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Is Marital Status A Determinant Of Self-Monitoring Of Blood Glucose?

Jasmine Evelyn Dixon Jones
University of Mississippi

IS MARITAL STATUS A DETERMINANT OF SELF-MONITORING OF BLOOD GLUCOSE?

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JASMINE DIXON JONES

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ABSTRACT

Glycemic control is one of the most important aspects of diabetes management and is necessary for the prevention or delay of complications associated with diabetes mellitus (DM). Self-monitoring of blood glucose (SMBG) is a technique used achieve glycemic control by revealing day-to-day changes in blood glucose levels. Since marriage protective effects have been shown for mortality, especially for men, it is useful to determine whether a similar relationship is found between marriage and SMBG. The purpose of this study is to examine whether marital status is a determinant of SMBG, when controlling for other variables, and whether marital status determines SMBG differently for males and females.

Demographic data were obtained from 465 individuals who self-reported a diagnosis of DM in the continuous NHANES 2009-2010, along with data about treatment, condition, and self-management practices. Using logistic regressions, significant predictors were identified for SMBG.

One-third (36%) of adults with diabetes in the U.S. population do not self-monitor their blood glucose level at least 1 time/day. A minority (29.5%) of females who are not married do not self-monitor daily, while this is true for nearly half (47.6%) of males who are not married. Insulin use is the major determinant for SMBG, along with age, race/ethnicity, and patient DM education. Marital status was found to be a significant predictor for SMBG among males, only when insulin and pills use were not included in the regression. Marital status was not identified as a significant predictor of SMBG for females.

Although marital status is independently associated with reduced mortality, a similar protective relationship is not shown between marital status and SMBG. Since SMBG may be a useful in the achievement of glycemic control, individuals with diabetes should incorporate this practice into their regimens for diabetes self-management.

DEDICATION

I dedicate this thesis to my late father, Darrell Keith Dixon Sr. His constant struggle with health inspired me to choose nutrition as an area of interest because it not only addresses the problem through treatment but also through prevention. He was always so proud of me and truly believed I could do anything. He raised me to show love to everybody, despite the circumstance. Last but not least, he showed me love in a way that only a loving and caring father could. I will forever and always miss him so much, but I find strength in knowing that he left me a great legacy to carry on.

LIST OF ABBREVIATIONS AND SYMBOLS

AACE	American Association of Clinical Endocrinologists
ADA	American Diabetes Association
CDC	Centers for Disease Control and Prevention
CSII	Continuous subcutaneous insulin infusion
CVD	Cardiovascular disease
DSM	Diabetes self-management
FPG	Fasting plasma glucose
GDM	Gestational diabetes mellitus
HbA1c	Glycated hemoglobin
IDDM	Insulin-dependent diabetes mellitus
MDI	Multiple daily injections
NHANES	National Health and Nutrition Examination Survey
NIDDM	Non-insulin-dependent diabetes mellitus
SMBG	Self-monitoring of blood glucose
T1DM	Type 1 diabetes mellitus
T2DM	Type 2 diabetes mellitus

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CHAPTER I - INTRODUCTION

Diabetes mellitus (DM) refers to a group of diseases that are characterized by hyperglycemia as a result of deficiencies with insulin production, alone, or accompanied with insulin sensitivity. Approximately 8.3% of the United States (U.S.) population is affected by DM, as 18.8 million persons have been diagnosed, while an estimated 7 million persons are believed to have undiagnosed DM (Centers for Disease Control and Prevention (CDC), 2011). Persistent hyperglycemia is associated with adverse effects on, essentially, every body system including cardiovascular disease (CVD), nephropathy, neuropathy, and retinopathy. Such complications can ultimately lead to chronic illnesses and death (Shrivastava, Shrivastava, & Ramasamy, 2013). However, the prevention or delay of complications associated with DM may be achieved with intensive glycemic control (Ohkubo et al., 1995; R. C. Turner, Holman, Cull, & Stratton, 1998).

The treatment and management of DM is quite complex and meticulous. Furthermore, persons with DM or their family members provide 95% or more of the care involved with disease management. The self-management of DM consists of: self-monitoring of blood glucose (SMBG), tailoring nutrition to daily needs, regular physical activity, and adherence to medication regimens in order to achieve adequate glycemic control. Self-management should also involve understanding and integrating each component of care in order to make the appropriate adjustments according to daily needs (Sigurardóttir, 2005).

The two main techniques used to monitor glycemic control include HbA1c testing and SMBG, which most often involves using “point of care” devices known as portable glucose meters to obtain a small amount of blood from the arm or finger, usually between one and four times a day, to test the level of blood glucose concentration (Montagnana, Caputo, Giavarina, & Lippi, 2009). SMBG is considered the cornerstone of DM management, as it provides relevant information that helps achieve glycemic control by reflecting the effectiveness of treatment, exposing the potential need for adjustments, and providing information about daily variations of glycemic changes that is not available with HbA1c testing. The efficacy of SMBG is controversial but has been shown to be associated with improved glycemic control, improved health outcomes, and reduced mortality (Martin et al., 2006).

Despite the debates about the effectiveness of SMBG, the American Association of Clinical Endocrinologists (AACE) Diabetes Care Plan Guidelines recommend that individuals using insulin should monitor blood glucose at least two times a day or before each injection of insulin. However, the recommended frequency for SMBG remains unclear and depends on the type of pharmacotherapy used to help achieve target blood glucose levels. Generally, SMBG is not required for individuals exclusively taking oral anti-hyperglycemic agents that do not include sulfonylureas or glinides to regulate blood glucose, as these agents are less likely to cause hypoglycemia. Individuals who rely on insulin therapy should self-monitor blood glucose more frequently (Handelsman et al., 2011; Nathan et al., 2009). However, a study investigating the frequency of SMBG and its relationship with glycemic control showed that greater than ¼ of persons using insulin did not monitor blood glucose level at least once per day. Sixty-five percent of the persons using oral agents did not monitor at least one time daily, while most individuals treated with diet alone did not monitor glycemic levels (Harris, Cowie, & Howie, 1993; Harris, 2001).

An association between social support and DM self-management behaviors has been widely researched, yielding at least minimal evidence of a positive influence. The different types of social support include: family support, peer support, and healthcare provider support with further distinctions between structural and functional social support (Chew, Khoo, & Chia, 2011; Gao et al., 2013; Strom & Egede, 2012; Tang, Brown, Funnell, & Anderson, 2008). Dunbar-Jacob and Schlenk (2001) suggest patient adherence as the link between social support and improved health. Adherence refers to an individual's acceptance of illness and the willingness to follow through with treatment recommendations and regimens for health maintenance (DiMatteo, 2004). Social support may be essential to accomplishing adequate SMBG, in order to achieve positive health outcomes. Despite the extensive research about the impact of social support on DSM, there is very little evidence about the relationship between marriage and SMBG. The existing literature examines the impact of marriage quality, marriage satisfaction, and spousal involvement (Trief, Himes, Orendorff, & Weinstock, 2001; Trief, Ploutz-Snyder, Britton, & Weinstock, 2004).

