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Longitudinal Effects of Depression and Sexual Dysfunction On Glycemic Control in Veterans with Diabetes

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LONGITUDINAL EFFECTS OF DEPRESSION AND SEXUAL DYSFUNCTION ON GLYCEMIC CONTROL IN VETERANS WITH DIABETES

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ABSTRACT

Diabetes rates are on the rise, particularly among members of racial and ethnic minority groups. Individuals with diabetes are more vulnerable to developing depressive symptoms when compared to those without diabetes. While there appear to be no racial and ethnic differences in depression prevalence estimates among individuals with diabetes, members of racial and ethnic minority groups are less likely to achieve glycemic control over time, and may be at greater risk for diabetes related health issues.

One such health issue is sexual dysfunction, with individuals with diabetes being more vulnerable to sexual dysfunction than those without diabetes. Sexual dysfunction may have significant biopsychosocial impacts on an individual's ability to manage their diabetes. However, the potential impact of sexual dysfunction on glycemic control is still unclear. Possible racial and ethnic differences in the prevalence of sexual dysfunction among individuals with diabetes are unknown. The relationship between, and potential long-term impact of, depression and sexual dysfunction on glycemic control has received very little attention in the diabetes research literature. This study sought to address this gap in the literature, as well as contribute more information regarding possible racial and ethnic differences in outcomes among individuals with diabetes by examining racial differences in glycemic control, the prevalence of depression and sexual dysfunction, and the longitudinal impact of these disorders on glycemic control among a national sample of veterans. Racial and ethnic differences in prevalence of depression and sexual dysfunction were expected. Additionally, significant individual and interactive impacts of

race and depression/sexual dysfunction status on glycemic control over time were expected.

Data from 50,039 veterans with diabetes were included in the current investigation. Relevant data were extracted from the Veteran's Affairs (VA) Informatics and Computing Infrastructure (VINCI), which is partnered with the Corporate Data Warehouse (CDW) that manages VA patient health records. Veterans were classified as depressed or experiencing sexual dysfunction based on ICD-9 codes for depression and sexual dysfunction. General linear mixed model regression analyses were conducted examine changes over time, represented by age, in A1C levels among the different diagnostic groups. Post-hoc curvilinear analyses of longitudinal models were also conducted.

The findings revealed racial and ethnic differences in the prevalence of depression and sexual dysfunction among veterans with diabetes, with White American veterans having higher percentage rates of depression (phi = .02) and Black American veterans having higher percentage rates of sexual dysfunction (phi = .12). Findings for both linear and curvilinear analyses of longitudinal models also revealed significant differences in A1C levels across racial and ethnic groups, as well as diagnostic groups, over time. Specifically, Black American veterans and veterans with sexual dysfunction exhibited decreasing mean A1C levels over time while White American veterans and veterans with no diagnosis exhibited gradually increasing mean A1C levels over time. Significant racial and ethnic differences in A1C levels were also present among veterans with depression. Findings suggest possible impact of race, sexual dysfunction, and depression on long-term glycemic control. Implications of the findings are discussed.

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CHAPTER 1

INTRODUCTION

Due to continually rising prevalence rates of diabetes in the last decade, there has been a strong and persistent increase in diabetes research. The Centers for Disease Control (CDC) estimates that diabetes affects nearly 26 million people in the United States, meaning that about eight percent of the U.S. population has diabetes (CDC, 2011). The majority of persons with diabetes have either type 1 or type 2 diabetes, although other types of diabetes are recognized (e.g., gestational diabetes or diabetes resulting from a specific genetic or medical condition) (CDC, 2011).

Type 1 diabetes accounts for 5% to 10% of all diagnosed cases of diabetes in adults, and develops when the body's immune system destroys pancreatic beta cells (CDC, 2011). Since these are the only cells in the body that make insulin, people with type 1 diabetes must have insulin delivered by injection or a pump in order to survive (CDC, 2011). Type 2 diabetes is more common than type 1 diabetes, accounting for about 90% to 95% of all diagnosed cases in adults. It usually begins as insulin resistance, a disorder in which the cells do not use insulin properly; as the need for insulin rises, the pancreas gradually loses its ability to produce the hormone. Type 2 diabetes is associated with a number of risk factors, including older age, obesity, family history of diabetes, history of gestational diabetes, impaired glucose metabolism, and physical inactivity (CDC, 2011).

Members of racial and ethnic minority groups are at high risk for diabetes. After adjusting for population age differences, a 2007–2009 national survey of persons aged 20 years or older indicated that 7.1% of non-Hispanic Whites, 8.4% of Asian Americans, 11.8% of Hispanics, and 12.6% of non-Hispanic Blacks had been diagnosed diabetes. Among all non-White Hispanics surveyed, rates were 7.6% for both Cubans and for Central and South Americans, 13.3% for Mexican Americans, and 13.8% for Puerto Ricans (CDC, 2011). Members of racial and ethnic minority groups, particularly Black Americans, are also at greater risk for experiencing medical complications due to diabetes when compared to White Americans (CDC, 2011).

Such prevalence rates are problematic due to their associated health risks. Adults with diabetes have heart disease death rates about 2 to 4 times higher than adults without diabetes, and the risk for stroke is 2 to 4 times higher among people with diabetes (CDC, 2011). Also, diabetes is the leading cause of new cases of blindness among adults and is the leading cause of kidney failure, accounting for 44% of new cases in 2008 (CDC, 2011). Furthermore, about 60% to 70% of all persons diagnosed with diabetes have mild to severe forms of nervous system damage, as severe forms of diabetic nerve disease is a major contributing cause of lower-extremity amputations (CDC, 2011). Given these data, and as prevalence rates continue to rise, diabetes is clearly a serious medical condition that continues to significantly impact the American people.

Diabetes and Depression

While diabetes increases the risk of many physical health conditions, research suggests that patients with diabetes may also be at risk for co-morbid mental health issues, especially depression. The results of a meta-analytic investigation of 42 studies

indicated that the odds of depression among diabetics was twice that of the non-diabetic comparison group, a finding that was not contingent upon gender, type of diabetes, subject source, or assessment method (Anderson, Freeland, Clouse, & Lustman, 2001). The results of a more recent meta-analysis of ten controlled studies also suggested that the prevalence of depression was significantly higher in patients with type 2 diabetes compared with those without, with the prevalence of depression being higher among females with type 2 diabetes compared to males with diabetes (Ali, Stone, Peters, Davies, & Khunti, 2006). Fisher, Skaff, Mullan, Arean, Glasgow, and Masharani (2008) explored the prevalence of affective disorders, depressive affect, and diabetes- specific emotional distress (i.e., negative emotions towards diabetes and its treatment) over time among 506 patients with type 2 diabetes. They found that patients with type 2 diabetes displayed high rates of affective disorders over an 18-month period, relative to community adults. Specifically, patients with diabetes had 60% higher rates for major depressive disorder and 7% higher rates for dysthymia (persistent depressive episodes lasting longer than two years) compared to community adults without diabetes, with women and younger patients being at high risk for both conditions over time (Fisher et al., 2008).

deGroot, Pinkerman, Wagner, & Hockman (2006) found no differences in depression scores between racial and ethnic groups or diabetes type, but results also suggested that Black Americans were less likely to report any depression treatment, receipt of antidepressant medications, or receipt of treatment from a mental health professional compared to White Americans. Wagner, Tsimikas, Heapy, de Groot, and Abbott (2007), reported similar findings in a study in which scores for depressive

symptoms were similar among White American, Black American, and non-White Hispanic patients with diabetes. However, Black Americans reported lower rates of physician-diagnosed depression than White Americans, and those Black Americans who endorsed depressive symptoms reported marginally lower rates of pharmacotherapy than White Americans.

Overall, the results of these studies indicate that the prevalence of depression appears to be higher among patients with diabetes when compared to the general population. While there do not appear to be racial and ethnic differences in depression scores among diabetes patients, depression may often go undiagnosed in Black American diabetes patients. Black Americans are also less likely to receive treatment for depression when compared to White Americans. These issues may be related to racial and ethnic differences in the presentation of depressive symptoms, with Black Americans endorsing more somatic symptoms than affective symptoms or changes in mood when compared to White Americans (Baker, Okwumabua, Philipose, & Wong, 1996; Brown, Schulberg, & Madonia, 1996; Das, Olfson, McCurtis, & Weissman, 2006). This presentation may lead to providers to assume that there is only a physical health issue that needs to be treated and not a psychological issue. There are also racial and ethnic differences in attitudes about treatment for depression. A recent study of older Americans (individuals over age 60) revealed that depressed older adults endorsed a high level of public stigma about mental health treatment, and were not likely to be currently engaged in or seek mental health treatment for their depression (Conner, Copeland, Grote, Koeske, Rosen, et al. 2010). The also found that Black American older adults were more likely to internalize stigma and endorsed less positive attitudes toward seeking mental health treatment than

their White American counterparts. Such findings highlight the importance of understanding the impact of depression within a diabetes population, possibly paying particular attention to Black Americans to ensure accurate diagnosis and treatment of their depression.

Impact of Diabetes and Depression on Physical Health

Given the high prevalence of depression among patients with type 1 and type 2 diabetes, there has been a growing interest in how depression impacts diabetes-related health complications and medical outcomes. The results of one meta-analytic investigation revealed a significant association between depression and a variety of diabetes complications among patients with type 1 and type 2 diabetes, including diabetic retinopathy, nephropathy, neuropathy, macrovascular complications, and sexual dysfunction (de Groot, Anderson, Freedland, Clouse, & Lustman, 2001). Other study results indicate that individuals with diabetes and depression report a poorer quality of life, including both physical and mental health difficulties, more frequently than those without depression (Ciechanowski, Katon, & Russo, 2000; Kaholokula, Haynes, Grandinetti, & Chang, 2003). This particular outcome may be related to poor control of diabetes, such that depressed mood may result in less motivation to properly manage diabetes or feelings of hopelessness about one's ability to manage diabetes. In addition, Zhang, Norris, Gregg, Cheng, Beckles, and Kahn (2005) found that severe depressive symptoms significantly elevated the risk for mortality among U.S. adults with diabetes.

One of the more commonly studied diabetes-related outcomes is glycemic control. Glycemic control is fundamental to the management of diabetes (American Diabetes Association, 2005). The most common techniques for effective assessment of

glycemic control are self-monitoring of blood glucose by diabetes patients and health care providers performing A1C tests every two to three months. Lower A1C levels have been associated with lower risk of diabetes-related health complications, including heart attacks, cardiovascular-related deaths, and reduction of microvascular and neuropathic complications (American Diabetes Association, 2005).

Research examining the relationship between depression and glycemic control has provided mixed results. The results of a meta-analytic investigation of 24 studies measuring the association between depression and glycemic control, as indicated by an assessment of total glyco-hemoglobin (GHb), suggested that depression was associated with poor glycemic control (hyperglycemia) among patients with type 1 and type 2 diabetes, although the direction of the relationship was not specified (Lustman, Anderson, Freedland, de Groot, Carney, and Clouse, 2000). The results of several studies have shown a significant relationship between depression and A1C levels in individuals with type 1 diabetes, suggesting that the more severe the depression, the worse the glycemic control (Ciechanowski, Katon, Russo, & Hirsch, 2003; Lustman, Clouse, Ciechanowski, Hirsch, & Freedland, 2005; Pouwer & Snoek, 2001). However, the results of other studies have shown no evidence of a relationship between depression and A1C levels in persons with type 2 diabetes (Ciechanowski et al., 2000; Ciechanowski et al., 2003; Kaholokula et al., 2003; Lee, Chapa, Kao, Jones, Kapustin, et al. 2009). Such a variety of findings could be due to most of these studies having a cross-sectional vs. longitudinal designs, as well as differences in populations used and covariates examined.

