.04) and hemoglobin A1C. This implied that as diabetes knowledge, functional health literacy, communicative health literacy, critical health literacy, highest level of education, incomes, and years with diabetes increased, diabetes knowledge increased. This also implied that as age and hemoglobin A1C increased, diabetes knowledge decreases.

**Functional, Communicative, and Critical Health Literacy**

According to structure coefficients from hierarchical linear regression models predicting diabetes outcomes in the form of hemoglobin A1C, functional health literacy explained a statistically and practically significant (p<.01, r²=.44) amount of variance. Lai et al. (2013) found a statistically significant relationship between functional health literacy and education (p=.001). Heijmans et al. (2015) found a statistically and practically significant negative relationship between functional health literacy and the following variables: age (p<.001, r²=.06) and illness duration (p<.05, r²=.003); and statistically significant relationships were found between functional health literacy and the following variables: education level (p<.001) and income (p<.001). Ishikawa et al. (2008) found a practically and statistically significant positive relationship between functional health literacy and diabetes knowledge (p=.01, r²=.04). In the current research study, bivariate correlations revealed statistically and practically significant positive relationships were found between functional health literacy and highest level of education (p<.01, r²=.13), income (p<.01, r²=.14), total health literacy (p<.01, r²=.54), diabetes knowledge (p<.01, r²=.15), communicative health literacy (p<.01, r²=.11), and critical health literacy (p<.01, r²=.13); and statistically and practically significant negative
relationships were found between age ($p = .003, r^2 = .07$) and hemoglobin A1C ($p < .01, r^2 = .09$). This implies as highest level of education, income, total health literacy, diabetes knowledge, communicative health literacy, and critical health literacy increase, functional health literacy increases; and as age and hemoglobin A1C increase, diabetes knowledge decreases.

Structure coefficients from hierarchical linear regression models predicting diabetes outcomes revealed communicative health literacy as a statistically and practically significant predictor ($p < .001, r^2 = .26$). Heijmans et al. (2015) found practically and statistically significant relationships between communicative health literacy and the following variables: age ($p < .001, r^2 = .05$) and illness duration ($p < .01, r^2 = .006$); and statistically significant relationships were found between communicative health literacy and the following variables: education level ($p < .001$) and income ($p < .001$). Ishikawa et al. (2008) found a statistically and practically significant positive relationship between communicative health literacy and diabetes knowledge ($p < .001, r^2 = .09$), and a statistically and practically significant negative relationship between communicative health literacy and age ($p = .02, r^2 = .04$). Inoue et al. (2013) found statistically significant relationships between communicative health literacy and critical health literacy ($p < .01$).

Review of bivariate correlations among variables in the current research study revealed statistically and practically significant positive relationships between communicative health literacy and the following variables: highest level of education ($p = .006, r^2 = .06$), years with diabetes ($p = .005, r^2 = .06$), total health literacy ($p < .01, r^2 = .71$), functional health literacy ($p < .01, r^2 = .11$), and critical health literacy ($p < .01, r^2 = .54$). A statistically
significant relationship existed between communicative health literacy and race (p=.03, r²=.03). A statistically and practically significant negative relationships existed between communicative health literacy and hemoglobin A1C (p=.03, r²=.03).

Review of structure coefficients from hierarchical linear regression predicting diabetes outcomes in the form of hemoglobin A1C revealed critical health literacy was a statistically and practically significant predictor (p<.01, r²=.24). Heijmans et al. (2015) found statistically and practically significant negative relationships between critical health literacy and the following variables: age (p<.001, r²=.04) and illness duration (p<.01, r²=.003); and statistically significant relationships between critical health literacy and the following variables: education level (p<.001) and income (p<.001). Ishikawa et al. (2008) found a statistically and practically significant positive relationship between critical health literacy and diabetes knowledge (p=.002, r²=.06). Inoue et al. (2013) found a statistically significant relationship between critical health literacy and communicative health literacy (p<.01). Review of bivariate correlations among variables in the current research study revealed statistically and practically significant positive relationships between critical health literacy and the following variables: highest level of education (p=.006, r²=.06), years with diabetes (p=.01, r²=.05), total health literacy (p<.01, r²=.71), diabetes knowledge (p<.01, r²=.11), functional health literacy (p<.01, r²=.13), and communicative health literacy (p<.01, r²=.54). Statistically and practically significant negative relationships existed between age (p=.01, r²=.05) and hemoglobin A1C (p=.01, r²=.05).
Summary of Findings