More specifically, it is widely accepted that marital status, a variation of structural social support, is associated with longevity and improved health. This trend remains true across populations, both globally and in the United States (Hu & Goldman, 1990). However, a recent review of prospective studies yields inconsistent findings concerning differentiations among men and women, each type of unmarried status (i.e., never married, widowed, and divorced/separated), and age groups (Rendall, Weden, Favreault, & Waldron, 2011).

The purpose of this study is to examine the association between marital status and self-monitoring of blood glucose. This research aims to answer the following research questions:

1. What are the determinants of self-monitoring of blood glucose?
2. Is marital status a determinant of self-monitoring of blood glucose when controlling for other determinants?

3. Does marital status determine self-monitoring of blood glucose differently for males and females?

CHAPTER II – LITERATURE REVIEW

This chapter contains an overview of the literature regarding the pathophysiology and epidemiology of DM. The overview is followed by an exploration of literature addressing self-monitoring of blood glucose. Lastly, this review will end with a summary of studies that investigate the relationship between marital status and mortality.

TYPES OF DM

Type 1 Diabetes Mellitus (T1DM)

There are several different types of DM that are evident by high levels of glucose in the blood including type 1, type 2, gestational, and other rare types of diabetes mellitus. Because this study mainly focuses on types 1 and 2, there will only be a brief discussion of gestational and the other rare types of diabetes mellitus.

T1DM is an autoimmune disorder in which an individual's pancreatic beta cells are destroyed as a result of some combination of genetic and environmental interactions. As a result, individuals who are diagnosed with T1DM lack the ability to produce the hormone, insulin, which is responsible for the regulating the amount of glucose in the blood. The specific combinations of environmental and genetic interactions that cause T1DM remain unknown (Gan, Albanese-O'Neill, & Haller, 2012). Previously known as insulin-dependent diabetes mellitus (IDDM) or juvenile diabetes, T1DM is usually diagnosed among children and young adults. This form is only found in approximately 5% of all adults diagnosed with DM. Currently, there are no known strategies to prevent or cure T1DM (Centers for Disease Control and Prevention (CDC), 2011).

As a result, the main goal of treatment is to improve the quality of life among individuals living with the disease. In order to prevent or delay complications and sustain survival, individuals with T1DM must rely on exogenous insulin therapy, along with the help of healthcare professionals, to regulate and control blood glucose levels (Gan et al., 2012).

Type 2 Diabetes Mellitus (T2DM)

T2DM is a metabolic disorder characterized by high levels of glucose in the blood, or hyperglycemia, as a result of insulin resistance. This insulin resistance usually occurs before the disease develops, occurring when an individual's body cells do not utilize insulin properly. T2DM is usually prefaced by a condition called prediabetes in which blood glucose levels are higher than normal but too low for a diagnosis of DM. This evolutionary process from normal glucose tolerance to impaired glucose tolerance and eventual T2DM is the result of insulin resistance that leads to an eventual defect of insulin production by the pancreatic beta cells. The pancreas is required to produce elevated amounts of insulin in order to regulate blood glucose levels and, consequently, is unable to achieve adequate, insulin production that overcomes the resistance. T2DM is commonly treated with diet therapy, physical activity, oral anti-hyperglycemic agents such as Metformin, and insulin therapy (Centers for Disease Control and Prevention (CDC), 2011; Simmons, 2010; Surampudi, John-Kalarickal, & Fonseca, 2009).

As the most common form of diabetes mellitus, T2DM accounts for approximately 90% to 95% of all the cases of diabetes mellitus. Formerly known as non-insulin-dependent diabetes mellitus (NIDDM) or adult onset diabetes, T2DM has several associating risk factors including race/ethnicity, age, and family history of DM, along with the history of gestational diabetes, obesity, and sedentary lifestyle. This form of DM is rare among children and young adults but is increasingly becoming more prevalent among children and adolescents who are African

Americans, American Indians, Asians, and Hispanics/Latin Americans. These races/ethnicities are at a greater risk of developing T2DM and its associating consequences (Centers for Disease Control and Prevention (CDC), 2011).

Other Types of Diabetes Mellitus

Gestational diabetes mellitus (GDM) is a condition of glucose intolerance that occurs or is, initially, identified and diagnosed during pregnancy. African American, Hispanic/Latin American, and American Indian women are at a greater risk for developing this form of diabetes mellitus. A woman's risk of developing GDM is enhanced even more with obesity and a family history of diabetes mellitus. Treatment is required for blood glucose regulation in order to prevent harm in the mother and the infant (Centers for Disease Control and Prevention (CDC), 2011).

GDM, seemingly, occurs as a result of the same pathophysiological processes and pathways as with other types of DM that develop outside of pregnancy (type 1 and type 2 DM). Therefore, women with GDM have a high risk of developing T2DM after pregnancy. A review of longitudinal studies reveal that most women with GDM experience the progression to T2DM, but an estimate of only 10% of women are diagnosed soon after delivery (Buchanan & Xiang, 2005).

There are other rare types of DM that are precipitated as a result of particular circumstances including surgery, illnesses, infections, pancreatic disease, and taking medications. Additionally, specific genetic combinations may trigger the onset of uncommon forms, such as maturity-onset DM during youth. There are infrequent forms of DM that may occur as a result of gene mutations, neonatal glucose intolerance, and atypical maladies of the immune system. These and other rare forms of DM only account for 1% to 5% of all known incidents of DM(Centers for Disease Control and Prevention (CDC), 2011; Mihai, Mihai, Cijevschi-Prelipcean, & Lăcătuşu, 2011).

DM is a growing epidemic in the U.S. and around the world. Furthermore, the prevalence of DM among adults has steadily increased. The prevalence rates are expected to continue increasing, due to decreased levels of physical activity and increased rates of obesity. In 2000, 11 million Americans were diagnosed with DM, yielding a prevalence of 4%. By 2010, there were almost 19 million known cases of DM in the U.S., while there is a projection of an increase to 29 million by the year of 2050 to yield a prevalence of 7.2%, based on emerging trends and prevalence data for age-, sex-, and race-specific rates of diagnosed DM from the National Health Interview Survey and projected population demography data from the Bureau of Census. Also, the rates of DM have remained higher among non-Hispanic African Americans and Mexican-Americans when compared to non-Hispanic whites (Harris et al., 1998). The projection reveals an expectation of the greatest increases appearing among African-American males and females, 75 years or older (Boyle et al., 2001; Wild, Roglic, Green, Sicree, & King, 2004).

