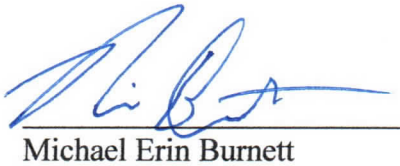
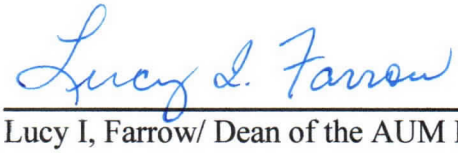
I hereby submit two (2) copies of my thesis, **"The Relationship between Depression and Diabetes Self-Care: Behavioral Risk Factors Surveillance System, 2006" By: Michael Erin Burnett** for inclusion into the AUM Library. One copy will be bound and placed in the circulating collection; the remaining copy will be retained as a preservation copy. I also give permission to the Library to make copies of this thesis for preservation purposes.



Michael Erin Burnett — 3/28/11 — Date



Lucy I, Farrow/ Dean of the AUM Library — March 28, 2011 — Date

THE RELATIONSHIP BETWEEN DEPRESSION AND

DIABETES SELF CARE ADHERENCE:

BEHAVIORAL RISK FACTOR SURVEILANCE SYTEM, 2006

Except where reference is made to the work of others, the work described in this thesis is my own or was done in collaboration with my advisory committee. This thesis does not include propriety or classified information.

Michael Erin Burnett

Certificate of Approval:

Steven G. LoBello, PhD, Chair
Professor
Psychology

Peter Zachar, PhD
Professor
Psychology

Bridgette D. Harper, PhD
Assistant Professor
Psychology

Jeffrey Ellwell, PhD
Provost
Academic Affairs

THE RELATIONSHIP BETWEEN DEPRESSION AND

DIABETES SELF CARE ADHERENCE:

BEHAVIORAL RISK FACTOR SURVEILANCE SYTEM, 2006

Except where reference is made to the work of others, the work described in this thesis is my own or was done in collaboration with my advisory committee. This thesis does not include propriety or classified information.

Michael Erin Burnett

Certificate of Approval:

Steven G. LoBello, PhD, Chair
Professor
Psychology

Peter Zachar, PhD
Professor
Psychology

Bridgette D. Harper, PhD
Assistant Professor
Psychology

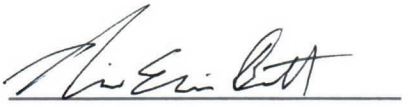
Jeffrey Ellwell, PhD
Provost
Academic Affairs

THE RELATIONSHIP BETWEEN DEPRESSION AND

DIABETES SELF CARE ADHERENCE:

BEHAVIORAL RISK FACTOR SURVEILANCE SYTEM, 2006

Except where reference is made to the work of others, the work described in this thesis is my own or was done in collaboration with my advisory committee. This thesis does not include propriety or classified information.



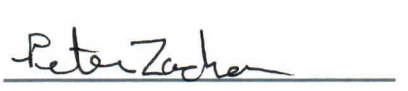
Michael Erin Burnett

Certificate of Approval:

Steven G. LoBello, PhD, Chair

Professor

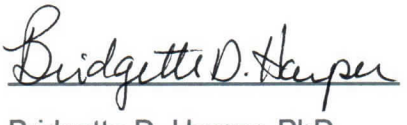
Psychology



Peter Zachar, PhD

Professor

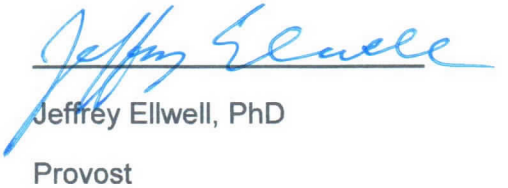
Psychology



Bridgette D. Harper, PhD

Assistant Professor

Psychology



Jeffrey Ellwell, PhD

Provost

Academic Affairs

The Relationship between Depression and Diabetes Self–Care: Behavioral Risk Factors Surveillance System, 2006

by

Michael Erin Burnett

A thesis submitted to the Graduate Faculty of

Auburn University Montgomery

in partial fulfillment of the

requirements for the degree of

Master of Science

Montgomery, Alabama

[Diabetes, Depression, Self-care, Adherence, BRFSS]

Approved by

Dr. Steven LoBello, Chair, Professor of Psychology

Dr. Peter Zachar, Professor of Psychology

Dr. Bridgette Harper, Assistant Professor of Psychology

Abstract

The relationship between depression and diabetes self-care was determined in a representative sample of diabetic adults aged 18 - 99 (n = 15,226) surveyed by the Center for Disease Control's Behavioral Risk Factor Surveillance System 2006. Results indicate significant effects of depression on the diabetes self-care behaviors exercise and diabetes education, and the diabetes health outcome foot sores. Respondents with no depression and those experiencing a minor depressive episode were more likely to report exercise than those experiencing a major depressive episode. Respondents with no depression were more likely to report attending diabetes education classes than those experiencing a major depressive episode. And respondents experiencing no depression and a minor depressive episode were more likely to report no foot sores than participants experiencing a major depressive episode. Significant effects for major depressive episodes were also found in six covariates: diabetes type, race, sex, marital status, level of education, and income. No effects for depression were found in the diabetes self-care behaviors foot and blood glucose checks.

Acknowledgements

Thanks to my family, my friends, my fellow students, and my faculty mentors who supported me during this endeavor.

Table of Contents

List of Tables

List of Abbreviations

APA	American Psychiatric Association
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control
DSM-IV	*Diagnostic and statistical manual of mental disorders* (4th ed., text revision)
HbA1C	Hemoglobin A1C
HRQOL	Health Related Quality of Life
PHQ-8	Patient Health Questionnaire-8 Depression Scale
PHQ-9	Patient Health Questionnaire-9 Depression Scale
QOL	Quality of Life
SAS	Statistical Analysis Software
W.H.O	World Health Organization

Review of Literature

Introduction

Increasing evidence suggests that depression and diabetes are related (Talbot & Nouwen, 2000). One in four diabetes patients have depression, while people with depression are twice as likely to develop diabetes when compared to those who are not depressed (Anderson et al, 2001; Knol, Twisk, Beekman, Snoek, & Pouwer, 2006). Depression in diabetes is also related to negative treatment outcomes such as elevated blood sugar levels, more medical complications, increased hospitalization, and poorer treatment adherence (Ciechanowski, Katon, & Russo, 2000; de Groot, Anderson, Freedland, Clouse, & Lustman, 2001; Lustmanet al., 2000)

Poor treatment adherence to diabetes self-care procedures is a growing problem (van Dulman et al, 2007). Diabetes self-care generally includes eating healthy, exercising, glucose monitoring, and taking insulin or oral medications designed to improve glucose utilization. Adherence to self-care is vital for positive diabetes outcomes and improved health related quality of life (American Diabetes Association, 2009). An emerging line of research explores the potential role of depressions on adherence to diabetes self-care behaviors. Several studies of clinical samples have indicated that depression is negatively associated withdiabetes self–care (Ciechanowski, Katon, and Russo, 2000; Lin et al, 2004). Only one previous study was identified that analyzed the impact of depression on diabetes self-care behaviors from a large population perspective (Egede, Ellis, and Grubaugh, 2009). The purpose of the current study is to add to our understanding of the relationship between depression and adherence to diabetes

self-care behaviors using a sample that is representative of the adult United States population.