Recent research suggests that racial and ethnic minorities, particularly members of non-White Hispanic and Black American populations, are less likely than members of

non-Hispanic White populations to achieve glycemic control (Fan, Koro, Fedder, & Bowlin, 2006; Saydah, Cowie, Eberhardt, DeRekeneire, & Narayan, 2007; Suh,, Choi, Plauschinat, Kwon, & Baron, 2010). A number of factors have been investigated in order to better understand and explain this health disparity, including racial and ethnic differences in the access to health care and prescription drug coverage, differences in preventative care practices, receipt of less optimal care from providers, and biological and socioeconomic factors (Kirk, D'Agostino, Bell, Passmore, Bonds, et al., 2006).

Racial and ethnic differences in depression are another factor potentially maintaining the racial and ethnic differences in glycemic control. The relationship between depression and glycemic control among racial and ethnic minority populations has been investigated in a few studies, with most studies focusing on Black American populations. Gary, Crum, Cooper-Patrick, Ford, and Brancati (2000) found that among Black Americans with type 2 diabetes, depressive symptoms were marginally associated with higher A1C levels, but was significantly associated with higher levels of total cholesterol and triglyceride. In an ethnically diverse sample of elderly diabetes patients, another study found a weak relationship between depression and A1C, but also found that depression did not predict change in glycemic control (Trief, Moin, Izquierdo, Teresi, Eimicke, et al., 2006). Recently, Wagner, Abbott, Heapy, and Yong (2009) found that higher depressive symptoms were associated with higher A1C, more long-term diabetes complications, and more diabetes medications among a sample of Black Americans. The findings of these studies suggest a relationship between depression and poor diabetes control among Black Americans. However, it appears that more studies exploring

multiple racial and ethnic minority populations are needed to better understand possible racial and ethnic differences.

Generally, depression appears to be related to increased diabetes complications, poorer quality of life, and increased mortality risk among patients with diabetes. Although the results are mixed, depression also appears to have some relationship to glycemic control among patients with diabetes, particularly among Black Americans.

Diabetes, Depression, and Sexual Dysfunction

Sexual dysfunction is another diabetes-related complication that can potentially be associated with both depression and diabetes. Both male and female patients with diabetes report difficulties with sexual dysfunction. Estimates of the prevalence of sexual dysfunction in women with diabetes range from 18 to 42%, while prevalence estimates of erectile dysfunction in men with diabetes ranges from 20 to 75% (National Diabetes Information Clearinghouse, 2008).

Results of a recent review of studies investigating sexual dysfunction in women with diabetes revealed that type 2 diabetes seemed to have a greater impact on women's sexuality than type 1 diabetes, which the authors hypothesized may be related to age, menopausal status, co-morbid factors, or social and psychological factors (Giraldi and Kristensen, 2010). Sexual problems in women with diabetes mostly include lack of sexual desire, sexual dissatisfaction, orgasmic disorder, arousal disorder and poor lubrication (Bultirini, Carosa, Colpi, Poccia, Iannarelli, et al, 2004). Some research findings suggest that neuropathy, vascular impairment, and psychological complaints are possible risk factors of female sexual dysfunction in diabetic women (Amaral, Oliveira, & Ramalho-Santos, 2008), while other findings suggest that the incidence of sexual

dysfunction in women with diabetes may be less related to physical diabetes complications and more related to psychological factors, including quality of the partner relationship and coexisting depression (Enzlin, Mathieu, Van Den Bruel, Vanderschueren, & Demyttenaere, 2003; Giraldi & Kristensen, 2010).

Men who have diabetes are two to three times more likely to have erectile dysfunction than men who do not have diabetes, and men with diabetes may experience erectile dysfunction as much as 10 to 15 years earlier than men without diabetes (NDIC, 2008). Research findings suggest that diabetes causes damage to nerves throughout the body including the penis, making neuropathy a major risk factor for erectile dysfunction (Agostini, Rossi, & Pajalich, 2006; Zdravko, Kamenov, Tsanka, & Yankova, 2007). While some research findings suggest that significant risk factors for sexual dysfunction in men, but not women, included BMI, duration of diabetes, and diabetic complications (Enzlin, 2003), other research findings indicated no major gender differences between sexual dysfunction and age, diabetes status, duration of diabetes and hypertension (Ziaei-Rad, Vahdaninia, & Montazeri, 2010).

There is very little research estimating the prevalence of sexual dysfunction among members of racial and ethnic minority groups in the general population and reported rates of sexual dysfunction for men appear to be inconsistent. Laumann, Paik, and Rosen (1999) found racial and ethnic differences in the prevalence of sexual problems among a sample of 1,410 men and 1,749 women, namely that Black Americans appeared more likely than White Americans and non-White Hispanics to have sexual problems, and non-White Hispanics appeared less likely to have sexual problems. These results were particularly significant among women, with specific problem areas including

lack of desire for sex, arousal difficulties, inability to achieve climax or ejaculation, anxiety about sexual performance, climaxing or ejaculating too rapidly, physical pain during intercourse, and not finding sex pleasurable (Laumann et al., 1999). However, Saigal, Wessells, Pace, Schonlau, and Wilt (2006) found among a sample of 3566 men, that non-White Hispanic men, younger than 50 years of age, had more than twice the prevalence of erectile dysfunction compared with similar non-Hispanic Black and non-Hispanic White men.

Another study examining racial and ethnic differences in sexual dysfunction among middle-aged women found significant group differences for sexual arousal, pain during intercourse, desire, and frequency of sexual intercourse. Specifically, Black American women reported higher frequency of sexual intercourse than White American women; non-White Hispanic women reported lower physical pleasure and arousal; and Chinese women reported more pain and less desire and arousal than the white women, as did the Japanese women (Avis, Zhao, Johannes, Ory, Brockwell, & Greendale, 2005).

Unfortunately, no studies were found that estimated the prevalence of sexual dysfunction among members of racial and ethnic minority groups with diabetes, although some studies estimated the prevalence of erectile dysfunction among members of racial and ethnic minority groups with other chronic diseases, including prostate cancer and heart failure (Siegel, Moul, Spevak, Alvord, & Costabile, 2001; Hebert, Lopez, Castellanos, Palacio, Tamariz, & Arcement, 2008). Given that diabetes is the leading contributor to erectile dysfunction and is also significantly related to sexual dysfunction in women, knowledge of racial and ethnic differences in prevalence rates could enhance understanding and possibly treatment of sexual dysfunction among those with diabetes.

Similar to the literature on the relationship between depression and glycemic control, study results regarding a relationship between sexual dysfunction and glycemic control are mixed. Only a few studies have examined the relationship between sexual dysfunction and glycemic control. Some studies have found no relationship between sexual dysfunction and levels of A1C among both genders (Shiri, Ansari, & Hassani, 2006; Ziaei-Rad et al., 2010). Other studies have identified glycemic control as an independent predictor of sexual dysfunction in men (Khatib, Jarrah, Shegem, Bateiha, Abu-Ali, & Ajlouni, 2006), while others have found no relationship between glycemic control and sexual dysfunction in women (see Giraldi & Kristensen, 2010). Overall, it appears that further research is needed to better understand the possible association between sexual dysfunction and glycemic control, particularly among men.

Sexual dysfunction, specifically loss of interest in sexual activity, is a common symptom of depression, and the occurrence of sexual dysfunction appears to be consistently higher in patients with depression than in the general population (Kennedy & Razvi, 2009). Kennedy, Dickens, Eisfeld, and Bagby (1999) found that among 55 males and 79 females diagnosed with major depression, some of the frequently reported sexual problems in untreated patients with depression included reduction in sexual desire (approximately 40% of men and 50% of women), difficulties with erection/ejaculation (22% of men), or difficulties with orgasm (15% of women). Also, it seems that the relationship between sexual dysfunction and depression could be bidirectional, in that the presence of either one of these conditions may trigger or exacerbate the other (Kennedy & Razvi, 2009).

Patients with diabetes and depression may be particularly vulnerable to the effects of sexual dysfunction. However, very few studies have examined the relationship between depression and sexual dysfunction among patients with diabetes. Results of a recent review of the literature on sexual dysfunction and women with diabetes revealed that depression appeared to be a significant risk factor for female sexual dysfunction (Giraldi & Kristensen, 2010). Among men with diabetes, the risk of erectile dysfunction was found to be higher in those with depression compared to those without depression (Shiri et al., 2006); no studies examining racial and ethnic differences were found. Given the potential impact depression has on patient management of their diabetes, and the increased physical and psychological impact that sexual dysfunction may have on patient management of their diabetes, more information is needed regarding the impact of depression and sexual dysfunction on diabetes management, particularly on glycemic control; racial and ethnic differences also need to be further explored.

Summary

Diabetes prevalence rates are on the rise, particularly among members of racial and ethnic minority groups. Patients with diabetes are more vulnerable to developing depressive symptoms when compared to those without diabetes, with some racial and ethnic differences in treatment and rates of diagnosis. Depression appears to influence the relationship to diabetes-related health complications, including glycemic control. Based on published studies, there appears to be no racial and ethnic differences in depression prevalence estimates among diabetes patients; however, racial and ethnic minorities are less likely to achieve glycemic control, and may be at greater risk for diabetes related health issues.

One of the many health complications related to diabetes is sexual dysfunction, with diabetes patients being more vulnerable to sexual dysfunction than those without diabetes. The results of a possible relationship between sexual dysfunction and glycemic control are inconsistent, and while there is some research examining racial and ethnic differences in the general population, the findings are also inconsistent and there is very little research examining racial and ethnic differences in the prevalence of sexual dysfunction among individuals with diabetes. Despite the risk of depression among those with diabetes and the potential psychological impact of sexual dysfunction, the relationship between, and the impact of, depression and sexual dysfunction has received very little attention in the diabetes research literature.

The Current Study

This study was designed to address gaps in the diabetes literature by contributing more information regarding racial and ethnic differences. Specifically, this study was designed to test racial and ethnic differences in the prevalence of depression, and, to the best of this author's knowledge, will be one of the first investigations designed to examine racial and ethnic differences in sexual dysfunction among men with diabetes. The purpose of this study is to explore the potential impact of depression and sexual dysfunction on glycemic control among individuals with diabetes, namely if individuals with diabetes diagnosed with depression and/or sexual dysfunction (i.e., depression only, sexual dysfunction only, or comorbid depression/sexual dysfunction) have more difficulties with glycemic control compared to individuals with diabetes who have neither disorder. This study was designed to explore the possibility of a longitudinal impact of these disorders on glycemic control, as well as possible racial and ethnic differences.

This study is designed to explore these questions using a sample of veterans. Diabetes is highly prevalent among veterans. Of 877,775 veterans surveyed by Miller, Safford, and Pogach (2004), the prevalence of diabetes among veterans was 19.6% in 2000, and the annual incidence of diabetes in veterans is approximately 2% per year. Diabetes is the third most common diagnosis in the VA system, affecting 25% of 22,645 VA patients surveyed by Reiber, Au, McDonell, and Fihn (2004).

Also, the prevalence of depression among veterans with diabetes and the possible impact of depression on glycemic control among members of this population have been examined in few studies. According to the Veterans Health Administration (VHA) External Peer Review Program (EPRP), 85% of 21,489 veterans have received annual depression screenings since fiscal year 2004 (Office of Quality Performance, 2006), and on average, almost 9% of veterans screen positive for depression (Desai, Rosenheck, & Craig, 2006). In regards to glycemic control, one study using a cohort of veterans with type 2 diabetes to investigate the longitudinal effects of depression on glycemic control found a significant relationship between depression and glycemic control as measured by A1C, and that depression appeared to be associated with persistently higher A1C levels over time (Richardson, Egede, Mueller, Echols, & Gebregziabher, 2008). Also, similar to the non-veteran population, veterans who are members of racial and ethnic minority groups have been found to have poorer glycemic control (higher A1C levels) when compared to White American veterans (Egede, Mueller, Echols, & Gebregziabher, 2010).