The projections of increasing global DM prevalence rates are parallel to that of the U.S. Based on a review of studies and prevalence data from 91 countries, the global prevalence of DM will reach 7.7% by 2030 with 439 million cases of DM among adults. This is an indication of the growing and concerning burden of DM, specifically for developing countries. Additionally, these estimates are not based on the projections of obesity and may not provide an accurate and lucid depiction of the growing "diabetes mellitus epidemic." Instead, the number of cases of DM worldwide may greatly exceed the projected numbers and pose a larger and more dangerous threat to society than is currently expected. Therefore, it is essential to allocate resources and efforts, effectively, in order to reduce the future burden of DM among adults and children (Shaw, Sicree, & Zimmet, 2010; Wild et al., 2004).

COMPLICATIONS ASSOCIATED WITH DM

Previous studies show an association between hyperglycemia and microvascular and macrovascular complications (Klein, 1995; Pirart, 1978; Standl et al., 1996). Microvascular complications refer to nephropathy and chronic kidney disease, sensory neuropathy, amputations of the lower extremities, and retinopathy. On the other hand, macrovascular complications include chest pain, myocardial infarction, CVD, congestive heart failure, and stroke. Increased levels of hyperglycemia are associated with an increased risk of such complications and mortality as a result of all causes(Adler et al., 1997; Groeneveld, Petri, Hermans, & Springer, 1999; R. Turner et al., 1998). The increased risk is, generally, associated with drastically high concentrations of blood glucose. Additionally, hyperglycemia, manifested as ranges of hemoglobin A1c (HbA1c) between 6% and 11%, is associated with the further development of microvascular complications in individuals with T1DM (Diabetes Control and Complications Trial Research Group, 1996).

Some complications associated with DM may be classified as sporadic, as they are recurring and require repetitive treatment. For example, an individual with DM may experience foot ulcers many times after diagnosis. On the other hand, certain complications are progressive, resulting in further damages that yield additional, long-term disabilities. One common example is chronic kidney disease that progresses to end-stage renal disease (ESRD). According to data from the National Health and Nutrition Examination Survey (NHANES), the prevalence of chronic kidney disease, amputations or medical conditions of the feet, and eye damage (all microvascular complications) are drastically higher than that of macrovascular complications.

Other DM-related complications include reduced resistance to bacterial and viral infections (i.e. pneumonia and influenza), dental disease, and the delivery of infants who are large-for-gestational age, along with other birth complications, among pregnant women (American Association of Clinical Endocrinologists, 2007; Deshpande, Harris-Hayes, & Schootman, 2008).

Whether recurrent or progressive, DM-related complications contribute to the rising economic burden of DM and the widespread loss of functionality among individuals with DM. By the year 2007, the economic burden of both prediabetes and DM in the U.S. exceeded $215 billion, as a result of decreased productivity and increased healthcare costs. The average yearly cost for each case of T1DM nearly doubles that of T2DM. However, the number of cases of T2DM greatly exceeds the number of T1DM cases. Each American has a burden cost, whether or not he has been diagnosed with DM, and these alarming, rising costs highlight the importance of DM prevention, along with, quality and effective treatment (Dall et al., 2010).

TREATMENT FOR DM

Multidisciplinary Team

Each individual diagnosed with DM should have a comprehensive treatment plan that considers his/her medical history, relevant behavior and risk factors, ethnic and cultural background, and environment. A multidisciplinary team is best for the delivery of quality and effective care for those with DM. The team should include a primary care physician, endocrinologist, and nurse practitioner. The team can also consist of a registered nurse, certified diabetes educator, registered dietitian, exercise specialist, and mental health care professional. The opportunity to work with an exhaustive team of healthcare providers allows individuals to acquire a wealth of knowledge about an array of different topics, addressing their general and unique health concerns. Some health care providers are able to devote more time and attention to specific topics that may positively influence health outcomes. According to individuals with diabetes mellitus, CDEs often provide more practical education than physicians (Handelsman et al., 2011).

Glycemic and Other Goals

The association between hyperglycemia and diabetes mellitus-related microvascular and macrovascular complications has been widely accepted. Additionally, efforts and therapies used to achieve glycemic control, including intensive insulin therapy, have also been shown to lower the rates of microvascular complications and some cardiovascular illnesses associated with DM. There are two major methods used to monitor blood glucose levels and achieve glycemic control, which includes testing HbA1c levels and the self-monitoring of blood glucose (SMBG). HbA1c refers to the proportion of hemoglobin that is a product of glucose saturating erythrocytes (glycation), reflecting the mean blood glucose level over 2-4 months since erythrocytes have a general life span of 120 days (American Diabetes Association, 2011; Jeffcoate, 2004).

A review of supporting evidence yields conflicting specific targets for glycemic control. The fasting plasma glucose (FPG) of healthy persons does not rise above 99mg/dL or above 120 mg/dL after meals (Handelsman et al., 2011). Nonetheless, a significant association has been shown between T2DM and FPG levels of 87 mg/dL and 94 mg/dL (Hayashino et al., 2007; Tirosh et al., 2005). Due to highly varying conditions, glycemic goals should be individualized and feasible. Each individual has different amounts of risk factors and comorbidities, along with different psychosocial and economic states. According to the AACE, most non-pregnant individuals with DM should aim for HbA1c at or below 6.5%, while reducing the risk of hypoglycemia as much as possible. Glucose concentrations 2 hours after eating should remain less than 140 mg/dL in order to accomplish this glycemic goal, while FPG should remain less than 110 mg/dL. Individuals with extensive comorbidities, prevalent complications, and severe hypoglycemia may require a less restrictive glycemic goal (HbA1c 7% – 8%), as the specific goals are much more difficult to achieve despite intensive glycemic control (Handelsman et al., 2011). On the other hand, the American Diabetes

The American Diabetes Association (ADA) states that T2DM is diagnosed when the fasting plasma glucose level is ≥ 126 mg/dL, the post-prandial plasma glucose level is ≥ 200 mg/dL, or a random plasma glucose level ≥ 200 mg/dL accompanied by regular symptoms of hyperglycemia. The recommended goals from ADA include an HbA1c level of 7%, a pre-prandial plasma glucose level of 70-130 mg/dL, and a post-prandial plasma glucose level of < 180 mg/dL(American Diabetes Association, 2011).

Evidence shows a strong association between previous hyperglycemia and DM-related complications, among individuals with T2DM. However, the risk is reduced with any reduction in HbA1c. Each 1% reduction in HbA1c lowers the risk of all DM-related end-points, death, myocardial infarction, and microvascular complications. The lowest risk of complications is found among individuals with HbA1c below 5.0%(Holman, Paul, Bethel, Matthews, & Neil, 2008; Khaw et al., 2004; R. C. Turner et al., 1998). Risk factors for CVD should be reduced, as it is a primary cause of death among those with DM. In addition, low-density lipoprotein cholesterol should remain less than 100 mg/dL, and less than 70 mg/dL for those with CVD or at high risk for developing CVD. High-density lipoprotein should exceed 40 mg/dL in men and 50 mg/dL in women (Handelsman et al., 2011).