Diabetes

Diabetes mellitus is a chronic metabolic condition characterized by elevated blood glucose levels and the inability of the body to control these levels (Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 2001). The World Health Organization estimates that 170 million people have diabetes; this figure is projected to at least double by 2050 (W.H.O., 2004). General symptoms of diabetes include: blurry vision, excessive thirst, fatigue, frequent urination, hunger, and weight loss. A diagnosis is made when a patient has a combination of these symptoms and a, and strict adherence to self-care recommendations, such as maintaining a healthy diet and engaging in regular exercise. This combination treatment may efficiently control blood sugar and prevent fasting blood glucose level above 200 mg/dl. Treatment involves prescription medications to improve glucose utilization and/or insulin replacement symptoms. There are several different types of diabetes, such as Type 1, Type 2 and gestational (American Diabetes Association, 2009). The discussion in this paper and the focus of this study is limited to Type 1 and Type 2 diabetes.

Type 1 diabetes is the most serious form of diabetes and typically manifests in childhood or young adulthood. It affects close to 20% of those diagnosed with diabetes and is marked by progressive damage of insulin producing beta cells in the pancreas. This leads to little to no insulin secretion for use in the body (Atkinson and Maclaren, 1994). The cause(s) of Type 1 diabetes

are not fully understood, although genetics, viruses, and autoimmune dysfunction are thought to play roles (American Diabetes Association, 2009).

Type 2 diabetes is far more common than Type 1, accounting for an estimated 80% of those diagnosed with the disease. Typically Type 2 diabetes is diagnosed in adulthood, but increasingly younger people are acquiring the condition (American Diabetes Association, 2009). Type 2 diabetes is not characterized by destruction of insulin producing beta cells and Type 2 diabetics are capable of producing insulin. In Type 2 more time is required for the body to utilize glucose, resulting from factors such as reduced insulin sensitivity, increased glucose secretion, and a reduction of insulin secretion (Awad, 2004; Kahn, 1994). According to the American Diabetes Association (2009), risk factors that increase the likelihood of developing Type 2 diabetes are: age > 45 years old, obesity, family history of the disease, pregnancy with gestational diabetes, HDL cholesterol under 35 mg/dl, low activity level, and dietary factors. Also, ethnic groups such as African Americans, Hispanics, and Native American are at a greater risk of developing Type 2 diabetes than other groups (American Diabetes Association, 2009).

Diabetes treatment goals are to prevent immediate complications such as diabetic ketacidosis, and to prevent long term consequences such as end-organ damage. Ketacidosis occurs when glucose is not available in the body as a fuel source resulting in the usage of fat instead. Long term consequences of diabetes affect almost every organ of the body and may include: blindness, cardio vascular disease, stroke, kidney failure, nerve damage, foot ulceration, and

amputation. Uncontrolled diabetes could complicate pregnancy, increasing the likelihood of birth defects (American Diabetes Association, 2009). In 2007, diabetes cost the United States $174 billion. Indirect costs including disability payments, time lost from work, and reduced productivity cost an estimated $58 billion. Direct costs such as hospitalizations, medical care and treatment supplies totaled $116 billion (NIH National Diabetes Clearinghouse, 2009). In addition, diabetes is the seventh leading cause of death in the United States (U.S. Department of health and Human Services, 2000).

Diabetes treatment also requires regular adherence to a combination of self-care behaviors. For Type 1 diabetes, these behaviors generally include healthy eating habits, exercising, maintaining a healthy body weight, and taking insulin (typically injections). Insulin intake must be balanced with diet and daily activities. Glucose levels must also be closely monitored through frequent blood glucose tests. These tests are conducted several times daily by patients with personal glucose monitoring devices. A laboratory test called the hemoglobin A1C (HbA1C) is taken several times per year and measures patient's average blood glucose level from the previous 2 – 3 months (American Diabetes Association, 2009). Specifically, the HbA1C test measures the percentage of hemoglobin - a protein in red blood cells that carries oxygen that is coated with sugar (glycated). Poor blood sugar maintenance is indicated by high HbA1C levels. Also, if one has been diagnosed with diabetes, higher HbA1C levels mean a greater risk of developing diabetes complications. The HbA1C test has several

other names, like the glycated hemoglobin test and glycosylated hemoglobin test (American Diabetes Association, 2009).

Self-care behaviors for Type 2 diabetes are eating healthy, exercising, periodic glucose monitoring and insulin replacement or, more commonly, medications that enhance insulin sensitivity and glucose utilization (American Diabetes Association, 2009). Other important self-care behaviors for both Type 1 and Type 2 diabetes include: (1) regular eye exams to check for retinal damage, (2) up–to–date vaccinations, (3) regular dental exams to reduce gum infections, (4) monitoring blood pressure, (5) reducing or abstaining from consumption of alcohol, nicotine, and drugs, and (6) regular foot care to increase blood flow and reduce nerve damage (Glasgow and Eakin, 1998).

Adequate foot care requires adhering to a combination of lifestyle changes. This generally consists of regularly checking for blisters and sores, wearing adequate socks and shoes, washing feet daily, and maintaining blood flow by regularly massaging or elevating the feet (American Diabetes Association, 2009). Non-adherence to these procedures is one of the most important problems for people with diabetes and leads to nerve damage, such as peripheral neuropathy and the development of foot sores and ulcerations. Diabetic foot sores are caused by other factors too, including peripheral vascular disease, limited joint mobility and repeated trauma from abnormal load distribution on the foot (Valk, Kriegsmans, and Assendelf 2006). Foot ulcerations affect 15% of diabetes patients and precede an estimated 85% of limb

amputations. The risk of a lower body amputation is 15 times higher for diabetics (Reiber, 1994; Valk, Kriegsmans, and Assendelf 2006).

One line of research dealing with diabetes self-care investigates possible factors that affect or interfere with self- care. Such factors may include: age, race, physician characteristics and level of social support (DiMatteo et al, 1993; DiMatteo, 2003). Depression is also thought to be one of these factors (Callahan, Hui, Nienaber, Musick, & Tierney, 1994; Carney, Freedland, Eisen, Rich, & Jaffe, 1995; Simon, VonKorff, & Barlow, 1995; Ciechanowski, Katon, and Russo, 2000, Lee et al, 2009). Because one goal of this study is to investigate the possible effects of depression on diabetes self-care, it is necessary to review the current literature that bears on this relationship.