Given these findings it may be beneficial to start to explore this study's research questions using a sample of veterans. While this research could improve the overall health and management of diabetes among veterans, particularly racial and ethnic

minority veterans, it could also inform possible future investigations of these issues in the general diabetes population. The specific research questions and hypotheses are as follows:

- Question 1: Are there racial and ethnic differences in the prevalence rates of depression among veterans with diabetes?
    - Hypothesis 1: Consistent with existing literature, there will be racial and ethnic differences in rates of depression among veterans with diabetes, with White American veterans having higher rates than Black American veterans.
- Question 2: Are there racial and ethnic differences in rates of sexual dysfunction among veterans with diabetes?
    - Hypothesis 2: There will be racial and ethnic differences in rates of sexual dysfunction, with racial and ethnic minority veterans with diabetes having higher rates than White American veterans.
- Question 3: Are there longitudinal racial and ethnic differences in A1C levels (glycemic control) among veterans with diabetes?

  Hypothesis 3: Consistent with existing literature, there will be longitudinal racial and ethnic differences in A1C levels, with racial and ethnic minority veterans having higher A1C levels compared to White American veterans over time.
- Question 4: Do veterans with diabetes experiencing depression and/or sexual dysfunction have higher A1C values (poorer glycemic control) over time

compared to diabetic veterans with neither depression nor sexual dysfunction? Are there racial and ethnic differences in A1C values?

- Hypothesis 4: Veterans with diabetes experiencing depression and/or sexual dysfunction are expected to have higher A1C levels over time compared to veterans with diabetes with neither disorder. Racial and ethnic differences are also expected, with members of racial and ethnic minority groups having higher A1C levels within each diagnostic group.

Overall, this study will provide more information about the impact of depression and sexual dysfunction on veterans with diabetes and their abilities to manage their diabetes, while highlighting the possibility of racial and ethnic differences. This research will further inform future investigations of these issues in the general diabetes population.

CHAPTER 2

METHODS

Study Data

The data for this study were extracted from the Veteran's Affairs (VA) Informatics and Computing Infrastructure (VINCI), which is partnered with the Corporate Data Warehouse (CDW) and provides VA researchers access to integrated national datasets and tools for analysis in a secure, high-performance computing environment. The data are accessible to authorized users only, who log onto VINCI via a virtual private network connection (VPN) or through a computer on the VA intranet through a Secure Gateway. VINCI stores the requested data on a Standard Workspace. By Office of Research and Development (ORD) policy, VINCI is not authorized to allow the transfer of any patient-level data out of its secure environment without special permission. To ensure data security, VINCI created a File Transfer Utility to facilitate all data transfers including the transfer of tables and graphics generated as part of routine analysis.

The data for this study entailed records of inpatient and outpatient visits to VAMC's throughout the nation, including primary care visits and specialty care visits. The clinical data obtained for this study included: International Classification of Diseases, Ninth Edition (ICD-9) diagnostic codes for type 2 diabetes, depression and sexual dysfunction; laboratory data with HbA1c results; ICD-9 diagnostic codes for the

possible comorbid diagnoses of hypertension, coronary heart disease, and stroke; and demographic data, including age, race, gender, marital status, and state of residence.

Study Population

A national cohort of 105,411 veterans with diabetes who had received a diagnosis of depression and/or sexual dysfunction between June 2007 and June 2012 were identified. Racial and ethnic groups included were then as non-Hispanic White (NHW), non-Hispanic Black (NHB), and Other (Asian, Native Hawaiian/Pacific Islander, and Native American/Alaskan Native). There were several collection methods for race included in the raw data, including "observer", "proxy", "unknown", or no collection method specified. Only veterans with a "self-identification" method associated with race were included, as it was deemed to be the most reliable source of race information. It should be noted that although non-White Hispanic populations were discussed in the Introduction, non-White Hispanic veterans were not clearly identified in this study's sample, likely due to a coding issue in the database; this issue will be discussed further in the Discussion. Veterans diagnosed with schizophrenia and/or bipolar disorders were excluded from the analyses to be consistent with the overall purpose of the investigation.

Design and Procedures

Measures

Diagnoses of depression and sexual dysfunction were determined based on ICD-9 codes associated with billable encounters found in patient medical records. In other words, diagnoses were determined based on a veteran having at least one clinical encounter during which depression or sexual dysfunction was identified as a primary or secondary issue noted during the appointment. Veterans were then classified into four

diagnostic categories based on the ICD-9 codes. Veterans with at least one ICD-9 code for depression (296.2, 296.3, 296.9, 300.4, 311) were included in the depression only group; veterans with at least one ICD-9 code for sexual dysfunction (320, 799.81, V41.7) were included in the sexual dysfunction only group; veterans with at least one ICD-9 code for both depression and sexual dysfunction were included in the comorbid depression/sexual dysfunction group; and veterans with no ICD-9 code for either depression or sexual dysfunction were included in the no diagnosis group.

For this study, glycemic control was defined by lab test results for hemoglobin A1C. A1C test results show a patient's average blood sugar level over time. The result is reported as a percentage. The American Diabetes Association (ADA) recommends that diabetes patients keep their A1C levels less than 7%, which is considered normal glycemic control; an A1C level greater than 8% is considered poor glycemic control. (ADA, 2005). Results of lab test data for A1C in a given 3-month time interval was extracted from patient medical records. The 3-month interval was chosen because A1C levels are generally measured every three months, which is the approximate lifespan of the red blood cells that store blood glucose information. For patients with two or more A1C values in a given 3- month time interval, the most recent A1C value for that interval was used as it would include the most recent blood glucose information stored in the red blood cells.

Data Analytic Strategy.

Several analyses were conducted to obtain descriptive statistics and to test the study hypotheses. Descriptive information was obtained by comparing demographic and clinical variables across the four diagnostic groups (Table 2.1). Descriptive statistics

revealed that females and members of the "Other" racial and ethnic group comprised only small percentages of the total sample at 7% and 5%, respectively. These groups were removed from further study analyses, due to the difficulty of making meaningful statistical inferences about these populations given the small sample sizes and the heterogeneity of the 'Other' racial and ethnic group.

The age range for the participants in the sample was large (i.e., 23-years-old to 103-years-old), which highlights the heterogeneity of the sample. Given this study's accelerated longitudinal design, it is standard procedure to rescale the 'Time' variable to age, which models participants to enter and leave the study at different times as opposed to modeling them all as covering the same time in each participant's lives. To rescale time to age, a person–period dataset was created for each patient to cover 3-month intervals from June 2007 to June 2012 to correspond with patient A1C results data. Each 3-month interval was then assigned a corresponding number to create the time variable 'Time-Period' (i.e., June 2007 = Time-Period 0). The 'Time-Period' values and the minimum age for the sample (23-years-old) were then used to create a new time variable accounting for age, 'Time', using the following formula: Time= ((Patient Age – 23) + (.25*Time-Period))/Constant. The normality of the distribution of the newly created time variable was assessed and while the distribution was found to be normal, the tail ends of the distribution were long. Cases below the 25^{th} and above the 75^{th} percentiles were dropped to remove the extreme cases from the study, leaving 52,039 patients in the final study sample.

To examine racial and ethnic differences in the rates of depression and sexual dysfunction (Hypotheses 1 and 2), chi-square analyses of depression and sexual

dysfunction diagnoses by racial and ethnic group were conducted. General linear mixed models were used to test hypotheses 3 and 4. To address hypothesis 3, a general linear model was conducted to compare unadjusted mean A1C values across all time points for each of the racial and ethnic groups. Next, a linear mixed model approach was used to model the relationship between A1C levels as a continuous variable and race and ethnicity over time. The model included A1C as the dependent variable (y), and race (x) and time (t) as primary variables of interest, and the interaction between x and t (y on x, t, and x*t).

Similar procedures were used to examine A1C levels over time among veterans with diabetes in the four diagnostic groups (Hypothesis 4). Again, a general linear model approach was used to compare unadjusted mean A1C values across all time points, this time for each of the depressed/sexual dysfunction diagnostic groups, and a general linear mixed model approach was used to examine changes over time in A1C levels among the different depressed/sexual dysfunction diagnostic groups, as well as to explore possible racial and ethnic differences in A1C levels within diagnostic groups. Model building occurred in a hierarchical fashion. The first linear model contained A1C as a dependent variable (y), and diagnostic group (x) and time (t) as the primary fixed effects of interest. Thus, the first model included x, t, and the interaction between x and t (y on x, t, and x*t). To examine possible racial and ethnic differences within diagnostic groups, a second linear fitted with the diagnostic group as a primary fixed effect of interest and race as a further adjustment variable (y on x, t, and race), along with the interaction term between race and the diagnostic group (y on x, t, race, and x*race). A final model was fitted to examine the impact of other covariates on racial and ethnic differences within diagnostic

groups. All models contained a person-level random effect to account for correlation of A1C values within individuals. Also, least square means were obtained from all models to compare adjusted mean A1C values for the different diagnostic groups. All statistical tests were conducted in SAS, using a two-tailed $\alpha=0.05$ level of significance.

Table 2.1- Original sample demographic and clinical characteristics

	Depression	Sexual Dysfunction	Depression/ Sex Dysfunction	Neither Diagnosis	All
N	76,048	1,744	20,323	7,296	105,411
(%)	(72%)	(2%)	(19%)	(7%)	
Mean A1C values	7.23	7.33	7.44	7.25	7.31
(S.D.)	(1.51)	(1.46)	(1.65)	(1.56)	(1.53)
Mean age in years	66.6	67.3	65.4	69.8	66.5
(S.D.)	(11.17)	(8.78)	(8.49)	(11.16)	(9.90)
Sex (%)					
Male	91.5	99.9	99.3	95.5	93.4
Female	8.5	0.11	0.68	4.55	6.6
Race/ethnicity (%)					
Black	13.7	25.3	22.8	15.0	15.9
White	81.5	69.1	72.0	79.6	79.3
Other	4.7	5.3	5.2	5.4	4.9
Marital Status (%)					
Never Married	8.3	6.4	6.1	8.4	7.9
Married	54.0	55.0	57.2	51.7	54.5
Separated	3.4	3.7	4.4	3.2	3.6
Divorced	25.3	28.7	26.4	26.2	25.6
Widowed	9.1	6.2	5.8	10.5	8.5
Hypertension (%)	91.0	93.6	93.8	90.0	91.5
Heart Disease (%)	48.5	50.1	48.2	52.9	48.8
Stroke (%)	23.5	23.2	23.2	25.6	23.6

CHAPTER 3

RESULTS

This study included data from a national sample of 52,039 veterans. The mean age was 66-years-old (M = 66.0, SD = 2.80), with ages ranging from 60 to 70-years-old, and 59% of the sample self-identified as married. Eighty-six percent (86%) were White American and 15% were Black American. Sixty-eight percent (68%) had been diagnosed with depression only, 2% with sexual dysfunction only, 24% with comorbid depression/sexual dysfunction, and 6% had neither diagnosis. See Table 3.1 for additional demographic information for the sample.

Hypotheses 1 & 2: Depression and Sexual Dysfunction Prevalence

Chi-square results revealed racial and ethnic differences in the prevalence of depression among veterans with diabetes [χ^2 (2, N = 52,039) = 30.64, p < .0001], with White American veterans having higher rates of depression (91%) than Black American veterans (90%). However, the effect size for this analysis was small (phi = .02), which suggest that despite the statistical significance of the Chi-square finding, the overall differences in depression rates between White American veterans and Black American veterans was not large. Chi-square results also revealed significant racial and ethnic differences in the prevalence of sexual dysfunction [χ^2 (2, N = 52,039) = 721.06, p < .0001], with Black American veterans having higher rates of sexual dysfunction (38%) than White American veterans (24%). The effect size for this analysis was also small (phi = .12), which suggests that despite the statistical significance of the Chi-square finding,

the overall differences in sexual dysfunction rates between Black American veterans and White American veterans was also not large.

Hypothesis 3: Racial and Ethnic Differences in A1C Levels over Time

Table 3.2 shows the results for examining racial and ethnic differences in changes in A1C levels over time. Results indicate there was a significant race-by-time interaction (β= -.30, t (51,997) = -5.77, p <.0001), indicating a significant difference in the changes of mean A1C levels over time between White American and Black American veterans. Figure 3.1 depicts these mean changes in A1C levels over time, demonstrating a decrease in mean A1C levels for Black American veterans as age increases, whereas mean A1C levels for White Americans increased in relation to an increase in age. Specifically, the mean A1C level for Black American veterans decreased from about 7.3% at age 60 to about 7.2% by age 74. Conversely, the mean A1C level for White American veterans increased from about 7.1% at age 60 to about 7.2% by age 74.