Comprehensive Care Approaches

Several strategies may be used to achieve the designated goals and targets for optimal health outcomes associated with DM care, including strategic lifestyle changes and pharmacotherapy. Registered dietitians/nutritionists or knowledgeable physicians use medical nutrition therapy to develop highly individualized plans that address several topics essential to glycemic control and the reduction of risks associated with complications and CVD. The dietitian or physician, generally, recommends consistent carbohydrate intake, in addition to an insulin dosage that corresponds with a specific carbohydrate intake pattern. This method is often referred to as carbohydrate counting. Healthy eating, weight management, adequate protein intake, and limitation of high glycemic index foods are also topics of education. Other healthcare professionals may also address adequate sleep, cessation and avoidance of tobacco products, and stress reduction (Handelsman et al., 2011).

Regular physical activity has been shown to improve glycemic control. Despite the difficulty of determining the effect of exercise alone, physical activity, including aerobic exercise and strength training, contributes to the weight management aspect of DM management when coupled with calorie restriction. The suggested 150 minutes per week of moderately intense exercise is a widely accepted recommendation. This includes brisk walking and other comparable activities. Among those with diabetes mellitus, flexibility and strength training activities should also be considered. Professionals should evaluate each individual to determine potential restrictions and limitations related to physical activity and help each person develop goals and a plan of action to gradually achieve those goals, with an exercise prescription (Handelsman et al., 2011).

Individuals, using strategies to achieve specific glycemic goals, must take care to reduce the risk of hypoglycemia, or low blood glucose, which causes recurring morbidity and occasional mortality. For individuals with T2DM, this involves determining the appropriate oral anti-hyperglycemic agents, as differences exist between the various available agents. Metformin has intermediate glycemic control durability (Kahn et al., 2006). However, the addition of a sulfonylurea to Metformin greatly increases the risk of hypoglycemia compared to the use of Metformin, alone, or the use of sulfonylurea with thiazolidinedione, another oral anti-hyperglycemic agent (Belsey & Krishnarajah, 2008). Other agents include dipeptidyl peptidase 4 inhibitors and bromocriptine mesylate, which are not associated with an increased risk of hypoglycemia. Practitioners should also consider whether the FPG or postprandial glucose is the main target, while considering the common adverse effects associated with each oral agent, in order to determine the best selection for each individual (Handelsman et al., 2011).

For individuals with DM, the use of any type of insulin therapy increases the complexity of disease management. Insulin is required for all individuals with T1DM, while insulin therapy should also be considered for individuals with T2DM, particularly those who have not achieved glycemic control with oral anti-hyperglycemic agents, alone. A physiologic insulin regimen providing basal and prandial insulin, such as multiple daily injections (MDI) or continuous subcutaneous insulin infusion (CSII) is recommended. MDI refers to one or more basal insulin injections to regulate blood glucose levels overnight and between meals, in addition to prandial insulin injections before each meal to regulate blood glucose levels related to eating. MDI regimen, often, yields episodes of hypoglycemia, especially among individuals who experience difficulty with adherence to the regimen. CSII, also known as insulin pump therapy, refers to the continuous infusion of short-acting insulin delivered under the skin. It is particularly useful for those with T1DM who are ambitious and well educated about DM management. Success with CSII requires extensive education, several reevaluations, and a knowledgeable practitioner or physician (Handelsman et al., 2011).

Additionally, insulin analogues may be used to achieve glycemic control. Premixed insulin is available in combinations of 70% intermediate-acting insulin and 30% regular acting insulin, providing blood glucose regulation between meals and after meals. The dosage of premixed insulin regimen is not flexible, as the injection doses cannot be changed. Premixed insulin therapy is not always successful in achieving glycemic goals and requires increased doses or frequency. However, hypoglycemia and weight gain are adverse consequences of such increases.

Instead, basal-bolus insulin therapy provides more flexibility and is useful for individuals with irregular mealtimes. This regimen involves 4 daily injections that provide basal and prandial insulin. The dosage of insulin depends on body weight, level of insulin resistance, and the amount of carbohydrate consumption at each meal. Adjustments to each basal and prandial dosage should be made to achieve glycemic control, while reducing the risk of hypoglycemia (Handelsman et al., 2011).

Diabetes Self-Management

The high rate of morbidity and complications associated with DM can be delayed and prevented by achieving and maintaining glycemic control with appropriate DM self-management (Ohkubo et al., 1995; R. C. Turner et al., 1998). Diabetes self-management (DSM) behaviors include healthy eating (including limiting high fat foods and caloric restrictions for overweight and obese individuals), physical activity, SMBG, and foot care (Shrivastava et al., 2013). Self-management of DM should also consist of acknowledging and treating symptoms related to DM, seeking appropriate medical care for specific health problems, and engaging in behaviors that reduce the risk of developing further complications and comorbidities (Glasgow & Strycker, 2000; Goodall & Halford, 1991; Shrivastava et al., 2013). Previous studies that explore effective DSM reveal adequate health professional advice (Agborsangaya et al., 2013; Sigurardóttir, 2005). Other determining elements include family behavior among older Mexican Americans and influences of spirituality, stress, and multi-caregiving responsibilities among African-American women (Samuel-Hodge et al., 2000; Wen, Shepherd, & Parchman, 2003).

SELF-MONITORING OF BLOOD GLUCOSE (SMBG)

Glycemic control and individual blood glucose targets can be achieved with comprehensive care and effective DSM. According to the ADA, daily blood glucose values generate reliable information that may aid with adjusting treatment regimens and insulin doses. SMBG provides more useful information about daily (Nathan et al., 2009). When used properly, SMBG is an essential component of modern DM management and a source of meaningful clinical data that can contribute to adequate glycemic control and positive health outcomes. Regarded as the cornerstone of DM management, SMBG is especially useful among individuals with T1DM, those receiving insulin therapy, and those with a history of asymptomatic hypoglycemia (Nathan et al., 2009). A more recently developed method of SMBG involves wearing a continuing glucose monitoring system that is known to detect glycemic variations that are often missed with the conventional method of SMBG, potentially changing the course of DM management in the future (Boland et al., 2001).

SMBG is used to achieve and maintain glycemic control, expose problems with DM management, identify and prevent hypoglycemia and severe hyperglycemia, increase motivation among individuals with DM, and improve the individual's understanding of DM and its management (Karter et al., 2001; Walford, Gale, Allison, & Tattersall, 1978). A review of studies shows a greater reduction in HbA1c when SMBG is included in a multi-component treatment regimen than in those that do not include it. However, findings from a different study show no relationship between HbA1c and SMBG among participants (Davis, Bruce, & Davis, 2006). Additionally, a systematic review of studies shows an inadequate level of effectiveness of

SMBG on glycemic control. Researchers propose that improvements in glycemic control as a result of SMBG occur only in the context of appropriate education among persons with DM and their healthcare providers (Clar, Barnard, Cummins, Royle, & Waugh, 2010). Epidemiologic data, on the other hand, suggests an association between SMBG and reduced rates of DM-related morbidity and all-cause mortality among persons with T2DM, regardless of the type of pharmacotherapy (Martin et al., 2006). Although, studies reveal at least minimal evidence of an association between SMBG and improved glycemic control and health outcomes, evidence shows a lack of adherence to SMBG among Americans with DM. By investigating the relationship between glycemic control and SMBG among individuals with DM in the U.S. population, researchers found that greater than twenty-five percent of those using insulin did not monitor blood glucose level at least once per day. Sixty-five percent of the persons using oral agents did not monitor at least one time daily, while most individuals treated with diet alone did not monitor glycemic levels (Harris et al., 1993; Harris, 2001).