Depression

Depression is the most commonly diagnosed mental disorder and is considered a major public health concern throughout much the world (Murray & Lopez, 1997). According to the U.S. Department of Health and Human Services (1999), major depression is the leading cause of disability and has been shown to decrease overall functional ability when it accompanies a chronic medical condition, such as diabetes mellitus. Additionally, depression accounts for over two-thirds of suicide attempts each year (U.S. Department of Health and Human Services, 1999). Depression is defined by the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders 4th Edition, Text – Revision* (DSM IV – TR, 2000) as a mental disorder characterized by either cardinal symptoms of low mood and self-esteem, and a loss of interest or pleasure in

normally enjoyable activities. Five or more symptoms must be present for longer than two weeks. Additional symptoms of depression are: decrease or increase in appetite, insomnia or hypersomnia, psychomotor agitation or retardation, fatigue or loss of energy, feelings of worthlessness, excessive or inappropriate guilt, diminished ability to think or concentrate, indecisiveness, recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, having a specific plan for committing suicide, or a suicide attempt (APA, 2000). Diagnosis of major depressive disorder is based on experiences and behavior reported by the patient or friends and/or relatives. Minor depression is the presence of a depressed mood or loss of pleasure with one or more periods of depressive symptoms, involving 2 – 4 of the symptoms listed for major depression. It is estimated that 10 – 25% of the overall population has a lifelong risk of developing either major or minor depression (APA, 2000). In addition, by 2050 approximately 46 million adults aged 18 and older will be diagnosed with major depression (Heo et al, 2008). Prevalence is unclear for minor depression, but is commonly seen in primary care and outpatient mental health settings (APA, 2000).

Many studies confirm a relationship between depression and diabetes (Anderson et al, 2001). Diabetes patients with depression are at an increased likelihood of having more diabetes related complications, perceived functional limitation and hyperglycemia (elevated blood sugar) (Lustman et al, 2000; de Groot et al, 2000; Fisher et al, 2001; and Engum et al, 2005). Diabetes complications and depression have also been associated with obesity, physical

inactivity, marital status, and socio-economic status (Everson et al, 2002; Peyrot and Rubin, 1997; Katon et al, 2004; Eagle and Zheng, 2003; Reyerson et al, 2003). Anderson et al (2001) conducted a meta-analysis of 42 studies that reported the prevalence of depression among diabetes patients. This study investigated the prevalence of depression as a function of the depression scale used to establish diagnosis, diabetes type, and gender. Results indicate that the risk of having depression in patients with diabetes is twice that of non - diabetics (Anderson et al, 2001). The risk of developing depression was lower in Type 1 vs. Type 2 diabetes. In addition, prevalence and risk estimates were found unrelated to the method used to diagnose depression (diagnostic interviews vs. self-report scales).

Several recent studies reported a strong relationship between depression and glycemic control (HbA1C) in individuals with Type 1 diabetes. This suggests that depression leads to poor glycemic control (elevated HbA1C), or that an unknown variable causes both depression and poor glycemic control (Ciechanowski, Katon, Russo, & Hirsch, Van Tilburg et al., 2001). Other studies have found little to no evidence of an association between Type 2 diabetes, depression, and HbA1C (Ciechanowski et al., 2000; Ciechanowski et al., 2003; Kaholokula et al., 2003; Lane et al., 2000; Paschalides et al., 2004).

Self-care Adherence

One major problem physicians have in treating diabetes and other chronic conditions is the difficulty in encouraging adherence to medical treatment recommendations (Dulmen et al, 2007). Adherence with medical treatment is

defined as the tendency to follow the medical advice of physicians (Dulman et al, 2007; Mazben, 2008). A large body of research has shown that higher rates of adherence are associated with better health outcomes (DiMatteo, 1994, 2000; Dunbar-Jacob & Schlenk, 2001; Honish et al, 2006). With diabetes, positive outcomes include: a stable glucose level, lowered body weight, regulated blood pressure, improved organ function and reduced end-organ damage, and lowered medical costs (AHRQ, 2005).

Several methodologies are available to assess overall level of diabetes self–care. The weakest of these are indirect measures of control, such as physician judgments of patient adherence. Direct methods such as glucose testing and monitoring (e.g. pill counts) are time consuming and subject to human error. Self–reports are also open to criticism, but are slightly more reliable than indirect measures of control (Toobert, Hampson, and Glasgow, 2000). For this reason, several standardized self–report assessments have been designed to measure overall diabetes self-care. The most widely used tests include the Diabetes Regimens Questionnaire (Kurts, 1990), The Rand Corporation Diabetes Adherence Questionnaire (Hays et al, 2005), and the Summary of Diabetes Self–Care Activities (Toobert, Hampson, and Glasgow, 2000). These tests are important, especially in clinical settings, because they offer physicians a perspective into their patients' level of adherence to self – management recommendations (Famwell and Anderson, 2001).

Researchers have identified several factors that favorably alter adherence to diabetes self-care. The factors most related to self-care adherence are positive

physician personality characteristics, stable social support systems and participation in disease management programs (Dimatteo et al, 1993; Dimatteo, 2003; Lynn, 2004). Dimatteo et al (1993) conducted a two year longitudinal study examining physician attributes and practice methods in relation to patient adherence to treatment. The study included 186 physicians and their patients' with diagnoses of hypertension, heart disease, and diabetes. The researchers evaluated patient adherence to medication, exercise, and diet recommendations. Predictors of adherence were: high physician job satisfaction, specialty field, small patient caseload, scheduled follow–up appointments and patient health distress. Baseline adherence rates were taken and compared with adherence rates two years later. All measures of adherence were self–report. In each of the four analyses, a positive effect on adherence was found when measured at the two year follow up. Personal characteristics of physicians, medical specialty, and tests ordered were also positively associated with adherence (DiMatteo et al, 1993).

DiMatteo (2004) conducted a meta-analysis of 122 studies that correlated social support with patient adherence to medical treatment. The researcher found a significant relationship between practical and emotional categories of perceived functional support and patient adherence. Practical support is the giving of assistance in practical, matter–of–fact ways, such as providing information, financial assistance, shelter, or help with daily tasks. Emotional support is varying forms of encouragement. This includes listening, empathizing, sympathizing, and helping one feel understood. Practical support had the highest association for

increasing patient adherence. Adherence was also 1.7 times greater in patients with close families, and 1.5 times lower in those from families in conflict (DiMatteo, 2004).