The current research determined that health literacy was not a moderator in the relationship between diabetes knowledge and diabetes outcomes. This means having adequate health literacy combined with adequate diabetes knowledge are not required to have an optimal hemoglobin A1C. In the current research study, total health literacy, years with diabetes, and diabetes knowledge were the strongest predictors of hemoglobin A1C. Total health literacy, diabetes knowledge, income, and years with diabetes explained the most variance in hemoglobin A1C scores. This implies that in order to improve hemoglobin A1C scores, total health literacy, years with diabetes, and diabetes knowledge must be considered. An increase in either diabetes knowledge or total health literacy may improve hemoglobin A1C scores.

In determining the relationship between functional health literacy, communicative health literacy, critical health literacy, diabetes knowledge, and diabetes outcomes, years with diabetes, critical health literacy, BMI, and diabetes knowledge were the strongest predictors of hemoglobin A1C scores. Functional health literacy, diabetes knowledge, communicative health literacy, and critical health literacy explained the most variance in hemoglobin A1C scores. This implies that in order to improve hemoglobin A1C scores critical health literacy or diabetes knowledge must be improved.

Implications for Future Practice

As implied by critical social theory, theory and practice must be intertwined (Dutta, 2010). Findings from this research study support the development of a health care system based on principles of the Chronic Care Model that provide comprehensive health
management for patients with diabetes that includes routine measurement of diabetes knowledge, total health literacy, functional health literacy, communicative health literacy, and critical health literacy. This system should also provide additional care for individuals in the low income and aging populations.

As implied by the current research, several principles of the Chronic Care Model should be implemented to improve hemoglobin A1C scores. Considering the importance of diabetes knowledge and total health literacy in predicting hemoglobin A1C scores, healthcare providers should include self-management support so that the patient’s support system is aware of diabetes knowledge and health literacy scores, knowledgeable of diabetes self-management skills, and capable of assisting the patient once they leave the healthcare environment. Delivery system redesign is needed so that professionals other than the physician are measuring functional health literacy, communicative health literacy, critical health literacy, and diabetes knowledge and reporting findings to the physician to be considered in the patient’s plan of care. Decision support is needed to ensure patients who are in the low income and/or aging populations have access to healthcare professionals when needed.

Among sociocultural variables, income was the strongest predictor of diabetes outcomes. Previous research supports the conclusion that individuals with less income have poorer management of chronic disease (Shillinger et al., 2006). Findings of this research study show statistically and practically significant relationships between income and diabetes knowledge ($p<.01, r^2=.11$), total health literacy ($p=.004, r^2=.06$), functional health literacy ($p<.01, r^2=.14$), and hemoglobin A1C ($p=.007, r^2=.05$). This implies that as
income increases so will diabetes knowledge, total health literacy, and functional health literacy; and hemoglobin A1C will decrease. Health care practitioners should pay extra attention in providing care to patients with diabetes and low incomes. Extra care should be taken to ensure patients with diabetes have the resources needed to apply self-management skills.

Implications for Future Research

Future research should focus on methods of improving total health literacy and functional health literacy. Findings of this research imply that improvements in total health literacy and critical health literacy may improve chronic disease outcomes. Future research should include an intervention aimed at increasing health literacy, and include an experimental design in order to gain insight on causal relationships.

Future research should also focus on a low income and aging populations in Mississippi. Review of structure coefficients revealed age and income explained a statistically and practically significant amount of variance in hemoglobin A1C scores. Because income has been shown to have a positive relationship with diabetes outcomes, and age has been shown to have a negative relationship with diabetes outcomes further exploration is needed to determine if low income aging populations are capable of properly managing chronic disease.

Limitations

Although results of the pilot test revealed the instruments used to assess diabetes knowledge and health literacy were likely valid and reliable when used to measure a population of adults in Mississippi with diabetes, it is important to acknowledge the
differences in the sample used and the actual population. The Mississippi population is 59.8% non-Hispanic White, 37.4% non-Hispanic Black, and 2.9% Hispanic/ Latino (U.S. Census Bureau, 2014). Among Mississippians, 81% have a high school diploma or higher, 20% have Bachelor’s degrees or higher, and median income is $38,832 (U.S. Census Bureau, 2014). Among pilot study participants, 33.3% were non-Hispanic White, 61.9% were non-Hispanic Black, and 0% were Hispanic. About 80.5% of participants had a high school diploma or higher, 42.8% had a Bachelor’s degree or higher, and median income was $40,500. This presents differences between the pilot study sample and the population of adults in Mississippi with diabetes.