There is much debate about the effectiveness of SMBG among individuals with T2DM who are not using insulin. Individuals using oral anti-hyperglycemic agents and/or diet, exclusively, are encouraged to use SMBG to determine success with achieving target blood glucose values and the possible need for treatment adjustments. However, several researchers argue that the use of SMBG among individuals not using insulin should be considered in the context of cost and inconvenience, suggesting that SMBG may be clinically beneficial but not cost-effective or the best use of time. Structure and education are identified as essential components to the success of SMBG among these persons. Other outcomes, such as quality of life and patient satisfaction, are also recognized as determinants of effective SMBG in those not using insulin (Cameron, Coyle, Ur, & Klarenbach, 2010; Polonsky & Fisher, 2013; Welschen et al., 2005).

Several studies that explore the factors influencing the frequency of SMBG among individuals with DM in the U.S. reveal significant predictors of SMBG. Using cross-sectional and longitudinal data, along with multivariate and linear regression models, findings indicate significant associations between SMBG and several determinants including the duration of the disease, insulin use, age, gender, race/ethnicity, education, English-communication ability, smoking status, and alcohol consumption. Other determinants of SMBG include whether persons have had a DM education class and the frequency of physician visits for DM care, specifically (Harris et al., 1993; Karter, Ferrara, Darbinian, Ackerson, & Selby, 2000). SMBG is less frequent among older individuals, those with lower neighborhood socioeconomic status, and those who have had fewer HbA1c tests and physician visits (Adams et al., 2003). Additionally, the frequency of SMBG has been shown to decrease with increasing age for individuals with T2DM (Evans et al., 1999). When compared to non-Hispanic whites and Mexican Americans, African Americans are 60% less likely to monitor their blood glucose at least once a day. In comparison to those with lower education levels, individuals with a college education are 80% more likely to monitor their blood glucose levels at least once a day (Harris et al., 1993).

Evidence suggests that all types of social support have a positive influence on improving DM self-management behaviors including adherence to treatment recommendations, nutritional selections, and physically active lifestyles. Additionally, social support has been shown to be positively associated with the improved ability to make healthcare decisions, enhanced psychosocial health, and less mortality (Chew et al., 2011; Gao et al., 2013; Strom & Egede, 2012; Tang et al., 2008).

Despite the extensive research about social support and its impact on DM self-management, there is little existing literature that addresses the impact of marriage. Previous studies that have examined the relationship between marriage and DM management investigate marriage quality and satisfaction (Trief et al., 2001; Trief et al., 2004). Moreover, to my knowledge, no previous study has extensively explored the association between marital status and SMBG, investigating differences between male and female and each category of marital status (single, married, divorced, separated, widowed, never married).

It has been long accepted that marriage is associated with lower rates of mortality and better health outcomes(Hu & Goldman, 1990). Kaplan and Kronick (2006) explored the relationship between marital status and all-cause mortality, along with cause-specific mortality, using data from the US national health interview survey and the national death index. The six categories of specific causes of death included infectious disease, cancer, cardiovascular disease, pulmonary disease, external causes such as homicides/suicides and accidents, and all "other" causes. By estimating the association with multivariate logistic regressions, findings showed that individuals who were never married had a greater risk of all-cause mortality (OR=1.58, CI 1.39 to 1.78) than those who were divorced or separated (OR=1.27) and widowed (OR=1.39). The researchers referred to this manifestation as the "never-married penalty." In addition to marital status, age was the strongest predictor of mortality, along with other determinants such as gender, income, race/ethnicity, and disability status. Also, those who were never married were over four times more likely to die as a result of infectious diseases. Being never married was a greater risk factor for the remaining causes of death excluding CVD, cancer, and pulmonary disease. This evidence contradicts the findings of several other studies, which indicate the divorced/separated or widowed statuses as the greatest risk factors of mortality among all marital states. However, it is difficult to draw conclusions of a causal relationship between marriage and lower mortality, or a protective effect of marriage, from cross-sectional data. An alternate conclusion addresses the potential concept of positive selection of healthier and wealthier individuals into marriage (Goldman, 1993). Yet, the protective effect of marriage remains evident after controlling for characteristics such as income, education, and health, which are believed to select individuals into marriage (Espinosa & Evans, 2008). Prospective data sets that reflect the individual-level are superior, yielding stronger evidence than that of cross-sectional data. However, studies that investigate mortality differences between men and women and the different unmarried statuses using individual-level, prospective data reveal inconsistent findings that identify the marriage protective effect for men and women (Lillard & Waite, 1995) or for men only (Zick & Smith, 1991), while there was no difference found between genders for old-age mortality (Manzoli, Villari, Pirone, & Boccia, 2007).

Rendall et al. (2011) propose two potential sources of the inconsistent findings, including the use of baseline, covariate data sets that do not appropriately reflect the time of exposure to mortality and the inappropriate use of statistical tests, failing to perform proper between group statistical analyses. As a result, they planned to resolve these inconsistent findings by using time-varying data from the U.S. Survey of Income and Program Participation and logistic regression models to estimate the yearly probability of death. The predictor variables included age, calendar year, race/ethnicity, educational attainment, working status, income earnings, and disability status. Also, statistical tests were performed to determine differences between the married and unmarried status, in addition to determining differences between ages, gender, and each unmarried status (never married, divorced/separated, and widowed). The findings showed strong, significant associations between being married and a lower probability of death among individuals ages 25-64 which decreased after controlling for socio-demographic characteristics that changed over time. The protective effects of marriage disappeared at older ages for both men (89 years) and women (84 years). Additionally, the survival benefit of marriage was lower for women than for men, but this occurrence decreased with age. There was no difference found between unmarried statuses among individuals who were 25 years of age, excluding an existing difference between divorced/separated men and widowed individuals. However, a greater risk of mortality into older age was found for divorced/separated men and women than that of men and women older than 25 years, who were never married or widowed. Similar results were found for divorced and separated men and women ages 65 and older. These findings support both proposed interpretations of a consistent protective effect of marriage that decreases with age and the selection of individuals into marriage, due to socio-demographic characteristics. Lastly, the findings give weak evidence of mortality differences between each unmarried status.