Hypothesis 4: Diagnostic Group Differences in A1C Levels over Time

Table 3.3 shows the results of Model 1 with A1C level as the dependent variable and diagnostic group as independent variable (adjusted for time). Results indicate a significant difference in A1C levels between veterans with a diagnosis of depression and/or sexual dysfunction and those without either diagnosis. Specifically, veterans with sexual dysfunction only had significantly higher A1C levels when compared to veterans with no diagnoses of depression or sexual dysfunction (β= .13, t (51,996) = 2.79, p = .01). Least square mean results for this model indicate a statistically significant mean difference in A1C levels between veterans with sexual dysfunction and those with no diagnosis, specifically, A1C levels for veterans with sexual dysfunction were 0.08

percentage points higher than A1C levels for veterans with no diagnosis (95% CI [0.03, 0.12], $p = 0.001$). Additionally, there were no significant diagnostic group-by-time interactions, indicating that there were no significant differences in the changes of mean A1C values as veterans within each diagnostic group increased in age (Figure 3.2).

A second model was run to examine possible racial and ethnic differences in A1C levels within each diagnostic group over time. Table 3.4 shows the results of Model 2 with A1C as the dependent variable and race and diagnostic group as independent variables (adjusted for time). Results revealed a significant race*group*time interaction for veterans in the depression group (β= -0.42, t (51,996) = -2.02, p = .04), indicating a significant difference in the changes of mean A1C levels over time between Black American veterans and White American veterans diagnosed with depression. Figure 3.3 presents these mean changes in A1C levels over time, demonstrating a decrease in mean A1C levels for Black American veterans diagnosed with depression as age increases, whereas mean A1C levels for White American veterans with depression increased in relation to an increase in age. Specifically, the mean A1C level for Black American veterans with depression decreased from about 7.3% at age 60 to about 7.2% by age 74. Conversely, the mean A1C level for White American veterans with depression increased from about 7.1% at age 60 to about 7.2% by age 74.

Building on Model 2, a third model was run to examine the impact of additional disease co-morbidities on possible racial and ethnic differences in A1C levels within each diagnostic group over time. Table 3.5 shows the results of Model 3 with A1C as the dependent variable, race and diagnostic group as independent variables (adjusted for time), and hypertension, coronary heart disease, and history of stroke as disease

covariates. Results revealed that the significant race*depression*time interaction found in Model 2 was maintained in this model (β= -.43, t (50,564) = -2.05, p = .04). Figure 3.4 presents these mean changes in A1C levels over time, demonstrating the same trend found in Model 2: a decrease in mean A1C levels for Black American veterans diagnosed with depression from about 7.3% at age 60 to about 7.2% by age 74 and an increase in mean A1C levels for White American veterans with depression from about 7.1% at age 60 to about 7.2% by age 74.

Post-hoc Analyses: Assessing for Curvilinear Trajectories

Upon closer analysis of the simple slopes for the linear model analyses, it seemed important to assess for possible curvilinear trajectories in the data. The linear modeling results suggested that A1C levels for veterans with diabetes gradually increased for White American veterans or decreased for Black American veterans as they get older. However, it's possible that the change in A1C over time is better understood as a curvilinear relationship, such that A1C levels should reach and optimal level (i.e., less than 7% for individuals with diabetes), and then stabilize rather than continue to increase or decrease as they get older. A curvilinear model may also provide more accurate information regarding the rate of change in A1C levels over time. For example, an individual newly diagnosed with diabetes could have a more rapid improvement in A1C levels initially as they take more deliberate steps to maintain healthy blood sugar levels, but then the rate of change slows as A1C levels begin to stabilize, assuming the individual's blood sugar levels remain under control.

Given the possible real-life trajectories for change in A1C levels, new analyses were conducted to fit the proposed longitudinal hypotheses (hypotheses 3 and 4) with

quadratic modeling. Specifically, while the previously tested linear model for racial and ethnic differences in A1C levels over time included A1C as the dependent variable (y), and race (x) and time (t) as primary variables of interest, and the interaction between x and t (y on x, t, and x*t), the non-linear model included A1C as the dependent variable (y), and race (x), time (t), and the quadratic term for time (t^2) as primary variables of interest, and the interactions between x, t, and t^2 (y on race, t, race*t, t*t^2, and race*t^2). The same modeling procedure was used for exploring a quadratic relationship for changes in A1C levels over time for veterans with depression and/or sexual dysfunction (y on x, t, x*t, t*t^2, and x*t^2), and possible racial and ethnic differences in A1C levels over time (y on race, x, t, race*x, race*t, x*t, race*t^2, x*t^2, t*t^2, race*x*t, and race*x*t^2). All models included a person level random effect to account for within-individual correlations of A1C values. Because t and t^2 are highly correlated, contrast tests for each two, three, and four-way interaction with the t or t^2 term were conducted as well as a contrast test for the goodness of fit for the quadratic model.

Results for Curvilinear Modeling

Racial and ethnic differences in A1C levels over time.

Table 3.6 shows the results for examining a curvilinear relationship for racial and ethnic differences in changes in A1C levels over time. Results indicate that there was a significant contrast test for race*t and race*t^2, indicating that race had a significant effect on A1C levels over time ($p < 0.001$). The contrast testing for improvement in goodness of fit of the quadratic modeling was also significant ($p < 0.001$), indicating the quadratic modeling of this analysis was a better fit than the linear modeling. Figure 3.5 depicts mean changes in A1C levels over time, demonstrating that Black American veterans

appeared to start with higher mean A1C levels that seemed to peak at a younger age before they began to gradually decrease. Mean A1C levels for White American veterans started lower and peaked and plateau at a later age compared to Black American veterans. Specifically, analyses revealed mean A1C levels for Black American veterans was 7.28% at age 60, peaked at 7.30% around age 62, and then decreased to 7.18% by age 74. The mean A1C level for White American veterans was 7.02% at age 60, peaked at 7.20% around age 68, and still remained at this level by age 74.

Diagnostic group differences in A1C levels over time

Table 3.7 shows the results for examining a curvilinear relationship for diagnostic group differences in changes in A1C levels over time (Model 1.2). Results revealed significant contrasts for sex dysfunction*time and sex dysfunction*time^2 (p = .0003) as well as for depression*sex dysfunction*time and depression*sex dysfunction*time^2 (p = .001). The significant contrasts indicate that veterans with sexual dysfunction and veterans with both depression/sexual dysfunction had significantly different changes in mean A1C levels over time compared to veterans with no diagnosis. The contrast testing for improvement in goodness of fit of the quadratic modeling was also significant ($p <$ 0.001), indicating the quadratic modeling of this analysis was a better fit than the linear modeling. Figure 3.6 depicts mean changes in A1C levels over time. Specifically, A1C levels for veterans with only sexual dysfunction appeared to start higher than those for veterans with no diagnosis, but they also peaked at an earlier age and decreased more rapidly than A1C levels for veterans with no diagnosis. Additionally, A1C levels for veterans with both depression/sexual dysfunction appeared to start at levels similar to the no diagnosis group and plateaued around the same age, but at a higher A1C levels than

the no diagnosis group. Specifically, the mean A1C levels for veterans with only sexual dysfunction was about 7.20% at age 60, peaked at 7.35% around age 62, and then decreased to about 7.04% by age 74. The mean A1C level for veterans with both depression/sexual dysfunction was about 7.06% at age 60, peaked at 7.25% around age 68, and still remained at this level by age 74. The mean A1C level for veterans with no diagnosis was about 7.06% at age 60, peaked at 7.20% around age 68, and still remained at this level by age 74.

Table 3.8 shows the results of the model examining a possible curvilinear relationship for racial and ethnic differences in A1C levels within each diagnostic group over time (Model 2.2). Results, revealed that the significant contrasts found in Model 1.2 were maintained, sex dysfunction*time and sex dysfunction*t^2 (p = .01) and depression*sex dysfunction*t and depression*sex dysfunction*t^2 (p = .02). However, there were no significant contrasts for any of the race*group categories over time, suggesting that there are no racial and ethnic differences in the patterns of change in A1C among veterans diagnosed with depression and/or sexual dysfunction. There was also no significant contrast for testing improvement in goodness of fit of the quadratic modeling (p = .11), indicating that the quadratic modeling was not a better fit for this analysis when compared to the linear modeling.

Table 3.9 shows the curvilinear modeling results for racial and ethnic differences in A1C levels among veterans with depression and/or sexual dysfunction after adjusting for additional covariates of hypertension, coronary heart disease, and history of a stroke (Model 3.2). Results reflect significant main effects for hypertension and coronary heart disease. However, the addition of covariates did not significantly impact Model 2.2, as

the significant contrasts for sexual dysfunction (p = .01) and comorbid depression/sexual dysfunction (p = .02) were sustained in this model. Again, here was also no significant contrast for the goodness of fit of the quadratic modeling (p = .07), indicating that the quadratic modeling was not a better fit for this analysis when compared to the linear modeling.

Table 3.1- Final sample demographic and clinical characteristics

	Depression	Sexual Dysfunction	Depression/ Sex Dysfunction	Neither Diagnosis	All
N	35,328 (68%)	1,054 (2%)	12,350 (24%)	3,307 (6%)	52,039
Mean A1C values (S.D.)	7.20 (1.48)	7.43 (1.54)	7.35 (1.49)	7.27 (1.48)	7.31 (2.81)
Mean age in years (S.D.)	66.0 (2.81)	66.1 (2.75)	65.9 (2.73)	66.2 (2.86)	66.0 (2.80)
Race/ethnicity (%)					
Black	12.3	25.6	21.9	15.5	15.1
White	87.7	74.4	78.1	84.5	85.9
Marital Status (%)					
Never Married	6.9	5.5	5.0	8.1	6.5
Married	58.7	57.6	59.9	52.8	58.6
Separated	3.1	2.8	3.9	3.6	3.3
Divorced	26.5	29.6	26.5	30.7	26.8
Widowed	4.9	4.6	4.6	4.8	4.8
Hypertension (%)	92.6	94.5	94.8	90.1	93.0
Heart Disease (%)	49.7	50.3	50.1	53.0	50.0
Stroke (%)	22.2	22.8	23.0	22.2	22.4

Table 3.2- Fixed effect estimates for changes in A1C values across racial groups over time.