While Kudar Richardson for SKILLD was similar to results found in previous research, this tool did not meet the cutoff of 0.70. Therefore this tool may not be a reliable method for measuring diabetes knowledge among adults living in Mississippi with a diagnosis of diabetes.

The current research study is a non-experimental design, and participants were recruited from existing diabetes self-management programs. Therefore the results may not be reflective of a general population of adults in Mississippi with diabetes. Individuals who attend diabetes self-management classes or are affiliated with a healthcare setting may have higher income, education levels, diabetes knowledge and health literacy compared to those who do not attend diabetes self-management classes or have an affiliation with a healthcare setting.
APPENDIX A – Pilot Study Questionnaire

Q1 You are being asked to complete a questionnaire as a part of the pilot study for a dissertation at The University of Southern Mississippi for Jameshyia Ballard Thompson, entitled 'Health Literacy as a Moderator in the Relationship between Diabetes Knowledge and Diabetes Outcomes'. This study aims to explore the relationship between diabetes knowledge, health literacy, and diabetes outcomes. Participation in this questionnaire is completely voluntary, and information provided will be anonymous. If you wish to continue, please move forward to the next question. If you choose not to participate, please exit now. This questionnaire will take about 30 minutes to complete. You may choose to stop completion of this questionnaire at any time.

Q60 Do you wish to complete the questionnaire?

☐ Yes
☐ No

Q59 The portion of the questionnaire you are about to complete is related to you and your family's background. Please answer as honest as possible.

Q6 I am 18 years of age or older.

☐ Yes
☐ No

Q5 Have you been diagnosed with diabetes at any point in my life? Being diagnosed with diabetes means a doctor has told you that you have diabetes, or you have had a hemoglobin A1C test that was 6.5 or higher at any point in your life.

☐ Yes
☐ No
Q4 Are you a current resident of Mississippi?

☐ Yes
☐ No

Q63 Are you currently taking anti-psychotics, or anti-epilepsy drugs?

☐ Yes
☐ No

Q61 Are you pregnant or breastfeeding?

☐ Yes
☐ No

Q62 Have you ever been told by a doctor you have end stage renal disease, or have you ever been on dialysis?

☐ Yes
☐ No

Q64 What is your current age in years? For example, if you are 29 years old, enter 29.

Q2 Please select the option that best describes your ethnicity

☐ Hispanic
☐ Non-Hispanic
Q3 Please select the option that best describes your race.

- White
- Black or African American
- American Indian or Alaskan Native
- Asian
- Native Hawaiian or Pacific Islander
- Other (Not listed above)

Q7 Please enter the total amount of income your family earns annually (each year) in dollars. For example: If your family earns a total of $45,000 each year, enter 45000.

Q8 Please select the option that best describes the highest level of education you have received.

- Less than high school diploma
- High school diploma or equivalent
- Associate's degree or trade
- Bachelor's degree
- Master's degree, or higher

Q9 What is your most current weight, in pounds?

Q10 What is your most current height, in inches?

Q11 What was your most recent hemoglobin A1C?

Q65 How long have you had diabetes? Please answer in years.
Q12 You are about to complete the part of the questionnaire that tells us about your knowledge about diabetes. Most questions will be fill in the blank, and require short answers. Spelling and grammar are not important. It is okay to answer 'I do not know', or 'I do not understand'. If you do not understand a question, another question will be provided to help you to better understand. Please answer using only your knowledge. Please do not use any outside sources (such as friends or family, Internet, handouts) to answer questions.

Q13 Do you know the answer to the following question: What are the signs and symptoms of high blood sugar?

○ I know the answer to this question
○ I do not know the answer to this question
○ I do not understand the question

Q14 What are the signs and symptoms of high blood sugar? Please list at least 2 signs and symptoms.

Q15 How do you feel when your blood sugar is high, or when you were diagnosed? List at least 2 signs and symptoms. If you do not know the answer to the question, please leave blank.
Q16 Do you know the answer to the following question: What are the signs and symptoms of low blood sugar?