Summary

The growing prevalence of DM, in the U.S. and worldwide, and its associating complications have increased the economic burden, and the projected cost is expected to continue rising at an alarming rate. The treatment goal for individuals with DM is to achieve and maintain strict glycemic control, which often consists of a complex regimen. DM self-management, including SMBG, eating a healthy diet, being physically active, and taking medications appropriately, constitutes a large proportion of DM care. SMBG, the cornerstone of DM management, provides essential information for successfully achieving and maintaining glycemic control. The efficacy of SMBG is controversial, particularly among those not using insulin, but has been shown to improve individuals' level of understanding and glycemic control and is highly recommended by healthcare providers. Despite the evidence of its benefits, there is a lack of SMBG among individuals with diabetes mellitus, especially older adults and African Americans. Social support has been identified as a determinant of DM self-management, including SMBG, but there is very little existing literature that addresses the relationship between marriage and SMBG. Marriage, a type of structural social support, is associated with less mortality, with an additional survival advantage seen among men. There is inconsistent evidence regarding mortality differences between men and women and the different categories of the unmarried state (never married, divorced/separated, and widowed). Exploring an association between marital status and SMBG may provide more information about methods used to improve self-management among individuals with DM.

CHAPTER III - RESEARCH DESIGN AND METHODS

The National Health and Nutrition Examination Survey (NHANES) is a population-based, survey designed to collect data regarding the health and nutrition of non-institutionalized adults and children in the United States (U.S.). The survey is conducted by the National Center for Health Statistics (NCHS) as a part of the Centers for Disease Control (CDC). The NHANES is exceptional, as it is a national survey that assesses health and nutritional information using both face-to-face interviews and physical examinations. Each participant is involved in a home interview about health, disease history, and diet, while the clinical examination involves medical and physiological measurements in addition to laboratory tests. HbA1c, which is used to reflect the plasma glucose levels over the past 120 days, was one of the laboratory tests measured during the separate clinical examination, along with body mass index (BMI). Self-reported data, laboratory data, and clinical data are obtained from a representative sample of U.S. children and adults.

Cross-sectional data from the continuous NHANES 2009-2010 were analyzed to identify determinants for SMBG among participants with DM. More recent data has been released, but at the time of this study NHANES 2009-2010 was the most recent dataset released in its entirety. Analyses were conducted to determine whether marital status is a significant predictor of SMBG behavior and to examine whether marital status determines SMBG differently for males than for females.

The continuous NHANES 2009-2010 had a sample of 10,537 participants. The sample for this study was reduced to 739 participants, who reported having received a diagnosis of DM by a doctor or health professional. Those who were under 20 years of age were excluded from the sample, yielding 725 participants. Also, two participants who refused to provide marital status data were excluded. Those whose income and BMI data were missing were also excluded, leaving a remainder of 668 participants. Since age is top coded at 80 years, all participants who were 80 years and older were excluded (69 participants). Additionally, participants who reported “I don’t know” as a response for age at diagnosis, along with those with missing treatment and DM education data were excluded (131 participants). Lastly, those with missing education, HbA1c, and SMBG data were excluded. The remaining 465 participants were included in the analysis. IRB approval was not required due to the use of secondary data with no identifiers.

Measures

Variables were strategically extracted from the core survey by isolating a group of questions that addressed DM including diagnosis, medical care, and self-management practices. The extracted variables can be divided into two main components: a screening question to identify all individuals with DM and detailed questions about the participants’ condition. Also, demographic data were extracted from the core survey, including marital status. Additionally, the two variables extracted from the clinical examination were HbA1c and BMI. Duration of DM was determined by subtracting the age at diagnosis from the age at the time of screening. The frequency of self-monitoring of blood glucose (SMBG), the dependent variable, was determined by the participants’ responses to the question, “How often do you check your blood for glucose or sugar? Include times when checked by a family member or friend, but do not include times when checked by a doctor or other health professional.” Each SMBG response was transformed to reflect an annual unit of measure. Then, the variable was dichotomized into the derived variable, *checks daily,* where $\geq 365 = 1$ and $< 365 = 0$. This method was validated by comparing the number of participants (297/63.87%) who reported self-monitoring their blood glucose ≥ 1 time per day to the number of those (299/64.3%) with ≥ 365 as a response for *checks daily*, which resulted in a correlation of 0.9933126.

Statistical Analyses

Binary logistic regression analyses were used to identify the determinants of SMBG, among those with DM. First, marital status, age, race/ethnicity, education, income, DM education, and duration of diabetes variables were included in the regression as explanatory variables for all participants. Then, additional covariates of HbA1c, taking insulin, and taking anti-hyperglycemic pills were entered into the regression, along with the previously mentioned covariates, to examine whether the determinants change when controlling for DM conditions. In addition, logistic regressions were run in the same manner as mentioned above for females and males, separately, in order to examine whether marital status determines SMBG differently for men and women. Statistical significance was defined as $P < .05$, using a one-tailed test. SPSS Statistics 20.0 was used to perform the statistical analysis.

CHAPTER IV- RESULTS

Sample Characteristics

The characteristics of the 465 participants with diabetes in the sample are summarized in Table 1. Almost half (41.7%) of the participants were ≥ 65 years of age, 48% were males, and 34.2% were non-Hispanic white. About a quarter (24.5%) of the participants had a household income under $20,000. The majority of the participants were currently married or living with a partner (60.0%) and had a high school diploma/GED or greater (62.6%). The mean duration of their diabetes was nearly 12 years (11.7 ±11.0), with a large variance. Over half of the participants (54.2%) had an HbA1c ≤ 7, and the mean BMI was 33.7 ± 8.3. Nearly half of the participants (47.5%) had seen a nurse educator or dietitian not more than a year ago for diabetes education. Also, 79.4% and 29.9% of the participants reported taking anti-hyperglycemic pills and insulin, respectively, to lower blood glucose.

Self-monitoring of Blood Glucose (SMBG) According to Marital Status and Gender

Table 2 presents the percentage of participants who self-monitor their blood glucose levels daily. Sixty-four percent of the sample checked their blood glucose level at least one time a day, regardless of marital status. Of all the male participants, 60.7% checked their blood glucose level daily, while 64% of males who were currently married/living with a partner and 52% of those who were not married checked daily. Of all the female participants, 67.6% checked their blood glucose level daily, while 64.7% of females who were married/living with a partner and 70.5% of those who were not married checked daily. Marriage is shown to have different implications for male and female participants, as it seems to have positive effect on

SMBG behavior among males but not females. Logistic regression analyses establish whether or not this is a mere coincidence.