Disease management programs demonstrate effectiveness at increasing patient adherence to medical treatment, including adherence to diabetes self–care regimens (Honish, 2006; Lynne, 2004). In general, disease management programs are aimed at increasing patient access to care and improving quality of service. Lynn (2004) evaluated the effectiveness of a diabetes disease management program [Disease Management Solutions (DMS)] used by over 8,000 persons in a managed care organization. Claims filed in a three year period for 1,368 patients with diabetes were analyzed. Patients enrolled in the DMS utilized more primary care services but had lowered costs compared to those not enrolled. The program also affected other aspects of care by bettering patient work productivity (e.g. fewer sick days), and increasing general adherence to recommended self–management procedures. Medical claims were used to verify and validate self–reported adherence to primary care physician visits, ophthalmological examinations, emergency room visits, and hospital admissions. Self–report was found to be a valid indicator of medical claims data recording emergency room visits and hospital admissions (Lynne, 2004).

Researchers have also investigated the role of quality of life in relation to adherence to diabetes self–care procedures. Quality of life (QOL) refers to overall well–being in life realms such as income, marital status, life–expectancy, and standard of living. The term Health Related Quality of Life (HRQOL) refers to

overall physical and mental well-being, further defined by seven measureable constructs: (1) physical functioning, (2) social functioning, (3) emotional functioning, (4) cognitive functioning, (5) pain, (6) vitality, and (7) overall well-being (Honish et al, 2006). Originally, HRQOL measures were developed as a cross cultural population status assessment primarily used for nationwide comparisons to assess outcomes of chronic medical illnesses. (Coons and Kaplan, 1992; Eren, Erdi, and Sahin, 2008; Guyatt et al, 1993). However, assessing HRQOL has become a frequent procedure to evaluate outcomes of individual patients with chronic medical conditions. Diabetes is a chronic condition that places heavy demands on patients; HRQOL is a major concern and is generally accepted as an important outcome for therapy (Eren, Erdi, and Sahin, 2008).

Honish et al (2006) conducted a study to explore the association between HRQOL and compliance to diabetes treatment regimens. HRQOL data were collected by sending the Short Form Health Survey (SF-12) (Honish et al, 2006) to 198 members of a large health plan who were diagnosed with diabetes. The SF- 12 is a standardized health status questionnaire that measures the previously listed seven constructs of HRQOL. Two aggregate scores - the physical and mental composite scores - assessed the physical and mental health of participants. Patient compliance was tested by examining the number of treatment guidelines completed, such as: having an HbA1C twice per year, a cholesterol test, an annual micoalbuminia test, and an eye exam (Honish et al, 2006). Results indicate that mental composite score and age are the best

predictors of diabetic treatment adherence. It was also determined that lower mental health scores (i.e. less depression) are related to better adherence (Honish et al, 2006).

A key area of research has been too determine the relationship between depression and adherence to diabetes self-care recommendations. Ciechanowski, Katon, and Russo (2000) administered a questionnaire to 367 diabetic patients in primary care clinics managed by two separate health maintenance organizations. The questionnaire gathered data on demographics, depression symptoms, diabetes awareness, diabetes self-management practices, and physical functioning. It also measured medical comorbidity, medical costs, HbA1C levels, and oral hypoglycemic prescription refills. Regression analysis was used to conclude how depression affects adherence to diabetes self-care and oral hypoglycemic regimens, HbA1C levels, overall functioning, and medical costs. Results of the study indicate that depressive symptoms were significantly associated with dietary recommendations. Specifically, diabetics with minor depressive symptoms, in comparison to those with moderate to severe symptoms, were more likely to report adhering to recommendations regarding quantity and types of food eaten. In addition, 15% of respondents with severe depression failed to adhere to oral hypoglycemic medication compared to 7% of those with moderate depression (Ciechanowski, Katon, and Russo, 2000).

Another study had 4,463 members of a major health maintenance organization – mostly Type 2 diabetics - complete a questionnaire measuring self

care, diabetes monitoring, and depression (Lin et al, 2004). Diagnostic laboratory and pharmacy data were used to assess adherence to self-care procedures, glycemic control, and use of preventative care services. Results indicate that major depression is associated with an unhealthy diet and inactive lifestyle and poorer adherence to oral hypoglycemic, anti-hypertensive, and lipid lowering medications. In contrast, preventative care methods such as foot checks, home glucose tests, and retinal checks were similar among depressed and non-depressed respondents. These results may generalize to primary care/HMO populations but not to the general population. The participants consisted only of patients belonging to a health maintenance organization, eliminating segments of diabetic patients who have no, or some other form of health care coverage.

Only one study was identified that used a national sample of adults to determine the relationship between depression and diabetes self-care. Egede, Ellis, and Grubaugh (2009) examined data from the Center for Disease Control's Behavioral Risk Factor Surveillance System 2006 (BRFSS, 2006) to determine an association between depression, diabetes self-care, and the quality of diabetes care received. Four self-care behaviors were measured: leisure activities, smoking, blood glucose checks, and foot checks. The study determined that both minor and major depressive episodes have impact quality of care and the diabetes self-care behavior by reducing leisure activities and increasing smoking. However, there is no evidence that the authors weighted their analyses to population values, which would prevent estimating the prevalence of depression among diabetics, and could also affect the associations

between depression and self-care behaviors (Egede, Ellis, and Grubaugh 2009). In addition, Egede, Ellis, and Grubaugh (2009) did not consider foot sores as an outcome variable or diabetes type as a classification variable in their analyses.

Statement of the Problem

Prior research demonstrates that depression is negatively associated with diabetes self-care, but the majority of these studies are based on clinical samples (Ciechanowski, Katon, and Russo, 2000, Lin, 2004). The goal of the current study is to broaden understanding the relationship between depression and adherence to diabetes self-care procedures by analyzing data from the BRFSS (2006). The BRFSS (2006) is a nationwide survey conducted annually under the auspices of the Centers for Disease Control (CDC) and measures a wide variety of health related behaviors in adults aged 18 – 99 (CDC, 2006). The current study hypothesized that depression is negatively associated with adherence to diabetes self -care behavior. A second hypothesis expands on the first by narrowing the form of depression that has a greater association with on self-care, and postulates that major depressive episodes have a greater negative association with self- care than minor depressive episodes. The rationale underlying these two hypotheses stems from the fact that depression impairs activity level; diabetes care requires a high level of energy and motivation (APA, 2000; American Diabetes Association, 2009). The relationship between depression and five diabetic self-care behaviors (i.e. exercise, diabetes education, foot sore occurrence, foot checks, and blood glucose checks) were evaluated while controlling for the effects of variables that could potentially influence the association (i.e. diabetes type, age, race, sex, marital status, level of education, and income).