○ I know the answer to this question
○ I do not know the answer to this question
○ I do not understand this question

Q17 What are the signs and symptoms of low blood sugar? Please list at least 2 signs and symptoms.

Q18 How do you feel when your blood sugar is low? List at least 2 signs and symptoms. If you do not know the answer to the question, please leave blank.

Q19 Do you know the answer to the following question: How do you treat low blood sugar?

○ I know the answer to this question.
○ I do not know the answer to this question.
○ I do not understand this question.

Q20 How do you treat low blood sugar? List at least 2 answers.

Q21 What should you do if your blood sugar is too low? How can you bring your blood sugar up? List at least 2 answers. If you do not know the answer to the question, please leave blank.
Q22 Do you know the answer to the following question: How often should a person with diabetes check his or her feet?

- I know the answer to this question.
- I do not know the answer to this question.
- I do not understand this question.

Q23 How often should a person with diabetes check his or her feet? Provide your answer below.

Q24 How often should a person with diabetes check his or her feet?

- Once a day
- Once a week
- Once a month
- I do not know

Q25 Do you know the answer to the following question: Why are foot exams important in someone with diabetes?

- I know the answer to this question.
- I do not know the answer to this question.
- I do not understand this question.

Q26 Why are foot exams important in someone with diabetes?

Q27 Why is it important to look at your feet? What are you looking for when checking feet? If you do not know the answer to the question, please leave blank.
Q28 Do you know the answer to the following question: How often should you see an eye doctor, and why is it important?

☐ I know the answer to this question.
☐ I do not know the answer to this question.
☐ I do not understand this question.

Q29 How often should you see an eye doctor, and why is it important?

Q30 In regards to going to the eye doctor.... How often? Why? If you do not know the answer to the question, please leave blank.

Q31 Do you know the answer to the following question: What is the normal fasting blood glucose, or blood sugar?

☐ I know the answer to this question.
☐ I do not know the answer to this question.
☐ I do not understand this question.

Q32 What is the normal fasting blood glucose, or blood sugar?

Q33 When you get up first thing in the morning, and check your blood sugar before you eat or take medicine, what should it be? What 2 numbers? If you do not know the answer to the question, please leave blank.
Q34 Do you know the answer to the following question: What is a normal hgbA1C (hemoglobin A1C) or 'average blood sugar test'?

- I know the answer to this question.
- I do not know the answer to this question.
- I do not understand this question.

Q38 What is a normal hgbA1C (hemoglobin A1C) or 'average blood sugar test'?

Q35 At the doctor... When they draw your blood from your arm and get an average blood sugar reading, what should it be? If you do not know the answer to the question, please leave blank.

Q36 Do you know the answer to the following question: How many times per week should someone with diabetes exercise and for how long?

- I know the answer to this question.
- I do not know the answer to this question.
- I do not understand this question.

Q37 How many times per week should someone with diabetes exercise and for how long?

Q39 How many times per week should you exercise? How long or how much per day?
Q40 Do you know the answer to the following question: What are some long-term complications of uncontrolled diabetes?

○ I know the answer to this question.
○ I do not know the answer to this question.
○ I do not understand this question.

Q41 What are some long-term complications of uncontrolled diabetes? Please list at least 2 complications.

Q42 Do you know anyone that has diabetes and had bad things happen to them? What are some of those bad things? Please list at least 2 answers.

Q43 You have completed the portion of the questionnaire about diabetes knowledge. Now you will be asked to complete questions about health literacy. Questions are multiple choice. You will be given statements about your experiences as a person with diabetes in the health care system. Please answer how often the following experiences have happened to you. Answers range from 1 to 4, with 1 meaning never and 4 meaning often.

Q44 When reading instructions or leaflets from hospitals or pharmacies, you found that the print was too small to read.

○ 1 Never
○ 2
○ 3
○ 4 Often
Q45 When reading instructions or leaflets from hospitals or pharmacies, you found characters or words that you did not know.

- 1 Never
- 2
- 3
- 4 Often

Q46 When reading instructions or leaflets from hospitals or pharmacies, you found that the content was too difficult.

- 1 Never
- 2
- 3
- 4 Often

Q47 When reading instructions or leaflets from hospitals or pharmacies, you needed a long time to read and understand them.

- 1 Never
- 2
- 3
- 4 Often

Q48 When reading instructions or leaflets from hospitals or pharmacies, you needed someone to help you read them.