Table 1. Characteristics of the sample (n=465)

Characteristics	n (%)	Mean ± SD
Age, y		
24-34	21 (4.5)	
35-44	30 (6.5)	
45-54	78 (16.8)	
55-64	142 (30.5)	
≥ 65	194 (41.7)	
Male	224 (48.2)	
Race		
Mexican American	99 (21.3)	
Black	120 (25.8)	
White	159 (34.2)	
Other Hispanic	57 (12.3)	
Other Race, including Multi-Racial	30 (6.5)	
Education Level		
No High School Diploma	174 (37.4)	
High School Diploma/GED or Equivalent	92 (19.8)	
Associate’s Degree/Some College	134 (28.8)	
College Graduate or Above	65 (14.0)	
Income		
Under $20,000	114 (24.5)	
Over $20,000	33 (7.1)	
$20,000 to $44,999	154 (33.1)	
$45,000 to $74,999	92 (19.8)	
$75,000 to Over	72 (15.5)	
Marital Status		
Married/Living with a Partner	280 (60.2)	
Widowed	63 (13.5)	
Divorced/Separated	86 (18.5)	
Never Married	36 (7.7)	
BMI		33.7 ± 8.3
Duration of Diabetes, y		11.7 ±11.0
Education from Diabetes Specialist		
1 year ago or less	221 (47.5)	
1 to 5 years ago	78 (16.8)	
More than 5 years ago	37 (8.0)	
Never	129 (27.7)	
HbA1c		
7 or Less	252 (54.2)	
Greater than 7	213 (45.8)	
Treatment		
Pills	369 (79.4)	
Insulin	139 (29.9)	

Table 2. Percent of participants who self-monitor blood glucose daily

	All (n=465)	Male (n=224)	Female (n=241)
All	64.3	60.7	67.6
Married	64.3	64.0	64.7
Not Married	64.3	52.4	70.5

Key Determinants of Self-monitoring of Blood Glucose

The results from the binary logistic regression analyses are presented in Table 3. In the shorter logistic regression, demographics including marital status, along with duration of diabetes and diabetes education from a nurse educator or dietitian were entered. When the regression was performed for entire sample, age ≥ 65 (OR = 1.9, *P* = .016), non-Hispanic white (OR = 3.4, *P* = < .001), diabetes education 1 year ago or less (OR = 1.7, *P* = .023), and duration of diabetes (OR = 1.0, *P* < .001) were significant predictors of SMBG. When HbA1c, taking insulin, and taking pills were added to the regression, age ≥ 65 (OR = 2.5, *P* = .003), non-Hispanic white (OR = 3.1, *P* = < .001), and diabetes education 1 year ago or less (OR = 1.6, *P* = .044) remained significant predictors of SMBG, along with taking insulin (OR = 6.5, *P* = < .001) and taking pills (OR = 1.8, *P* = .034). However, duration of diabetes was no longer statistically significant (OR = 1.0, *P* = .208). Marital status was not shown to be a significant predictor of SMBG (OR = 1.0, *P* = .432).

When the shorter regression was performed for females only, age 55-64 (OR = 0.8, *P* = .031) and age ≥ 65 (OR = 1.0, *P* = .006) were significant predictors of SMBG. Also, non-Hispanic white participants were 7 times as likely as Mexican-American participants to monitor their blood glucose level (OR = 7.0, *P* = .036). Duration of diabetes was, also, a significant predictor (OR = 1.1, *P* = .011). However, statistical significance did not hold for non-Hispanic white (OR = 1.7, *P* = .125) and duration of diabetes (OR = .77, *P* = .236) when HbA1c, taking insulin, and taking pills were added to the regression. Age 55-64 (OR = 1.8, *P* = .010) and age ≥ 65 (OR = 3.3, *P* = .004) remained as statistically significant predictors of SMBG. Female participants who were taking insulin were greater than 22 times more likely to monitor their blood glucose level daily (OR = 22.3, *P* = < .001) and those taking pills were more than twice as likely to self-monitor blood glucose (OR = 2.6, *P* = .033). The regression did not show marital status as a significant predictor of SMBG among female participants (OR = 0.8, *P* = .214).

The binary logistic regression was also performed for males only. The shorter regression revealed currently married/living with a partner as a significant predictor. Participants who were currently married/living with a partner were nearly twice as likely as those who were unmarried to self-monitor their blood glucose level at least one time a day (OR =1.9, *P* = .031). Non-Hispanic white (OR = 7.0, *P* = < .001), non-Hispanic black (OR = 3.1, *P* = .008), and duration of diabetes (OR = 1.1, *P* = .001) were statistically significant predictors, also. However, statistical significance for currently married/living with a partner did not hold when HbA1c, taking insulin, and taking pills were added to the regression (OR = 1.7, *P* = .072). Non-Hispanic white (OR = 7.6, *P* = < .001), non-Hispanic black (OR = 3.4, *P* = .007), and other race, including multi-racial (OR = 3.6, *P* = .048) were significant predictors. Also, the male participants who were taking insulin were nearly 5 times as likely to self-monitor their blood glucose level daily (OR = 4.8, *P* = < .001).

Table 3. Odds of Predicting Daily Self-monitoring of Blood Glucose

	All (n = 465)		All (n = 465)		Females (n = 241)		Females (n = 241)		Males (n = 224)		Males (n = 224)	
Predictors	**Odds Ratio**	*P*	**Odds Ratio**	*P*	**Odds Ratio**	*P*	**Odds Ratio**	*P*	**Odds Ratio**	*P*	**Odds Ratio**	*P*
Married	1.0	.437	.96	.432	.75	.181	.76	.214	1.9*	.031	1.7	.072
Age, y												
24-34	1.1	.449	.85	.396	1.6	.268	.71	.352	.62	.273	.65	.310
35-44	1.4	.223	1.5	.212	1.7	.210	1.1	.448	1.1	.432	1.6	.283
45-54 (omitted)												
55-64	1.4	.119	1.4	.148	2.3*	.031	1.8*	.010	.84	.357	.91	.432
≥ 65	1.9*	.016	2.5*	.003	2.9*	.006	3.3*	.004	.97	.479	1.3	.285
Race												
Mexican American (omitted)												
Other Hispanic	1.0	.466	1.0	.474	.96	.475	.75	.299	1.3	.310	1.6	.223
Non-Hispanic White	3.4*	< .001	3.1*	< .001	2.2*	.036	1.7	.125	7.0*	< .001	7.6*	< .001
Non-Hispanic Black	1.7	.051	1.6	.063	.97	.476	.78	.293	3.1*	.008	3.4*	.007
Other incl. Multi-racial	1.8	.111	1.9	.099	1.3	.335	1.2	.405	2.8	.069	3.6*	.048
Education												
No High School Diploma	1.4	.144	1.3	.194	1.1	.407	.91	.425	1.6	.162	1.5	.187
High School Diploma/GED (omitted)												
Some College/Assoc.'s Degree	1.1	.408	.87	.333	1.1	.421	.70	.233	.84	.354	.73	.263
Bachelor's Degree or Greater	1.1	.368	1.1	.434	1.4	.274	1.3	.329	.75	.296	.74	.295
Income												
Under $20,000	1.4	.112	1.4	.109	1.2	.329	1.2	.335	1.3	.257	1.3	.271
≥ $20,000 (omitted)												
Education from Diabetes Specialist												
1 year ago or less	1.7*	.023	1.6*	.044	1.6	.109	1.4	.179	1.8	.059	1.8	.071
1 to 5 years ago	1.3	.215	1.3	.204	1.3	.255	1.5	.210	1.1	.444	1.1	.456
More than 5 years ago	0.9	.413	.73	.246	.64	.231	.47	.128	1.5	.276	1.2	.403
Never (omitted)												
Duration of Diabetes, y	1.0*	< .001	1.0	.208	1.0*	.011	1.0	.413	1.1*	.001	1.0	.128
HbA1c ≤ 7			.81	.197			.77	.236			.81	.280
HbA1c > 7 (omitted)												
Treatment												
Insulin			6.5*	< .001			22.3*	< .001			4.8*	< .001
Pills			1.8*	.034			2.6*	.033			1.96	.083
-2 Log likelihood	549.454		509.954		275.863		244.399		256.592		241.400	