	Beta coefficient estimate	Standard Error	P-value
Intercept (ref. = NHW)	7.14	0.01	<.0001***
Non-Hispanic Black	0.11	0.01	<.0001***
Time	0.22	0.02	<.0001***
Non-Hispanic Black*Time	-0.30	0.05	<.0001***

*$p < .001$

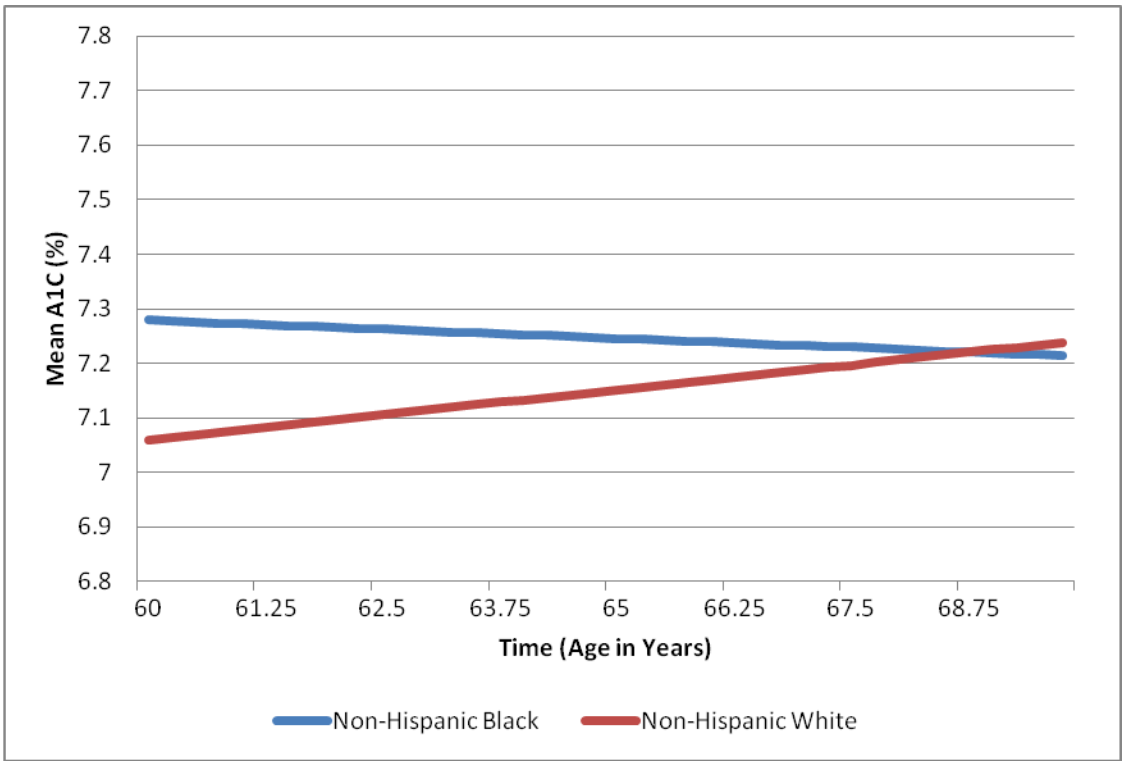

Figure 3.1- Mean changes in A1C levels over time for Black American and White American veterans.

Table 3.3- Fixed effect estimates for changes in A1C values across diagnostic groups over time (Model 1).

	Beta coefficient estimate	Standard Error	*P* value
Intercept (ref. = No diagnosis)	7.17	0.02	<.0001***
Depression	-0.02	0.02	0.37
Sexual Dysfunction	0.13	0.05	0.01*
Depression/Sex Dysfunction	0.07	0.05	0.13
Time	0.09	0.08	0.25
Depression*Time	0.10	0.08	0.23
Sexual Dysfunction*Time	-0.28	0.15	0.06
Depress/Sex Dys*Time	0.29	0.15	0.06

*$p < .01$

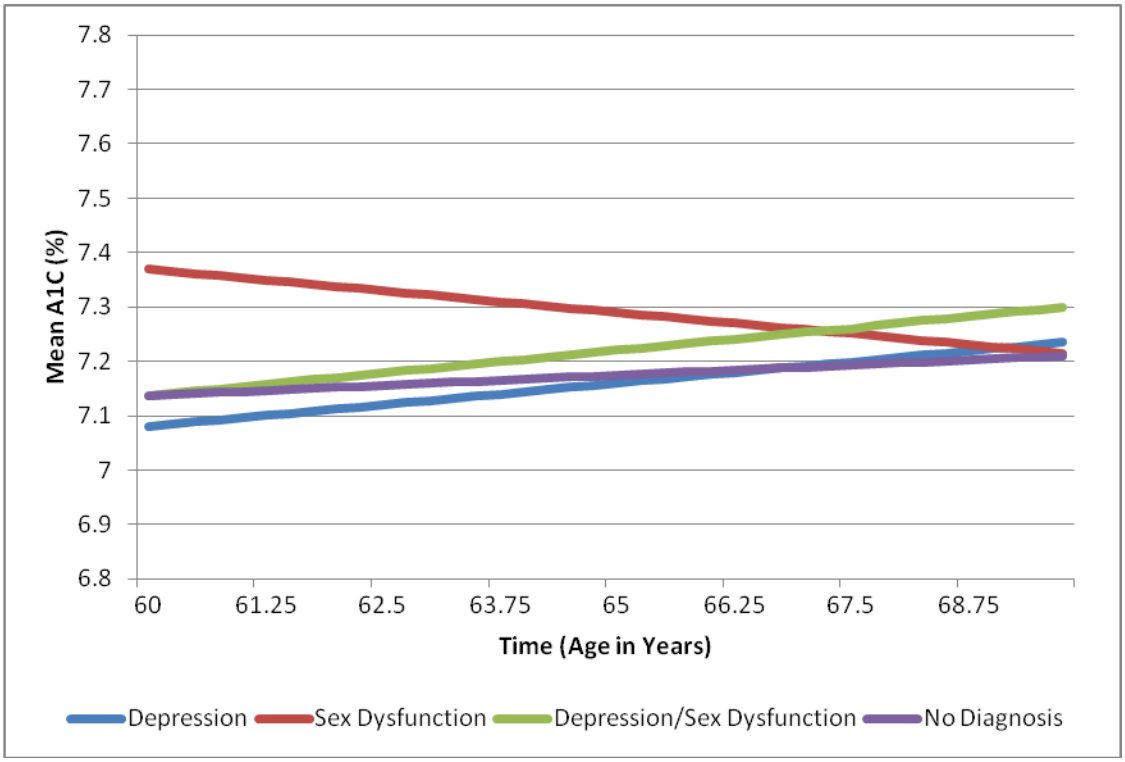

Figure 3.2- Mean changes in A1C levels over time for veterans with depression and/or sexual dysfunction.

Table 3.4- Fixed effect estimates for racial differences in A1C values within diagnostic groups (Model 2).

	Beta coefficient estimate	Standard Error	P-value
Intercept (ref.= No diagnosis, White)	7.14	0.02	<.0001****
Non Hispanic Black	0.23	0.06	0.01**
Depression	-0.003	0.03	0.89
Sex Dysfunction	0.09	0.05	0.08
Depression/Sex Dysfunction	-0.06	0.05	0.29
Time	-0.01	0.08	0.93
NHB*Depression	-0.14	0.06	0.03*
NHB*Sex Dysfunction	-0.04	0.11	0.73
NHB*Depress/Sex Dys	0.06	0.11	0.58
Black*Time	0.16	0.20	0.43
Depression*Time	0.12	0.08	0.14
Sex Dysfunction*Time	-0.39	0.16	0.01*
Depress/Sex Dys* Time	0.39	0.16	0.02*
Depression*Black*Time	-0.42	0.21	0.04*
Sex Dysfunction*Black*Time	0.02	0.34	0.94
Depress/Sex Dys* Black*Time	-0.05	0.36	0.88

**$p < .01$, *$p < .05$,

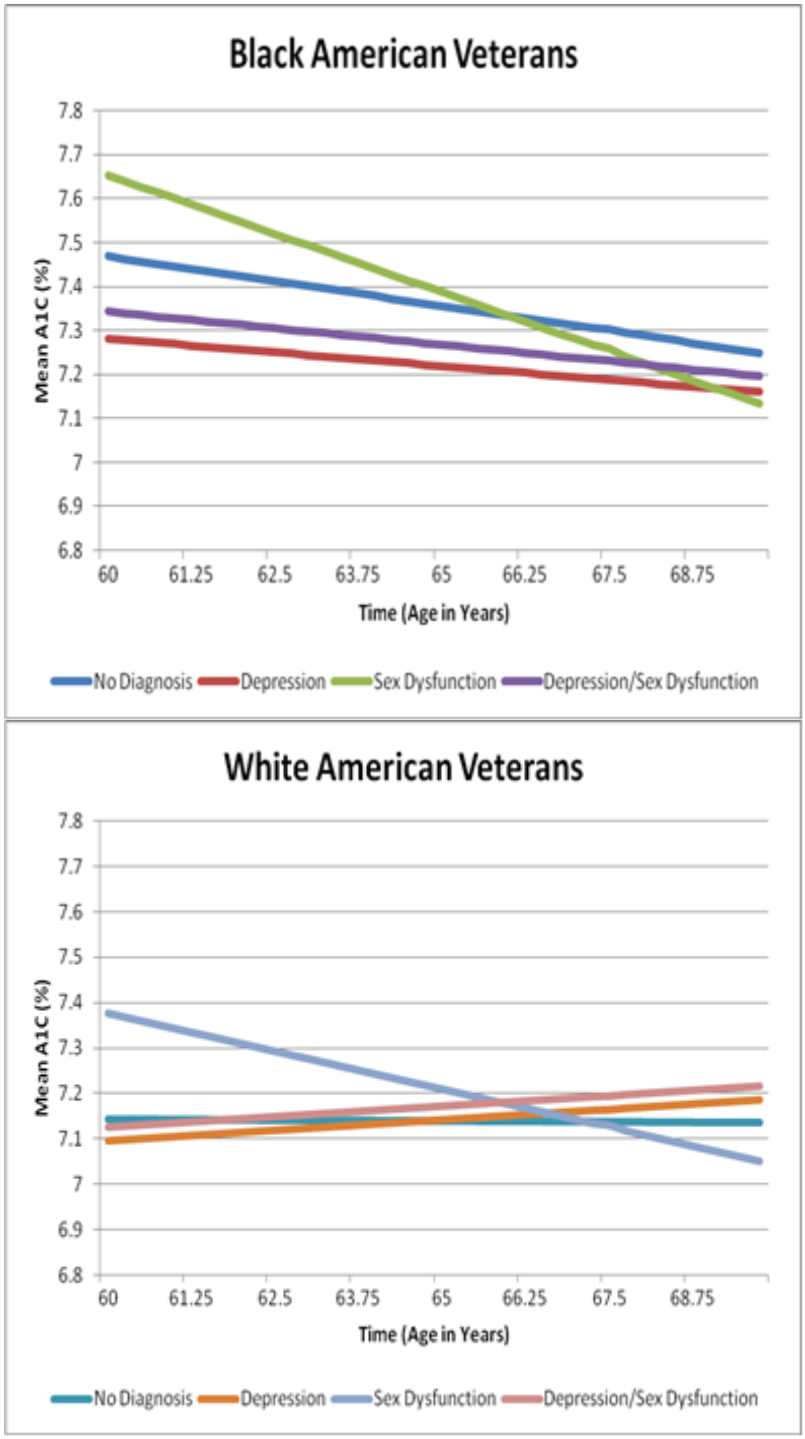

Figure 3.3- Racial and ethnic mean changes in A1C levels over time for veterans with depression and/or sexual dysfunction.

Table 3.5- Fixed effect estimates for racial differences in changes in A1C levels within diagnostic groups with covariates (Model 3)

	Beta coefficient estimate	Standard Error	P-value
Intercept (ref.= No diagnosis, White)	7.14	0.02	<.0001****
Hypertension	0.27	0.02	<.0001****
CHD	0.15	0.01	<.0001****
Stroke	0.0002	0.01	0.99
Non Hispanic Black	0.24	0.06	<.0001****
Depression	-0.002	0.02	0.93
Sex Dysfunction	0.09	0.05	0.09
Depression/Sex Dysfunction	-0.06	0.05	0.27
Time	-0.04	0.08	0.63
NHB*Depression	-0.14	0.06	0.26
NHB*Sex Dysfunction	-0.04	0.11	0.72
NHB*Depress/Sex Dys	0.06	0.11	0.57
Black*Time	0.16	0.20	0.41
Depression*Time	0.13	0.08	0.11
Sex Dysfunction*Time	-0.37	0.15	0.02*
Depress/Sex Dys* Time	0.37	0.16	0.02*
Depression*Black*Time	-0.43	0.21	0.04*
Sex Dysfunction*Black*Time	0.01	0.34	0.99
Depress/Sex Dys* Black*Time	-0.02	0.35	0.95