Method

Sample

The BRFSS (2006) is a nationwide (U.S.) survey conducted annually by the Centers for Disease Control (CDC, 2006). Participants are selected based on random digit dialing of phone numbers in all 50 states, The District of Columbia, Puerto Rico, and the U.S. Virgin Islands. The goal of the BRFSS (2006) is to generate a representative sample of the adult population of the United States. Weights are used for most statistical analyses to correct for possible biasing factors such as the number of adults in a residence, and the probability of a telephone number being randomly selected. BRFSS (2006) data sets are available for download at the CDC's website (CDC, 2006). The current study draws from the responses of the BRFSS (2006). The data for the current study were limited to the responses of adults between the ages 18-99 years with diabetes. The average age of the sample is 62.2 years, with a standard deviation of 13.1 years. For the BRFSS (2006), 22,994 individuals with diabetes were surveyed and administered the PHQ–8 questions (CDC, 2006). After removing individuals whose type of diabetes was ambiguous, 15,226 participants who met the inclusion criteria with respect to diabetes type remained in the sample.

Measurement: Diabetes Type

The goal of selection according to diabetes type is to produce a sample of respondents who could most clearly be identified as having either Type 1 or Type 2 diabetes. Respondents who reported borderline or gestational diabetes were excluded from the study. Study participants are classified as having Type 1

diabetes if their age at diagnosis was ≤ 30 years and they reported current insulin use. Participants who reported an age at diagnosis of > 30 years and no insulin use are classified as having Type 2 diabetes (LI, Ford, and Strine, 2008). Application of these criteria excluded 7,768 cases from the final sample. These were cases where type of diabetes could not be clearly established using the specified case definitions. Excluded respondents were either > 30 years when diagnosed, but reported insulin dependence, or were < 30 when diagnosed but were not insulin dependent.

Measurement: Depression

The PHQ-8 is an eight-item measure of depression based on the PHQ–9, which is designed to measure the nine symptoms of depression outlined in the DSM-IV-TR (Kroenke & Spitzer, 2001; Kroenke, Spitzer, and Williams, 2002). A question pertaining to recurrent thoughts of death and suicide was omitted from the PHQ–8 to allow for assessment of depression in circumstances where the interviewer cannot promptly intervene for individuals in danger of committing suicide, as is the situation when one is administering the telephone based BRFSS (Kroenke & Spitzer, 2002; Kroenke et al, 2009). Removal of this item does not significantly affect or threaten the validity of the PHQ–8 in comparison to the PHQ – 9 because recurrent thoughts of death and suicide are less frequently reported than the remaining eight symptoms (Kroenke, Spitzer, and Williams, 2001).

The PHQ – 8 was adapted for use in the Depression and Anxiety section of the BRFSS (2006) to measure depression symptoms during the 14 days prior to the survey administration. The eight questions ask how many days out of the past 14 were the following symptoms experienced: (1) little interest or pleasure in doing things, (2) feeling down, depressed, or hopeless, (3) trouble falling asleep, staying asleep, or sleeping too much, (4) feeling tired or having little energy, (5) poor appetite or overeating, (6) feeling bad about yourself, or that you're a failure and have let yourself or your family down, (7) trouble concentrating on things, and (8) Moving or speaking slowly to the point where others notice, or the opposite-feeling fidgety to the point where others notice. Respondents were to give responses ranging from 0 to 14 days for each item.

Calculation of PHQ-8 depression scores followed the work of Fan et al (2009). The number of days during which individuals report experiencing symptoms of depression are grouped into categories using a 0–3 scale (0-1 day = 0 *not at all*; 2-6 days = 1; *several days*; 7-11 days = 2 *more than half the days*; and 12-14 = 3 *nearly every day*). These scores for each symptom were then summed to yield a total PHQ–8 score. Total scores were classified into the depression categories outlined by Fan et al (2009) and used by LoBello and Zachar (2009). However, because no clinical interview was administered to participants a diagnosis of depression cannot be given. Therefore, identification of depression will be noted as minor depressive episode or major depressive episode. Scores ≤ 4 indicate no depression. Scores between 5 and 9 are categorized as minor depressive episode, while scores ≥ 10 are indicative of

major depressive episode. Kroenke et al (2009) determined that scores ≥ 10 have a sensitivity of 100% and a specificity of 95% for major depressive episode. Also, the sensitivity and specificity of the ≥ 10 cut score for major and minor of depressive episodes is 70% and 98% (Kroenke et al, 2009).

LoBello and Zachar (2009) demonstrated the validity of the PHQ – 8 major and minor depressive episode categories. They compared participants depressive episode categorization to another question on the BRFSS (2006); *Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?* Respondents in the no depression category averaged 2.4 days, 6.7 days in the minor depressive episode category, and 17.7 in the major depressive episode category. This was significant (r^2=.22, p<001). A Tukey test indicated the differences among these group means were significant, supporting the distinction and diagnostic relevance between depression categories in the PHQ – 8.

Measurement: Diabetic Self-Care Behaviors:

Self–care behaviors evaluated in this study are those behaviors a participant can do himself or herself (Wells et al, 1989; Ciechanowski, Katon, and Russo, 2000). Participation in tests and procedures done primarily by a health-care provider (eg, eye examination) do not require the same level of motivation needed to sustain regular, daily self-care behaviors. The self-care behaviors evaluated in this study include: a) blood glucose monitoring, b) checking feet for

ulcers, c) participation in diabetes management classes, and d) participation in regular physical exercise.

Self-care behaviors were measured from responses participants gave to the following set of questions pertaining to diabetes self–care procedures: (a) *during the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise*? The responses were *yes, no, don't know/not sure,* and *refused to answer* (b) *Have you ever taken a course or class in how to manage your diabetes yourself?* Responses were: *yes, no, don't know/not sure,* and *refused to answer*; (c) *About how often do you check your feet for any sores or irritations? Include times when checked by a family member or friend, but do not include times when checked by a health professional.* Responses are reported as either: *times per day*, *times per week*, *times per month*, *times per year;* and (d) *about how often do you check your blood for glucose or sugar? Include times when checked by a family member or friend, but do not include times when checked by a health professional.* Responses are reported as either: *times per day*, *times per week*, *times per month*, or *times per year* (CDC, 2006).

Foot sores are a major adverse outcome of non-adherence to diabetes self-care procedures (Reiber, 1994; American Diabetes Association 2009). The BRFSS asks about the occurrence of foot sores with the following question: *Have you ever had any sores or irritation on your feet that took more than four weeks to heal?* Possible responses were: *yes, no, don't know/not sure,* and *refused to answer.*

The questions about frequency of blood glucose monitoring and performing foot checks permitted responses in a variety of forms (frequency in days, weeks, months, or years). Rather than equating all responses on a single unit of measure, the responses were regarded as categories that reflected differences in frequency. For example, those who reported any number of daily blood glucose tests were classified as *daily* testers, while those who reported any value of monthly blood glucose tests were classified as *monthly* testers. For these two questions, the response categories likely overlap to some degree. Responses to the questions about participation in diabetes management classes and regular exercise, and the occurrence of foot ulcerations were answered either *yes* or *no*, but some respondents either couldn't or refused to respond. The analyses of these questions are limited to only valid responses and the final form of the responses to these questions is dichotomies.