- 1 Never
- 2
- 3
- 4 Often
Q49 Since being diagnosed with diabetes, you have collected information from various sources.

- 1 Never
- 2
- 3
- 4 Often

Q50 Since being diagnosed with diabetes, you have extracted (collected) the information you wanted.

- 1 Never
- 2
- 3
- 4 Often

Q51 Since being diagnosed with diabetes, you have understood the obtained (gathered) information.

- 1 Never
- 2
- 3
- 4 Often

Q52 Since being diagnosed with diabetes, you have communicated your thoughts about your illness to someone.

- 1 Never
- 2
- 3
- 4 Often

Q53 You have completed the portion of the questionnaire about diabetes knowledge. Now you will be asked to complete questions about health literacy. Questions are
multiple choice. You will be given statements about your experiences as a person with diabetes in the health care system. Please answer how often the following experiences have happened to you. Answers range from 1 to 4, with 1 meaning never and 4 meaning often.

- Q54 Since being diagnosed with diabetes, you have considered whether the information was applicable to your situation.
  - 1 Never
  - 2
  - 3
  - 4 Often

- Q55 Since being diagnosed with diabetes, you have considered the credibility of the information.
  - 1 Never
  - 2
  - 3
  - 4 Often

- Q56 Since being diagnosed with diabetes, you have checked whether the information was valid or reliable.
  - 1 Never
  - 2
  - 3
  - 4 Often
Q57 Since being diagnosed with diabetes, you have collected information to make health-related decisions.

☐ 1 Never
☐ 2
☐ 3
☐ 4 Often

Q58 Thank you for completing this questionnaire. Your time and efforts are greatly appreciated.
APPENDIX B – IRB Approval Letter

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

INSTITUTIONAL REVIEW BOARD
110 College Drive M3147 | Hattiesburg, MS 39406-0001
Phone: 601.266.5977 | Fax: 601.266.4597 | www.usm.edu/research/institutional-review-board

NOTICE OF COMMITTEE ACTION

The project has been reviewed by the University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 21, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.

Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 15101401
PROJECT TITLE: Health Literacy as a Moderator in the Relationship between Diabetes Knowledge and Diabetes Outcomes
PROJECT TYPE: New Project
RESEARCHER(S): Jamiesha Ballard Thompson
COLLEGE/DIVISION: College of Education and Psychology
DEPARTMENT: Educational Studies and Research
FUNDING AGENCY/SPONSOR: N/A
IRB COMMITTEE ACTION: Expedited Review Approval
PERIOD OF APPROVAL: 10/22/2015 to 10/22/2018

Lawrence A. Hosman, Ph.D.
Institutional Review Board

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APPENDIX C - Demographic Questionnaire

(1) Are you able to speak and read English?
   a. Yes
   b. No

(2) Have you ever been told by a doctor that you have diabetes, or have you ever had a hemoglobin A1C (or diabetes blood draw) of 6.5 or greater?
   a. Yes
   b. No

(3) If you identify yourself as having diabetes, how many years have you had diabetes?
   a. _________ Years

(4) Are you currently taking anti-psychotics or anti-epilepsy drugs?
   a. Yes
   b. No

(5) Are you pregnant or breastfeeding?
   a. Yes
   b. No

(6) Have you ever been told by a doctor that you have end-stage renal disease, or have you ever been on dialysis?
   a. Yes
   b. No

(7) What is your current age, in years?
   a. __________________________

(8) Please select the option that best describes your ethnicity.
   a. Hispanic
   b. Non-Hispanic

(9) Please select the option that best describes your race.
   a. White
   b. Black or African American
   c. American Indian or Alaskan Native
d. Asian

e. Native Hawaiian or Pacific Islander

f. Other (Not listed above)

(10) Please enter the total amount of income your family earns annually (each year) in dollars.

a. ______________________

(11) Please select the option that best describes the highest level of education you have received

a. Less than high school diploma

b. High school diploma or equivalent

c. Associate’s degree or trade

d. Bachelor’s degree

e. Master’s degree or higher

(12) What is your most current weight, in pounds?

a. ______________________

(13) What is your most current height, in inches?

a. ______________________

(14) Did you participate in the online version of ‘Health Literacy as a Moderator in the Relationship between Diabetes Knowledge and Diabetes Outcomes?’