**$p < .001$, *$p < .05$

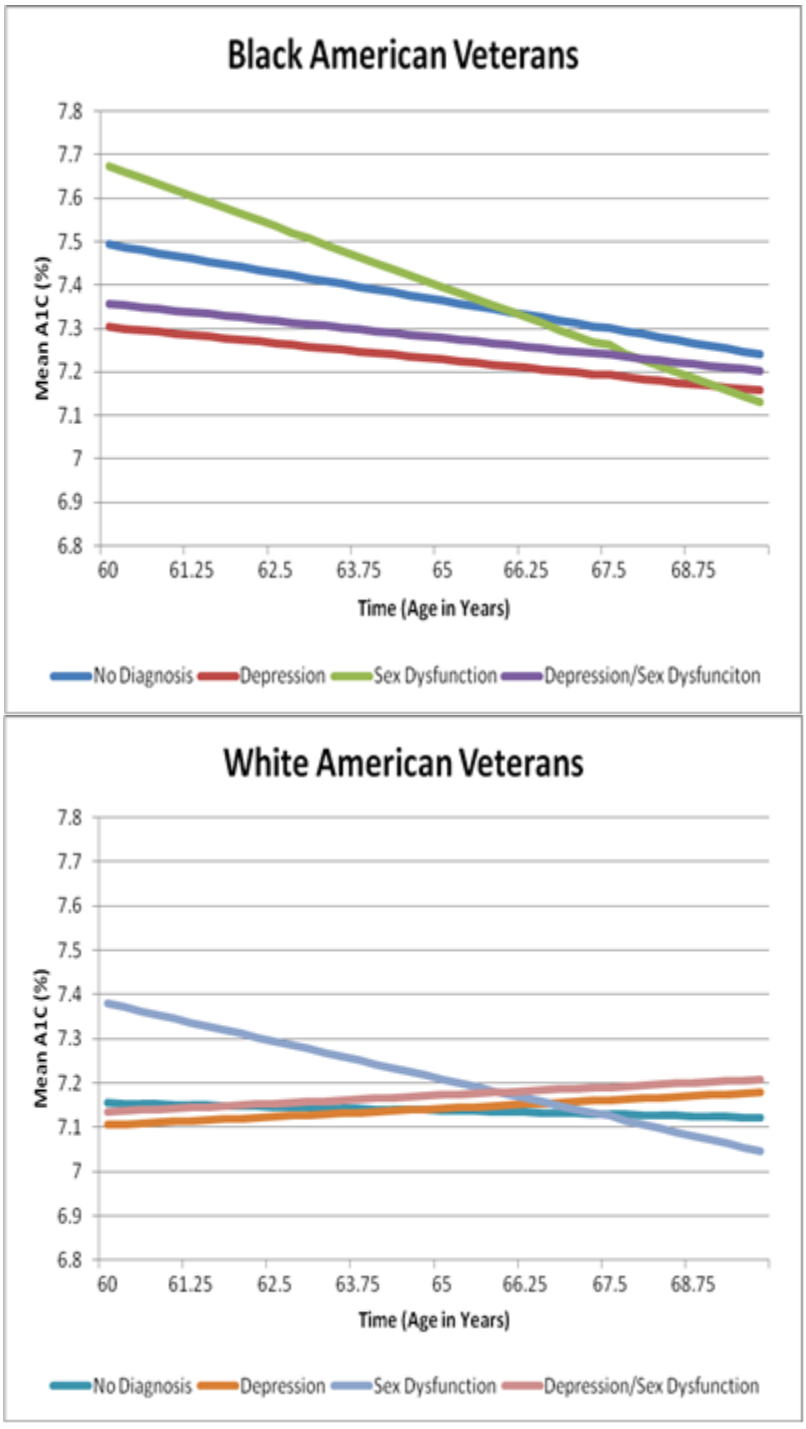

Figure 3.4- Racial and ethnic mean changes in A1C levels over time for veterans with depression and/or sexual dysfunction with covariates.

Table 3.6- Fixed effect estimates for curvilinear modeling of A1C values across racial groups over time

	Beta coefficient estimate	Standard Error	P-value
Intercept (ref. = NHW)	7.16	0.01	<.0001***
Non-Hispanic Black	0.12	0.02	<.0001***
Time	0.23	.02	<.0001***
$Time^2$	-0.33	0.06	<.0001***
Non-Hispanic Black*Time	-.032	0.05	<.0001***
Non-Hispanic Black*$Time^2$	-0.04	0.15	.81

*$p < .001$

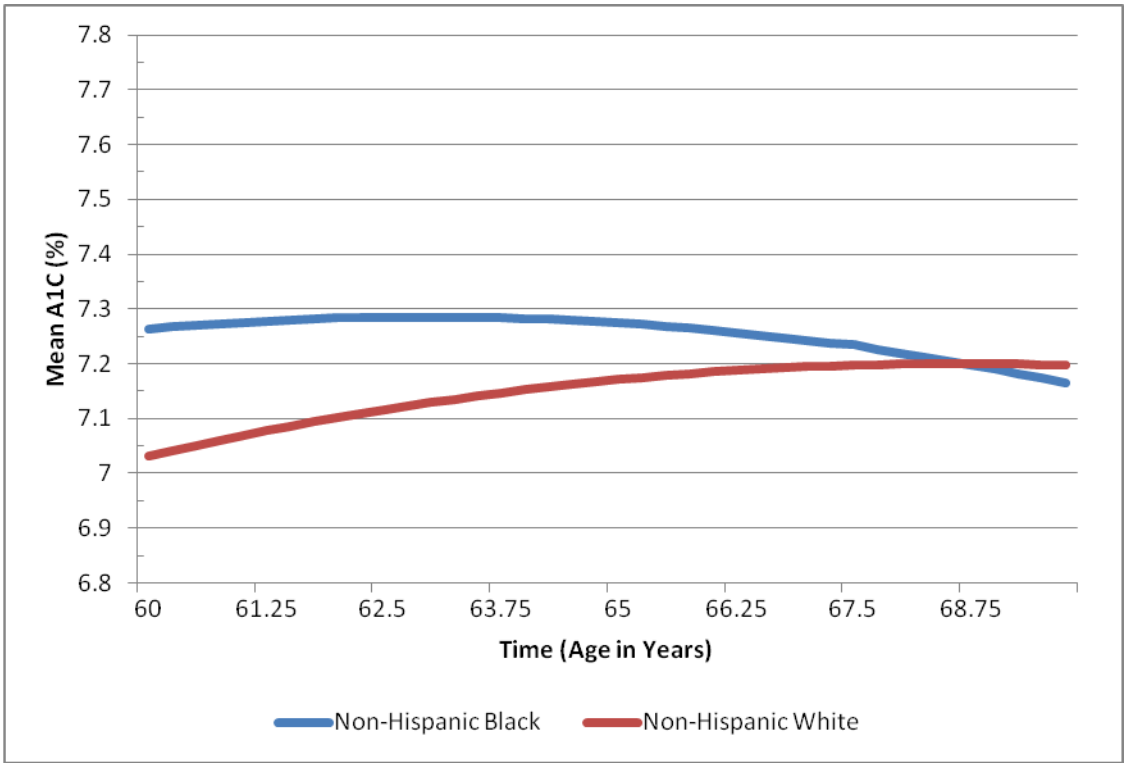

Figure 3.5- Curvilinear Modeling of Mean changes in A1C levels over time for Black American and White American veterans.

Table 3.7- Fixed effect estimates for curvilinear modeling of changes in A1C values across diagnostic groups over time (Model 1.2).

	Beta coefficient estimate	Standard Error	*P* value
Intercept (ref. = No diagnosis)	7.18	0.02	<.0001****
Depression	-0.03	0.02	0.30
Sexual Dysfunction	0.15	0.05	0.002**
Depression/Sex Dysfunction	0.10	0.05	0.06
Time	0.19	0.06	0.001**
Time^2	-0.30	0.18	0.10
Depression*Time	0.05	0.06	0.41
Depression*Time^2	0.10	0.19	0.58
Sexual Dysfunction*Time	-0.30	0.11	0.01*
Sexual Dysfunction*Time^2	-0.94	0.35	0.01*
Depress/Sex Dys*Time	0.32	0.11	0.01*
Depress/Sex Dys*Time^2	0.80	0.36	0.03*

**$p < .001$, *$p < .05$

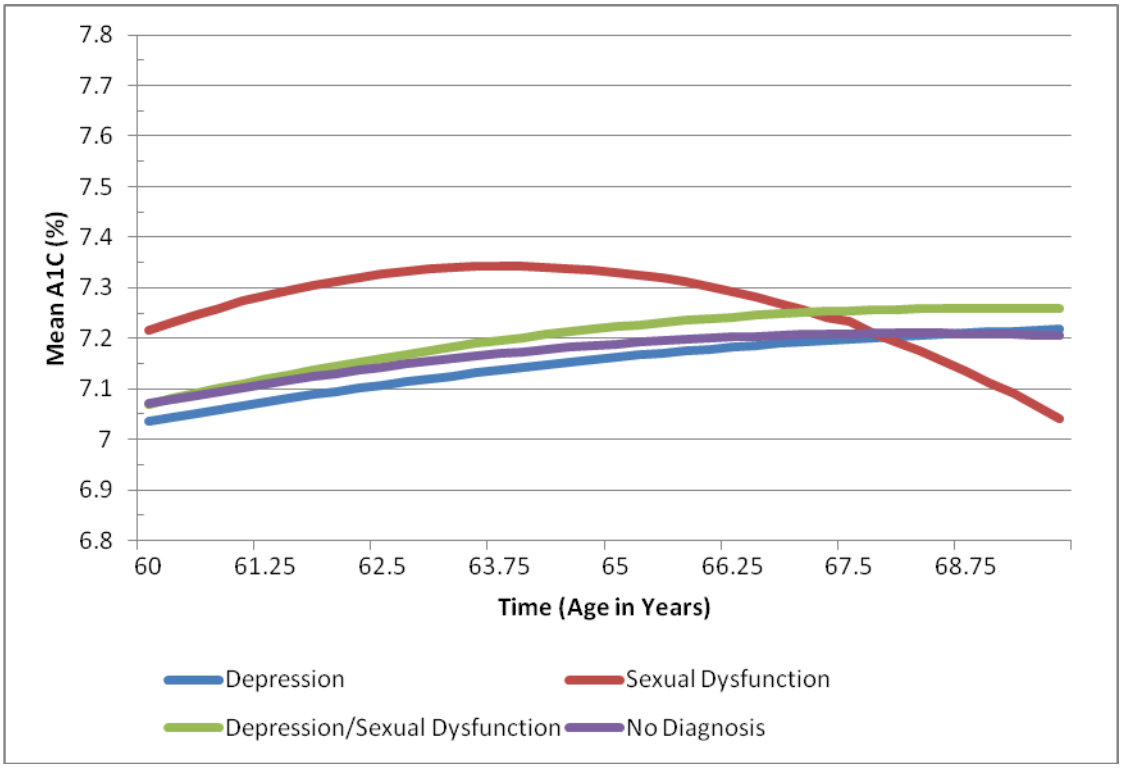

Figure 3.6- Curvilinear modeling of mean changes in A1C levels over time for veterans with depression and/or sexual dysfunction.

Table 3.8- Fixed effect estimates for curvilinear modeling of racial differences in A1C values within diagnostic groups (Model 2.2).