Measurement of Covariates

It is important to control for the possible confounding effects of several variables that could be related to either the outcome variables, depression status, or both. The covariates included in each model are diabetes type (Type 1 diabetes vs. Type 2 diabetes) age in years, race/ethnic group (classified in one of five categories: White, Black, Hispanic, Multiracial, and Other), marital status (classified in one of six categories: married, divorced, widowed, separated, never married, or member of an unmarried couple), education (classified in one of four categories: less than high school, high school graduate, attended college/technical school, or graduated from college/technical school), and income

(classified in one of six categories ranging from less than $15,000/year to more than $50,000/year, and unreported).

Statistical Analysis and Models

The data was analyzed using Statistical Analysis Software (SAS), *Surveylogistic module,* a program specifically developed to work with complex survey designs. This study required a series of five separate multivariable logistic regression models with the four specific self-care behavior questions and the question about foot ulceration occurrence as outcome variables. The predictor variable in each model is level of depression (no depression-minor depressive episode-major depressive episode).

Results

The initial goal of this study was to determine the impact of depression on adherence to diabetes self-care in adults between the ages of 18 and 99. Two hypotheses were analyzed: (1) depression is negatively associated with diabetes self -care behavior; (2) major depressive episodes have a greater negative association on self- care than minor depressive episodes. This study required a series of five separate multivariable logistic regression models as described in Methods. The results of each analysis are presented in the sections that follow.

Exercise

The BRFSS (2006) question pertaining to exercise asks *During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise*? Type 3 Analysis of Effects for exercise are presented in Table 1 and report a significant effect for depression (Wald $\chi^2 = 45.9$, $p<.0001$) Odds ratio estimates for exercise are represented in Table 2. Results indicate that participants experiencing no depression and a minor depressive episode are more likely to report exercise than those experiencing a major depressive episode (No depression OR = 0.6, 95% CI, 0.4 – 0.8; Minor depressive episode OR = 0.4, 95% CI, 0.3 – 0.5). Table 3 indicates that over half of participants (57%) experiencing a major depressive episode report no exercise, as opposed to those experiencing no depression (33%) or a minor depressive episode (44%). These findings support the study's hypotheses that depression is negatively associated with diabetes self -care behavior of regular exercise, and that major

depressive episodes have a greater negative association on exercise than minor depressive episodes.

Table 1 indicates that marital status (Wald $\chi^2 = 6.5$, p = 04) and level of education (Wald $\chi^2 = 47.0$, p <.0001) covariates are significantly related to self – reported exercise participation. Unmarried participants are more likely to report no exercise than married participants (OR = 1.3, 95% CI, 1.1-1.7). Regarding level of education, participants who report not graduating from high school (OR = 2.6, 95% CI, 1.9 – 3.5), graduating only high school (OR = 1.7 95% CI, 1.4 – 2.0) or attending some college (OR = 1.5, 95% CI, 1.2 – 1.9), are more likely than college graduates to report no exercise.

Table 1: *Summary Type 3 Analysis of Effect for Exercise*

Effect	DF	Wald Chi – Square	*p*
Exercise			
Diabetes Type	1	0.8	0.4
Age	1	2.1	0.1
Race	5	4.4	0.5
Sex	1	0.7	0.4
Depression	2	45.9	<.0001
Marital Status	2	6.5	.04
Education	4	47.0	<.0001
Income	5	10.7	0.1

Table 2: *Odds Ratio Estimates for Exercise*

Variable	Adjusted Odds Ratio	95% Confidence Interval
Diabetes Type		
Type 2	--	--
Type 1	1.2	0.8 – 1.7
Age	1.0	1.0 – 1.0
Race/Ethnic Background		
White	--	--
Hispanic/Latino	0.9	0.7 – 1.2
African-American	0.9	0.7 – 1.1
Multiracial	0.7	0.5 – 1.1
Other	1.0	0.7 – 1.5
Unknown	0.7	0.4 – 1.1
Sex		
Women	--	--
Men	0.9	0.8 – 1.1
Depression Category		
Major Depression	--	--
Minor Depression	0.4	0.3 – 0.5
No Depression	0.6	0.4 – 0.8
Marital Status Category		
Married	--	--
Not Married	1.2	0.9 – 1.4
Unknown	1.3	1.1 – 1.7
Education		
Graduated College	--	--
Attended College/TS	1.5	1.2 – 1.9
Graduated High School	1.7	1.4 – 2.0
Did not graduate HS	2.6	1.9 – 3.5
Unknown	0.5	0.1 – 2.0
Income		
$50,000 +	--	--
$35,000 - $49,999	1.2	0.9 – 1.6
$25,000 - $34,999	1.2	1.0 – 1.8
$15,000 - $24,999	1.3	1.0 – 1.8
Less Than $15,000	1.6	1.1 – 2.3
Unknown	1.6	1.2 – 2.1

Table 3: *Exercise Percents Table*

Variable	Exercise	No Exercise
Diabetes Type		
Type 2	64.4	35.6
Type 1	62.8	37.3
Race/Ethnic Background		
White	63.4	36.6
Hispanic/Latino	58.7	41.3
African-American	59.1	40.8
Multiracial	67.4	32.6
Other	65.3	34.7
Unknown	65.6	34.4
Sex		
Women	57.8	42.2
Men	66.2	33.8
Depression Category		
Major Depression	42.8	57.2
Minor Depression	56.1	43.9
No Depression	67.5	32.5
Marital Status Category		
Married	66.2	33.8
Not Married	55.7	44.3
Unknown	55.1	44.9
Education		
College Grad	75.2	24.3
Attend College/TS	64.4	35.6
Graduated HS	59.6	40.4
Did not Grad HS	48.1	51.9
Unknown	78.4	21,7
Income		
$50K	75.6	24.4
$35K- $49,999	67.7	32.3
$25K- $34,999	61.2	38.9
$15K- $24,999	57.7	42.3
<$15K	48.1	51.9
Unknown	57.8	42.2

Diabetes Education

The BRFSS (2006) question pertaining to diabetes education asks *Have you ever taken a course or class in how to manage your diabetes yourself?* Type

3 Analysis of Effects for depression presented in Table 4 report a significant effect for depression (Wald χ^2 = 6.4, p=04). Odds ratio estimates for diabetes education are represented in Table 5 and indicate that participants with no depression are more likely to report attending diabetes education classes than those experiencing a major depressive episode (OR = 1.3, 95% CI, 1.01 – 1.7). Table 6 indicates that nearly half of participants experiencing a major and minor depressive episodes (47%) report not attending diabetes education classes. These findings support the study's first hypothesis that depression is negatively associated with attending diabetes education classes. Hypothesis two is not supported because there are no significant differences in attending diabetes education classes between participants experiencing major and minor depressive episodes.