Notes: Data come from the continuous National Health and Nutrition Examination Survey (NHANES) 2009 – 2010. The sample consists of adults (ages 20-79) with diabetes mellitus in the U.S. population.
*$P < .05$

CHAPTER V - DISCUSSION

This data indicates that approximately one-third (36%) of adults with diabetes in the U.S. population do not self-monitor their blood glucose level at least 1 time/day. Additionally, 32% females and 39% of males with diabetes do not self-monitor 1 time/day. More specifically, 29.5% of females who are not married do not self-monitor daily, and this is true for an even greater number (47.6%) of males who are not married. The results of this study mirror that of a previous national study of SMBG, revealing the use of insulin as a major determinant, especially among females (Harris et al., 1993).

Besides insulin use, there were other significant predictors of daily SMBG including age, race/ethnicity, and DM patient education. Among all participants, those who were ≥ 65 years were twice as likely to self-monitor daily than those who were ages 24-34. This differs from the findings of previous studies, which show a trend of decreasing odds of SMBG with increasing age (Evans et al., 1999; Harris et al., 1993). Non-Hispanic whites were 3 times more likely to self-monitor 1 time/day compared with Mexican Americans. Also, those who had patient DM education from a nurse educator or dietitian within the past 12 months were nearly twice as likely to self-monitor daily than those who never received patient DM education. The significance of the variable, duration of diabetes, did not sustain after controlling for the types of treatment including the use of insulin and oral anti-hyperglycemic pills. Also, income and education were not significantly related to daily SMBG.

Marriage has been shown to have protective effects as it relates to health and mortality. It is the belief that marriage protects against death through emphasis on health, risk reduction, and compliance with medical regimens (Rogers, 1995). Married persons have been shown to have lower risks of death compared to non-married persons, even after adjusting for additional socioeconomic variables (Johnson, Backlund, Sorlie, & Loveless, 2000). Since SMBG is a technique or regimen used by individuals with diabetes to prevent or delay morbidity and mortality, it is useful to examine the relationship between marital status and SMBG. However, marriage was independently related to SMBG for males only, when the use of insulin and pills were not included in the logistic regression. Moreover, the significance for marriage as a predictor among males was dissolved after controlling for the use of insulin and anti-hyperglycemic pills ($P = .072$). Marital status was not shown to be a significant predictor of SMBG in females or any other instance.

Men and women are believed to have vast mortality differences as it relates to marital status. Some studies report marriage protection for males and females (Lillard & Waite, 1995), females only (Zick & Smith, 1991), and no difference for old-age mortality (Manzoli et al., 2007). Another study reports marriage protection and marriage selection effects for women who were not employed full-time (Waldron, Hughes, & Brooks, 1996). Also, divorced men have been shown to have the highest death rates among unmarried groups (Hu & Goldman, 1990). However, it has been suggested that gender mortality differences, as they relate to marital status, become smaller when employment and number of children are considered (Hemström, 1996). In order to examine the differences between males and females, the relationship between several predictors and daily SMBG was analyzed, separately, for each gender. Age was independently related to SMBG among females, along with using insulin and taking anti-hyperglycemic pills. Among males, however, race and insulin use were significant predictors of SMBG.

Implications

The ultimate goal of SMBG is to achieve optimal glycemic control and prevent complications and mortality associated with DM. Since hyperglycemia and poor glycemic control is associated with several diabetes-related complications, such as retinopathy, neuropathy, and nephropathy, achieving glycemic control is the single most important aspect of disease management for individuals with diabetes. SMBG is used to help achieve glycemic control by providing knowledge of day-to-day glycemic ranges and illuminating problems with treatment. Also, the prevention or delay of further complications contributes to cost-savings, as costly conditions such as blindness and end-stage renal disease (ESRD) often occur as a result of poorly controlled diabetes. Physicians, nutrition practitioners, and diabetes nurse educators should continue to place emphasis on the use of SMBG, especially among younger adults, those who have not received DM education within the past year, and those who do not use insulin.

Study Limitations

In this continuous NHANES data 2009-2010, it was not possible to differentiate between those with T1DM and T2DM. Analyzing this data by the type of diabetes may reveal more useful findings. Additionally, this study does not examine the relationship between SMBG and glycemic control and, therefore, does not address whether those who self-monitor daily have better glycemic control than those who do not self-monitor. Likewise, this study does not address whether marital status determines glycemic control differently for males and females. These topics should be the focus of future research.

Conclusions

In conclusion, one-third of the U.S. adults with diabetes do not self-monitor blood glucose at least 1 time/day. Insulin is the main predictor of daily SMBG, while the odds of daily

SMBG increase with age. Other significant predictors of SMBG are race/ethnicity and patient DM education. There are differences among determinants of SMBG for males and females. While age, race, insulin use, and taking anti-hyperglycemic pills determine SMBG for females, only race and insulin use determine SMBG for males. Although marital status is independently associated with reduced mortality, a similar protective relationship is not shown between marital status and SMBG. Since SMBG may be useful in the achievement of glycemic control, individuals with diabetes should incorporate this practice into their regimens for diabetes self-management.

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VITA

JASMINE JONES

Phone: (662) 902 - 8184 | 414 Ritchie St.
jedixon1989@gmail.com | Clarksdale, MS 38614

EDUCATION

BS University of Mississippi, Dietetics and Nutrition — May 2011

Graduated Summa Cum Laude

HONORS AND AWARDS

Student Development Grant Award
2013

Taylor Medal Recipient — 2011

Outstanding Student in Dietetics and Nutrition — 2011

RESEARCH EXPERIENCE

Robert Wood Johnson/MS Needs, University of MS — 2012 to 2013
Research Assistant, Dr. Teresa Carithers/Dr. Laurel Lambert

Ronald E McNair Baccalaureate Program, University of MS — 2010

"The Effects of a Church-based Health Fair on Participants' Attitudes toward Healthy Eating and Increased Physical Activity"

PRESENTATIONS

Poster Presentation, "Research Assessment of Positive Outcomes in the School Nutrition Environment through Policy Implementation," Food and Nutrition Conference & Exhibition, October 2013.