	Beta coefficient estimate	Standard Error	P-value
Intercept (ref.= No diagnosis, White)	7.13	0.03	<.0001****
Non Hispanic Black	0.25	0.07	0.01*
Depression	0.01	0.03	0.79
Sex Dysfunction	0.15	0.06	0.01*
Depression/Sex Dysfunction	-0.11	0.06	0.07
Time	-0.02	0.08	0.93
$Time^2$	0.09	0.25	0.71
NHB*Depression	-0.18	0.08	0.02*
NHB*Sex Dysfunction	-0.05	0.13	0.68
NHB*Depress/Sex Dys	0.08	0.13	0.54
Black*Time	0.18	0.20	0.37
Black* $Time^2$	-.031	0.66	0.63
Depression*Time	0.13	0.08	0.11
Depression* $Time^2$	-0.19	0.27	0.47
Sex Dysfunction*Time	-0.28	0.17	0.01*
Sex Dysfunction* $Time^2$	-1.06	0.53	0.05
Depress/Sex Dys* Time	0.29	0.17	0.08
Depress/Sex Dys* $Time^2$	0.90	0.55	0.10
Depression*Black*Time	-0.47	0.21	0.02*
Depression*Black* $Time^2$	0.62	0.70	0.37
Sex Dysfunction*Black*Time	-0.02	0.35	0.94
Sex Dysfunction*Black* $Time^2$	0.16	1.13	0.88
Depress/Sex Dys* Black*Time	0.002	0.37	0.10
Depress/Sex Dys* Black* $Time^2$	-0.26	1.18	0.82

**$p < .01$, *$p < .05$

Table 3.9- Fixed effect estimates for curvilinear modeling of racial differences in changes in A1C levels within diagnostic groups with covariates (Model 3.2)

	Beta coefficient estimate	Standard Error	P-value
Intercept (ref.= No diagnosis, White)	7.14	0.03	<.0001*
Hypertension (ref.= HiBP)	0.27	0.02	<.0001***
CHD (ref.= CHD)	0.15	0.01	<.0001***
Stroke (ref.= Stroke)	0.001	0.01	0.96
Non Hispanic Black	0.25	0.07	0.0004***
Depression	0.01	0.01	0.79
Sex Dysfunction	0.15	0.06	0.01*
Depression/Sex Dysfunction	-0.11	0.06	0.07
Time	-0.04	0.08	0.61
$Time^2$	0.05	0.25	0.84
NHB*Depression	-0.18	0.08	0.02*
NHB*Sex Dysfunction	-0.05	0.13	0.68
NHB*Depress/Sex Dys	0.08	0.13	0.53
Black*Time	0.18	0.20	0.37
Black* $Time^2$	-.030	0.66	0.65
Depression*Time	0.14	0.08	0.09
Depression* $Time^2$	-0.17	0.27	0.52
Sex Dysfunction*Time	-0.27	0.17	0.11
Sex Dysfunction* $Time^2$	-1.03	0.53	0.05
Depress/Sex Dys* Time	0.28	0.17	0.10
Depress/Sex Dys* $Time^2$	0.90	0.55	0.10
Depression*Black*Time	-0.47	0.21	0.03*
Depression*Black* $Time^2$	0.60	0.70	0.39
Sex Dysfunction*Black*Time	-0.04	0.35	0.90
Sex Dysfunction*Black* $Time^2$	0.15	1.13	0.89
Depress/Sex Dys* Black*Time	0.03	0.37	0.94
Depress/Sex Dys* Black* $Time^2$	-0.24	1.19	0.84

**$p < .01$, *$p < .05$

CHAPTER 4

DISCUSSION

This study was designed to address gaps in diabetes literature by testing racial and ethnic differences in the effects of sexual dysfunction and depression on glycemic control over time. Given the high prevalence of diabetes among veterans, this study examined research questions using a sample of veterans. To the best of this author's knowledge, this study was one of the first investigations designed to examine racial and ethnic differences in sexual dysfunction among men with diabetes. A strength of this investigation was the testing of both linear and curvilinear relationships for racial and ethnic differences in glycemic control and the impact of depression and sexual dysfunction on glycemic control over time. This is an important contribution to the literature since existing research appears to reflect tests of linear relationships. Quadratic modeling was found to be a better fit for analyses examining racial and ethnic differences in A1C levels over time, as well as for analyses examining differences in A1C levels over time between the four diagnostic groups. However, quadratic model was not found to be a better fit for analyses examining racial and ethnic differences in the impact of depression and/or sexual dysfunction on glycemic control over time.

Explanation of Findings

Racial Differences in the Prevalence of Depression.

It was expected that the results of testing Hypothesis 1 would reveal racial and ethnic differences in rates of depression among veterans with diabetes, specifically that

White American veterans would have higher rates of depression than Black American veterans, which would be consistent with existing literature. The results of this study revealed significant racial and ethnic differences in prevalence of depression among this national sample of veterans with diabetes, with White American veterans exhibiting higher rates of depression than Black American veterans. These findings could be a reflection of racial differences in the detection and diagnosis of depression seen among Black and White Americans in the general population. Research suggests that Black Americans tend to endorse more somatic rather than affective symptoms of depression (Baker, Okwumabua, Philipose, & Wong, 1996; Brown, Schulberg, & Madonia, 1996; Das, Olfson, McCurtis, & Weissman, 2006), which could reduce accurate detection and diagnosis of depression among Black American veterans with diabetes. Lower rates of depression among Black American veterans could also be indicative of lower rates of reporting due to culturally-specific beliefs and attitudes about depression. Egede (2002) found that perceived stigma and misconceptions about the etiology of depression among Black Americans with diabetes were significant barriers to this population seeking treatment for depression or adhering to treatment recommendations. Beliefs that depression is due to "personal weakness" or "self-pity" are not only barriers to treatment, but can also prevent Black Americans from disclosing depressive symptoms to their health care providers (Egede, 2002). It should be noted that while these findings were significant, the small effect sizes for the analyses (phi = .02) may suggest that the overall size of the effect may be smaller. Additional research is needed to determine overall clinical significance.

Racial Differences in Prevalence of Sexual Dysfunction

It was expected that the test of Hypothesis 2 would reveal racial and ethnic differences in rates of sexual dysfunction, with Black American veterans with diabetes possessing higher rates. The results of this study supported this hypothesis, with Black American veterans exhibiting higher rates of sexual dysfunction than White Americans veterans. Existing literature suggest that Black Americans report more problems with sexual dysfunction compared to White Americans (Laumann, et. al, 1999). Existing literature also indicates that men with diabetes more likely to have erectile dysfunction than men who do not have diabetes (NDIC, 2008). Therefore, it seems possible that Black American veterans with diabetes would be at greater risk for developing sexual dysfunction when compared to White American veterans. Also, Black American veterans had higher A1C levels compared to White American veterans, which suggest that they are at greater risk for developing other diabetes-health related complications. It is also possible that higher rates of sexual dysfunction among Black American veterans could be indicative of depression. As previously mentioned, Black American men tend to report more somatic symptoms of depression and may be more likely to report difficulties with sexual dysfunction rather than depressed mood. Additional research examining a possible relationship between the symptom presentation of depression and sexual dysfunction for Black American men is needed.

Linear and Quadratic Modeling of Racial Differences in Glycemic Control over Time

Based on existing literature, it was expected that longitudinal racial and ethnic differences in A1C levels would be found, with Black American veterans having higher A1C levels compared to White American veterans over time. Linear modeling results for

this study revealed that while A1C levels for Black American veterans started at higher levels compared to White American veterans, A1C levels gradually increased for White American veterans and decreased for Black American veterans as they grew older. The linear model for changes in A1C levels over time suggested that A1C levels would continue to increase for White American veterans as they grew older and continue to decrease for Black American veterans as they grew older. However, improvement in goodness-of-fit testing revealed that changes in A1C levels over time between Black and White American veterans were better understood as a quadratic relationship rather than a linear relationship.

The findings for the quadratic modeling were similar to the findings for the linear model, such that A1C levels started higher and decreased for Black American veterans and A1C levels started lower and increased for White American veterans. However, the quadratic modeling provided more specific information about the different patterns of change in A1C levels between Black and White American veterans. Specifically, the linear model did not capture the peak in A1C levels for Black American veterans before they began to decrease, nor did the linear model capture the peak/plateau of A1C levels for White American veterans at a later age compared to Black American veterans. Existing research suggests that there are three factors that independently predict change in A1C levels over time. Specifically, older age and having diabetes longer significantly predict decreases in A1C levels over time, while co-morbid health conditions significantly predict increases in A1C levels over time (Fisher, Mullan, Arean, Glasgow, Hessler, & Masharani, 2010). These differing patterns of change in A1C levels for Black and White American veterans suggested that Black American veterans may have been

diagnosed with diabetes at an earlier age than White American veterans, and thus their A1C levels began to decrease and stabilize at an earlier age as well. These findings also suggested that White American veterans may continue to have difficulties reaching stabilized A1C levels as they get older, which could be complicated by co-morbid health conditions related to the natural process of aging. Findings for a recent population-based study found no racial and ethnic differences in age of diagnoses of diabetes; however, it was noted that racial and ethnic differences in age of diagnosis were found in previous population-based studies, with Black Americans being diagnosed at younger ages than White Americans (Koopman, Mainous, Diaz, & Geesey, 2005). This study's results could be a reflection of this pattern.

It is important to note that A1C levels for White American veterans were still lower than those of Black American veterans overall and even peaked at a lower A1C level than Black American veterans, suggesting that they may be able to maintain glycemic control for a longer period of time than Black American veterans. These findings were partially consistent with existing research suggesting that Black Americans tend to have higher A1C levels than White Americans (Egede et al, 2010; Fan, et al., 2006; Saydah, et al., 2007; Suh, et al., 2010). However, this study's findings revealed that as both Black and White American veterans grew older, the differences in A1C levels seemed to disappear, such that both groups were trending towards lower A1C levels and improving glycemic control.

Linear and Quadratic Modeling of Longitudinal Impact of Depression and Sexual Dysfunction on Glycemic Control

It was expected that veterans with diabetes experiencing depression and/or sexual dysfunction would have higher A1C levels over time compared to veterans with diabetes with neither disorder. Linear modeling results revealed that veterans diagnosed with only sexual dysfunction had significantly different levels and rates of change in A1C levels as they grew older. Specifically, veterans with sexual dysfunction had higher A1C levels than veterans with no diagnosis, but A1C levels for veterans with sexual dysfunction decreased as they grew older and increased for veterans with no diagnosis.

However, improvement in goodness-of-fit testing revealed that changes in A1C levels over time between veterans diagnosed with depression and/or sexual dysfunction were better understood as a quadratic relationship rather than a linear relationship. Similar to the linear modeling results, quadratic modeling results also revealed a significant impact of sexual dysfunction on glycemic control, such that A1C levels for veterans with sexual dysfunction started higher, but decreased with age relative to A1C levels for veterans with no diagnosis starting lower and increasing with age. Quadratic modeling provided more specific information about these changes in A1C levels over time. Specifically, compared to mean A1C levels for veterans with no diagnosis, mean A1C levels for veterans with sexual dysfunction started higher, peaked, and then began to decrease as they grew older. Given research suggesting that having diabetes longer is a significant predictor of decreasing A1C levels (Fisher et al., 2010), it seems possible that veterans diagnosed with sexual dysfunction are potentially diagnosed with diabetes at a younger age compared to veterans with no diagnosis, so their A1C levels potentially

peaked and began to decrease at a younger age. A sexual dysfunction diagnosis at a younger age can have a significant psycho-social impact on how individuals with diabetes manage their illness. Specifically, sexual dysfunction can impact mood and decrease motivation for individuals with diabetes to adhere to strict diet and exercise regimens necessary to maintain health blood sugar levels, thus decreasing glycemic control. A sexual dysfunction diagnosis can also serve as an indicator of poor glycemic control. It may be reflective of more difficulties with neuropathic issues, which are likely more severe for veterans with higher A1C levels, or poor glycemic control. The downward trend in A1C levels among veterans diagnosed with sexual dysfunction could be related to having the diagnosis for a long period of time and therefore having a longer period to treat and learn to better manage their diabetes and any difficulties with sexual dysfunction.

Quadratic modeling results also revealed a moderately significant impact of co-morbid depression/sexual dysfunction on glycemic control. A1C levels for veterans with both depression and sexual dysfunction followed a similar gradually increasing trend as veterans with no diagnosis, but seemed to peak/plateau at a slightly higher A1C level than veterans with no diagnosis. Given research indicating that having a number of health complications in addition to diabetes is related to increasing A1C levels over time (Fisher et al., 2012), is it possible that the additional struggles with depression and sexual dysfunction makes managing diabetes somewhat more difficult for this diagnostic group, leading in to slightly higher A1C levels compared to veterans with no diagnosis. However, it should also be noted that while these findings were significant, the small mean A1C differences between veterans with both depression and sexual dysfunction

(7.25% at age 74) and veterans with no diagnosis (7.20% at age 74) suggest that the overall size of the effect may be smaller. Additional research is needed to determine overall clinical significance.