Table 4 indicates that diabetes type (Wald χ^2 = 15.7, p = <.0001), sex (Wald χ^2 = 12.3, p =.0005), and level of education (Wald X^2 = 45.9, p<.0001) covariates are significantly related to self–reported attendance to diabetes education classes. Odds Ratio Estimates (Table 5) indicate that participants with Type 1 diabetes are more likely to report attending diabetes education than those with Type 2 (OR = 2.1, 95% CI, 1.5 - 3.1). Men are less likely to report attending diabetes education classes than women (OR = 0.8, 95% CI, 0.6 – 0.9). And participants who report not graduating from high school (OR = 0.5, 95% CI, 0.4 – 0.7) and graduating from only high school (OR = 0.7, 95% CI, 0.6 – 0.8) are less likely than college graduates to report attending diabetes education classes.

Table 4: *Summary Type 3 Analysis of Effect for Diabetes Education*

Effect	DF	Wald Chi – Square	*p*
Diabetes Education	1	5.2	0.02
Race	5	2.1	0.8
Sex	1	12.3	0.0005
Depression	2	6.4	0.04
Marital Status	2	6.8	0.03
Education	4	45.9	<.0001
Income	5	3.6	0.6

Table 5: *Odds Ratio Estimates for Diabetes Education*

Variable	Adjusted Odds Ratio	95% Confidence Interval
Diabetes Type		
Type 2	--	--
Type 1	2.1	1.5 – 3.1
Age	1.0	1.0 – 1.0
Race/Ethnic Background		
White	--	--
Hispanic/Latino	0.9	0.7 – 1.2
African-American	1	0.8 – 1.3
Multiracial	1.1	0.6 – 1.8
Other	0.8	0.5 – 1.2
Unknown	1.1	0.5 – 2.1
Sex		
Women	--	--
Men	0.8	0.6 - 0.9
Depression Category		
Major Depression	--	--
Minor Depression	1.1	0.8 – 1.4
No Depression	1.3	1.01 – 1.7
Marital Status Category		
Married	--	--
Not Married	0.9	0.7 – 1.1
Refused to answer	0.8	0.7 – 1.0
Education		
Graduated College	--	--
Attended College/TS	1.0	0.9 – 1.3
Graduated High School	0.7	0.6 – 0.8
Did not graduate HS	0.5	0.4 – 0.7
Unknown	3.9	1.0 – 15.0
Income		
$50,000 +	--	--
$35,000 - $49,999	1.0	0.8 – 1.3
$25,000 - $34,999	0.9	0.7 – 1.2
$15,000 - $24,999	0.9	0.7 – 1.2
Less Than $15,000	1.0	0.7 – 1.4
Unknown	0.8	0.6 – 1.0

Table 6: *Diabetes Education Percents*

Variable	Took Class	Did not take class
Diabetes Type		
Type 2	51.8	48.2
Type 1	74.5	25.6
Race/Ethnic Background		
White	57.4	42.6
Hispanic/Latino	49.1	50.9
African-American	59.2	40.8
Multiracial	59.0	41.0
Other	51.9	48.1
Unknown	54.6	45.2
Sex		
Women	57.5	42.5
Men	54.2	45.8
Depression Category		
Major Depression	53.0	47.0
Minor Depression	52.8	47.2
No Depression	57.2	42.8
Marital Status Category		
Married	57.6	42,4
Not Married	52.8	47.1
Unknown	52.8	47.1
Education		
College Grad	62.0	38.0
Attend College/TS	63.0	37.0
Graduated HS	53.8	46.2
Did not Grad HS	42,5	57.5
Unknown	81.2	18.8
Income		
$50,000 +	62.7	37.3
$35,000 - $49,999	58.7	41.3
$25,000 - $34,999	55.3	44.6
$15,000 - $24,999	53.4	46.6
< $15,000	49.6	50.1
Unknown	52.5	47.5

Foot Sores

The BRFSS (2006) question pertaining to foot sores asks *Have you ever had any sores or irritation on your feet that took more than four weeks to heal?* Type 3 Analysis of Effects for foot sores are presented in Table 7 and indicate significance for depression (Wald $\chi^2 = 32.3$, $p<.0001$). Odds Ratio Estimates (Table 8) indicate that respondents experiencing no depression (OR = 2.8, 95% CI, 2.0 – 4.0) or a minor depressive episode (OR = 2.1, 95% CI, 1.5 – 2.9) are more likely to report no foot sores than participants experiencing a major depressive episode. Table 9 indicates that over one quarter of participants experiencing a major depressive episode (26%) and nearly one quarter experiencing a minor depressive episode (22%) report having foot sores. These findings support the study's two hypotheses that depression is negatively associated with the occurrence foot sores, and major depressive episodes have a greater negative association on the occurrence of foot sores than minor depressive episodes.

Table 7 indicates that the race (Wald $\chi^2 = 12.4$, $p = .03$) and income (Wald $\chi^2 = 24.7$, $p=.0002$) covariates are significantly related to the occurrence of diabetes related foot sores. Odds Ratio Estimates (Table 8) indicate that African American participants are more likely to report foot sores than white participants. And participants who have an annual income: <$15,000 (95% CI, 0.2 – 0.5); $15,000 - $24, 999 (95% CI, 0.3 – 0.8); $25,000 - $34,999 (95% CI, 0.4 – 0.9) – are less likely to report no foot sores than participants whose annual income is $50,000 +.

Table 7: *Summary Type 3 Analysis of Effect for Foot Sores*

Effect	DF	Wald Chi – Square	*p*
Foot Sores	1	9.6	0.002
Race	5	12.4	0.03
Sex	1	4.0	0.05
Depression	2	32.3	<.0001
Marital Status	2	1.0	0.6
Education	4	28.7	<.0001
Income	5	24.7	0.0002

Table 8: *Odds Ratio Estimates for Foot Sores*

Variable	Adjusted Odds Ratio	95% Confidence Interval
Diabetes Type		
Type 2	--	--
Type 1	0.7	0.4 – 1.3
Age	1.0	1.0 – 1.0
Race/Ethnic Background		
White	--	--
Hispanic/Latino	1.0	0.7 – 1.5
African-American	2.0	1.3 – 2.9
Multiracial	1.0	0.6 – 1.6
Other	1.2	0.7 – 2.2
Unknown	1.3	0.6 – 2.6
Sex		
Women	--	--
Men	0.7	0.5 – 1.0
Depression Category		
Major Depression	--	--
Minor Depression	2.1	1.5 – 2.9
No Depression	2.8	2.0 – 4.0
Marital Status Category		
Married	--	--
Not Married	1.0	0.7 – 1.4
Unknown	0.8	0.6 – 1.2
Education		
Graduated College	--	--
Attend College/TS	0.9	0.6 – 1.3
Graduated HS	1.4	1.0 – 1.9
Did not Graduate HS	1.1	0.7 – 1.7
Unknown	215.0	24.0 – 1000
Income		
$50,000 +	--	--
$35,000 - $49,999	0.9	0.6 – 1.3
$25,000 - $34,999	0.6	0.4 – 0.9
$15,000 - $24,999	0.5	0.3 – 0.8
Less Than $15,000	0.3	0.2 – 0.5
Unknown	0.5	0.3 – 0.7