a. Yes

b. No
APPENDIX D - Spoken Knowledge in Low Literacy in Diabetes Tool

The Spoken Knowledge in Low Literacy in Diabetes Scales

1. What are the signs and symptoms of high blood sugar?  
   How do you feel when your blood sugar is high or when you were diagnosed?  
   Needs at least (2): Extreme thirst, frequent urination, drinking or eating, blurred vision, and/or drowsiness/fatigue

2. What are the signs and symptoms of low blood sugar?  
   How do you feel when your blood sugar is too low?  
   Needs at least (2): Hunger, nervous/jitteriness, mood swings/irritability, confusion, sweaty, or fast heart rate

3. How do you treat low blood sugar?  
   What should you do if your sugar is too low?  
   How can you bring your blood sugar up if it’s too low?  
   Accept very general answer: Juice, milk, hard candy, 15 g of carbohydrates AND check blood sugar.

4. How often should a person with diabetes check his or her feet?  
   Once a day, once a week, or once a month?  
   Accept: Daily

5. Why are foot exams important in someone with diabetes?  
   Why is it important to look at your feet?  
   What are you looking for?  
   Accept very general answer: Prevention of morbidity due to neuropathic/immunologic consequences of diabetes

6. How often should you see an eye doctor and why is it important?  
   How often? Why?  
   Accept: Seen at least yearly AND screen/manage retinopathy, glaucoma, blindness, etc

7. What is a normal fasting blood glucose or blood sugar?  
   When you get up first thing in the morning and check your blood sugar before you eat or take medicine, what should it be?  
   What 2 numbers?  
   Accepted range: 70 (or 80) to 120

8. What is a normal HbA1c (hemoglobin A1C) or “average blood sugar test”?  
   When they draw blood from your arm and get an average blood sugar reading, what should it be?  
   Accept either: normal ≤6% or target ≤7%
9. How many times per week should someone with diabetes exercise and for how long?
   How many times a week?
   How long or how much per day?
   Accept within: 3-5 times per week for a total of 30-45 min each (must include frequency and duration)

10. What are some long-term complications of uncontrolled diabetes?
    Do you know anyone that has diabetes and had “bad things” happen to them?
    What are some of those “bad things”?
    Needs at least (2): Blindness/impaired vision, kidney damage/dialysis, amputation, neuropathy/impotence/gastroparesis, or cardiovascular disease
APPENDIX E - Functional Communicative Critical Health Literacy Tool

Functional, Communicative, Critical Health Literacy Scales

Each question is rated on a 4-point scale, ranging from 1(never) to 4(often).

I. In reading instructions or leaflets from hospitals/ pharmacies, you
   1) Found that the print was too small to read
   2) Found characters and words that you did not know
   3) Found that the content was too difficult
   4) Needed a long time to read and understand them
   5) Needed someone to help you read them

II. Since being diagnosed with diabetes, you have
   1) Collected information from various sources
   2) Extracted the information you wanted
   3) Understood the obtained information
   4) Communicated your thoughts about your illness to someone
   5) Applied the obtained information to your daily life

III. Since being diagnosed with diabetes, you have
   1) Considered whether the information was applicable to your situation
   2) Considered the credibility of the information
   3) Checked whether the information as valid or reliable
   4) Collected information to make health-related decisions
APPENDIX F - Permission to Use Spoken Knowledge in Low Literacy in Diabetes

Subject: Fwd: Permission
From: Jamesthyia Ballard (jamesthyia@yahoo.com)
To: jamesthyia@yahoo.com;
Date: Wednesday, July 15, 2015 2:52 PM

Sent from my iPhone

Begin forwarded message:

From: "Rothman, Russell" <russell.rothman@Vanderbilt.Edu>
Date: July 15, 2015 at 1:48:38 PM CDT
To: Jamesthyia Ballard <jamesthyia@yahoo.com>
Subject: RE: Permission

Yes, you are welcome to use the SKILLD>

Good luck

Russell Rothman, MD MPP
Professor, Internal Medicine, Pediatrics, & Health Policy
Assistant Vice Chancellor, Population Health Research
Chair, Internal Medicine & Pediatrics Section
Director, Center for Health Services Research
Center for Health Services Research
Suite 6150 Medical Center East
Vanderbilt University Medical Center
Nashville, TN 37232-0300
615-936-2149 (phone)
615-936-1269 (fax)

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