Linear and Quadratic Modeling of Racial and Ethnic Differences on Impact of Depression and Sexual Dysfunction on Glycemic Control over Time

This study also explored possible racial and ethnic differences in the effects of depression and sexual dysfunction on glycemic control over time. Linear modeling results indicated that Black American veterans with depression had higher A1C levels that decreased as they grew older, whereas White American veterans with depression had lower A1C levels that increased as they grew older. These findings were maintained after controlling for other illnesses significantly associated with diabetes, namely hypertension, heart disease, and history of stroke. Improvement in goodness-of-fit testing indicated that the quadratic modeling for this analysis, with and without the covariates, was not a better fit for the data when compared to linear modeling. The results of the linear modeling seem to follow the same overall trend found in racial differences in mean A1C change over time, specifically Black American veterans having higher A1C levels that decreased and White American veterans having lower A1C levels that increased as they grew older. Given that research on the impact of depression on A1C levels suggest only small to moderate effects over time (Lustman et al, 2000), these significant differences in mean A1C change over time among this sample of veterans with depression, suggests that aforementioned racial differences in A1C change patterns may persistent among Black and White American veterans with depression.

Study Implications

Although 50% of this sample of veterans had optimal A1C levels below 7%, this still indicates that there is a large portion of veteran with diabetes that may have some difficulty achieving glycemic control. An important finding of this study is that A1C levels vary by race and by diagnostic group, with Black American veterans and veterans with sexual dysfunction having the most significant changes in A1C as they grew older. These results also indicated that the changes in A1C levels and for Black and White American veterans and veterans with sexual dysfunction are best represented by quadratic modeling vs. linear modeling. For some of this study's analyses, the quadratic modeling provided more specific information regarding the trend of change in A1C levels, as it better captured changes in A1C levels that may naturally occur the longer a person has diabetes. These results also revealed that tracking changes in A1C levels as a person grows older can highlight important role of age on a person's ability to manage their diabetes. These findings suggest that future studies examining factors impacting changes in glycemic control over time should explore possible curvilinear trajectories for changes in A1C levels, as well as model time as a representation of age to best understand glycemic control the longer a person has diabetes and as they grow older.

Many studies have explored a number of factors potentially impacting an individual's ability to achieve and maintain glycemic control, including depression and sexual dysfunction. The existing literature on the impact of depression or sexual dysfunction on glycemic control is mixed, with some studies reporting significant differences in glycemic control between individuals with and without depression or sexual dysfunction and others reporting no differences in glycemic control. Findings

suggest that diagnoses of depression and/or sexual dysfunction may significantly impact the ability of veterans to achieve glycemic control, and are important factors to consider when assessing a patient's ability to effectively manage their diabetes.

It seems particularly important to acknowledge the potential biopsychosocial impact of sexual dysfunction as it relates to glycemic control. A sexual dysfunction diagnoses could simply be a reflection of poor glycemic control, such that individuals with poor glycemic control are at greater risk for developing diabetes-related health complications, such as sexual dysfunction. However, a sexual dysfunction diagnosis could also have significant psychosocial consequences related to being unable to perform sexually, including decreased sense of self-worth and relationship difficulties. Given research findings suggesting a reciprocal relationship between sexual dysfunction and depression, in that the presence of either one of these conditions may trigger or exacerbate the other (Kennedy & Razvi, 2009), a diagnosis of sexual dysfunction could be related to psychological distress, and perhaps depression. Negative moods associated with this distress can lead to a reduction in overall mind-body functioning manifesting behaviorally as poor adherence to diet, exercise, and medication regiments required to maintain healthy blood sugar levels and achieve glycemic control.

Given the mixed findings in the literature regarding the impact of depression on glycemic control, this study's findings highlight the possibility that this relationship could be mediated by difficulties with sexual dysfunction. Additional research exploring the impact of depression and sexual dysfunction on glycemic control is needed. Also, given this study's findings of significant improvements in glycemic control as veterans with sexual dysfunction grew older, additional research is needed to explore additional factors,

other than age of diabetes diagnosis, that may be contributing to reduced A1C levels as they age, such as differences in diabetes treatment (e.g., veterans with sexual dysfunction may receive more medical attention, be on higher doses of insulin, or pharmacological treatment of the sexual dysfunction improves motivation and ability to manage diabetes, etc.).

To further increase understanding of the impact of depression on glycemic control, this study's results suggest considering race as having an important influence on the relationship. Findings generally suggest that Black American veterans may struggle with higher A1C levels during their journey to achieve glycemic control when compared to White American veterans, but they appear to reach a turning point and start down the path of better controlling their diabetes at an earlier age compared to White American veterans. This implies that although White American veterans may have lower A1C levels to manage compared to Black American veterans, they are still at less than optimal A1C levels and may stay at these levels for longer periods of time before start down the path of better controlling their diabetes. This implies that treatment planning for White American veterans with diabetes may need to factor in the age, specifically the potential to develop health complications related to aging (e.g., sensory decline, reduced cognitive functioning, reduced physical functioning, etc.), and how these factors may further impact the veteran's ability to achieve glycemic control. This study's findings indicating racial differences in glycemic control among veterans with depression, suggest that depression may impact Black and White American veterans differently, given their different paths to achieving glycemic control. For example, depression may be more severe and have more of an impact on glycemic control for older White American

veterans with diabetes, causing their A1C levels to gradually increase as they age. Additional research is needed to explore the possible moderation effects of race on the relationship between depression severity and glycemic control.

In general, this study's findings highlight the overall importance of better understanding of the impact of emotional or psychological distress on a veteran's ability to manage his diabetes. Increased attention and understanding of psychological issues can be achieved by health care providers working together with behavioral health specialists. Health care models that emphasize a multi-disciplinary approach to health care can be an effective method of helping veterans with diabetes manage their illness as well as manage co-morbid emotional or psychological issues. Another way to obtain a better sense of the impact of psychological and emotional distress on glycemic control among veterans is to assess specifically for diabetes-related stress as opposed to depression. Fisher and colleagues (2010) analyzed cross-sectional and longitudinal data for a relationship between major depressive disorder and diabetes distress. They found that emotional distress specifically tied to diabetes and its management has both cross-sectional and longitudinal relationships with A1C, whereas MDD had no impact on glycemic control (Fisher et al., 2010). The authors suggested the relationship between diabetes-specific distress and glycemic control is bidirectional, such that high levels of diabetes distress can influence self-management and medication adherence with subsequent effects of glycemic control; on the other hand, poor glycemic control can lead to distress which could subsequently influence diabetes management. The results of this study suggest that assessing for diabetes distress may be informative for treatment planning among veterans diagnosed with diabetes.

Study Limitations

While this study has important strengths, there are a number of study limitations that can be improved upon by future studies. One such limitation is that this study was designed to test only quadratic trajectories for factors potentially impacting changes in glycemic control. A test for a quadratic trajectory only assesses for one inflection point (a peak or a valley), but the pattern of change in A1C level could have multiple peaks and valleys over an individual's lifetime. More complex forms than quadratic (e.g., cubic) were not tested due to possible inflation in the number of terms given the complexity of this study's proposed questions. Future studies could assess the possibility of more complex trajectories for change in glycemic control on more simplified models with fewer predicators.

Despite the statistical significance for these analyses, it is important to note that mean differences in A1C levels did not appear to be clinically significant when compared to estimates of mean differences between members of racial and ethnic minority groups and White Americans found in the diabetes literature, namely 0.65% corresponding to a moderate effect size of 0.31 (Kirk et al., 2005). However, the design of the current study is unique compared to the designs of the studies reporting racial and ethnic differences in glycemic control, making it clinical significance of this study's findings difficult to compare to existing standards in the literature. Specifically, most studies utilize cross-sectional designs as opposed to longitudinal designs, limiting the ability of these study's authors to make inferences about racial and ethnic differences in glycemic control over time. Also, to this author's knowledge there are no existing longitudinal studies examining changes in A1C levels as a person with diabetes grows older. This study's

findings show that differences in A1C levels between Black and White American veterans disappear as they increase in age, highlighting the importance of age in the pattern of change in A1C levels. Furthermore, many of the studies comparing glycemic control between Black and White Americans had both groups reporting A1C levels in the uncontrolled range (> 8%), potentially contributing to a higher mean difference. Given these differences, the currently literature may not provide sufficient information on which to base clinical significance of this study's findings.

Due the demographic characteristics of the study's sample, the study's results may have limited generalizability. For one, prior to removing females and members of racial and ethnic groups other than non-Hispanic Black and non-Hispanic White for generalizability purposes, the original study sample did not appear to include non-White Hispanics. Given the documented prevalence of diabetes among this population as well as research indicating possible difficulties with sexual dysfunction among non-White Hispanics, this would have been an important population to include in this studies analyses, and their absence from the sample may have significantly impacted the results. It is possible than non-White Hispanics appeared to be excluded from the final study sample due to a coding error in the VA patient database that led to non-White Hispanics being categorized as non-Hispanic White, non-Hispanic Black, or Native American. Given the growing non-White Hispanic population in the U.S., future research examining racial and ethnic differences in glycemic control should be sure to included non-White Hispanic populations, as diabetes and related health issues significantly impacts this group.

Generalizability of results to the general population may also be limited due to using a veteran sample, specifically a veteran sample who receives their health care services from a VA medical center. Income requirements must be met in order for veterans to qualify for VA services, so the population receiving health care services at a VA medical center tends to be older males of low SES, and with more co-morbid health conditions. Veterans receiving services at a VA medical center may also have more co-morbid mental health issues in addition to depression, including posttraumatic stress disorder, psychotic disorders, and substance abuse. While the unique qualities of this study's population highlight the importance of conducting more research specifically addressing the needs of veterans who receive their care at the VA, it would also be important to replicate this study using a non-veteran sample or conduct comparison studies to capture potential population differences in factors that influence glycemic control.

Another study limitation was the use of diagnoses to define depression. A diagnosis of depression is less meaningful than actual measurements of depression over time and does not reflect a level of severity. Furthermore, the use of depression diagnoses associated with billable clinical encounters may have inflated this study's prevalence of depression, possibly misrepresenting the number of veterans with depression. Almost 90% of veterans in this study's sample had at least one billable encounter that included a depression diagnosis. Such a huge proportion hinders the study's statistical power to detect significant differences in mean A1C levels between the diagnostic groups. Future VA studies should assess depression by using measures such as the Patient Health Questionnaire-9 (PHQ-9) scores or Beck Depression Inventory (BDI) scores rather than

diagnoses (Beck, Steer, Ball, & Ranieri, 1996; Spitzer, Kroenke, & Williams, 1999). The use of such measures would allow for a better understanding of the effect of depression on A1C levels over time.

While this study excluded veterans with schizophrenia and bipolar disorder, other common psychological disorders found in a veteran population were not screened or controlled for, namely posttraumatic stress disorder and substance abuse. It is possible that these disorders potentially increase A1C levels and negatively influence the efforts of veterans with diabetes in achieving glycemic control. I also did not screen for veterans who were receiving disability compensation from the VA based on their presumed exposure to Agent Orange or other herbicides, as this information was not available in the database. Previous literature has demonstrated a relationship between dioxin (the primary contaminant in Agent Orange and other herbicides) exposure and increased insulin resistance, the precursor to type 2 diabetes (Henriksen, Ketchum, Michalek, & Swaby, 1997). Therefore, veterans exposed to dioxin may have a biological susceptibility to developing type 2 diabetes, which could have a negative impact on A1C levels. Future studies should explore the effects of psychological disorders and biological susceptibility on glycemic control.

Conclusion

Given the ever-increasing prevalence of diabetes in the U.S. and the particularly high prevalence of diabetes among members of racial and ethnic minority groups and veteran populations, understanding the factors impacting diabetes-related health outcomes seems crucial to the effective treatment of diabetes in these populations. This study highlighted the importance of understanding and managing psychological factors

related to chronic illness, and the need to include assessment and treatment of mental health issues as an integral part of diabetes management strategies for veterans, particularly for veterans whose health outcomes are more significantly impacted by psychological distress. This study also highlighted the potential importance of a biopsychosocial approach to understanding individual health and the potential utility of a multidisciplinary approach to health care. Continuing to expand literature in this area could provide increased understanding of the relationship between physical and mental health issues and continue to inform the most effective methods for improving overall individual health.

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