Table 9: *Foot Sores Percents*

Variable	Foot Sores	No Foot Sores
Diabetes Type		
Type 2	9.5	90.5
Type 1	21.6	78.4
Race/Ethnic Background		
White	12.1	87.9
Hispanic/Latino	13.9	86.1
African-American	9.0	91.0
Multiracial	16.5	83.5
Other	12.3	87.7
Unknown	11.8	88.2
Sex		
Women	57.5	42.5
Men	12.2	87.8
Depression Category		
Major Depression	26.3	74.7
Minor Depression	22.3	85.3
No Depression	8.9	91.1
Marital Status Category		
Married	10.8	89.2
Not Married	14.4	85.6
Unknown	5.9	94.1
Education		
College Grad	10.2	89.8
Attend College/TS	14.0	86.0
Graduated HS	10.8	89.2
Did not Grad HS	14.6	85.5
Unknown	0.1	99.9
Income		
$50k	7.1	92.9
$35K - $49,999	9.3	90.7
$25K - $34,999	10.6	89.4
$15K - $24,999	12.9	87.1
<$15,000	21.5	78.5
Unknown	12.3	87.4

Foot Check

The BRFSS (2006) question pertaining to foot checks asks *About how often do you check your feet for any sores or irritations?* Education and marital

status were omitted from the foot check covariate model because each contained one cell with zero frequency. Removing this variable did not result in an improved goodness of fit model for an ordinal outcome variable, so the multi – category outcome variable was retained. Type 3 Analysis of Effects for foot checks are presented in Table 10 and do not support the study's two hypotheses that (1) depression is associated with foot checks, and (2) major depression has a greater association to foot checks than minor depression.

Table 10 indicates that diabetes type (Wald $\chi^2 = 17.9$, $p = .0001$) is significantly related to foot check adherence. All comparisons were made with daily foot checks as the reference condition. Odds Ratio Estimates (Table 11) indicate that participants with Type 1 diabetes are less to report never checking their feet than participants with Type 2 diabetes (OR= .24, 95% CI, 0.1 – 0.5). Table 5 indicates that race (Wald $\chi^2 = 39.2$, $p = .01$) is significantly related to foot check adherence, and Odds Ratio Estimates indicate significance in the-*other*- and -*unknown*-categories. Although these categories are within the race covariate, they are too ambiguous for interpretation because it is not possible to specify the actual racial/ethnic backgrounds of these particular survey respondents.

Table 10: *Summary Type 3 Analysis of Effects for Foot Checks*

Effect	DF	Wald Chi – Square	Pr>ChiSq
Foot Checks			
Diabetes Type	4	17.9	0.001
Age	4	2.7	0.6
Race	20	39.2	0.01
Sex	4	8.2	0.1
Depression	8	4.8	0.7
Income	20	28.9	0.1

Table 11: *Odds Ratio Estimate for Foot Check*

Variable	Daily vs. Weekly Checks	Daily vs. Monthly Checks	Daily vs. Yearly Checks	Daily vs. Never Checks
Diabetes Type				
Type 2	--	--	--	--
Type 1	1.25 (.8- 2)	1.1 (.6-2.3)	1.1 (.4-2.8)	*.24 (.1 - .5)*
Age	1.0(1.0-1.0)	1.0(1.0-1.0)	1.0(1.0-1.0)	1.0(1.0-1.0)
Race				
White	--	--	--	--
Hispanic	1.2 (.8-1.8)	.98 (.5-1.9)	1.4 (.7-2.6)	1.2 (.8-1.9)
AA	.7 (.5-1)	.6 (.4 – 1)	.6 (.3-1.4)	.7 (.5-1.1)
Multiracial	1 (.6 – 1.7)	.6 (.3-1.2)	.7 (.2-2.2)	1.1 (.5-2.5)
Other	*.5 (.3 -.9)*	1.5 (.7-3.4)	.5 (.2 -1.2)	1.2 (.7-2)
Unknown	*.45 (.2 - .9)*	.6 (.2 – 1.6)	.32 (.06-1.7)	*.34 (.2 - .8)*
Sex				
Women	--	--	--	--
Men	1.2 (1 – 1.5)	1.3 (.95-1.9)	1.2 (.7-1.8)	1.2 (.9-1.6)
Depression				
Major	--	--	--	--
Minor	1.2 (.8–1.7)	.8 (.5 – 1.5)	1.6 (.7-3.4)	1 (.6 – 1.5)
None	1 (.7 – 1.4)	.75 (.5-1.2)	1.3 (.7-2.5)	1 (.7 – 1.5)
Income				
50K +	--	--	--	--
35K-49,999	.9 (.6 – 1.1)	1.2 (.7-2.2)	.8 (.4-1.6)	1 (.7 – 1.7)
25K-34,999	.9 (.6-1.3)	.9 (.5-1.6)	.5 (.25-1.1)	1.3 (.9-1.9)
15K-24,999	.8(.6-1.1)	.8 (.5-1.2)	*.5 (.3 - .99)*	.8 (.6 – 1.2)
<15K	.8 (.6-1.3)	.8 (.4 – 1.6)	.6 (.3-1.1)	1.1 (.7-1.7)
Unknown	*.6 (.5 - .95)*	*.5 (.3 - .9)*	.5 (.3 -1)	1.5 (.96-2.2)

Blood Glucose Check

The BRFSS (2006) question pertaining to blood glucose checks asks *About how often do you check your blood for glucose or sugar?* Education was omitted as a covariate from the blood glucose check covariate model because it contained one cell with zero frequency. Removing this variable did not result in an improved goodness of fit model for an ordinal outcome variable, so the multi – category outcome variable was retained. Type 3 Analysis of Effects for blood sugar checks are presented in Table 12 and do not support the study's two hypotheses that (1) depression impacts foot checks, and (2) major depression has a greater impact on self-care than minor or depression.

Table 12 indicates that diabetes type (Wald $\chi^2 = 77.6$, p= <.0001), race (Wald $\chi^2 = 39.5$, p=.01), and sex (Wald $\chi^2 = 19.6$, p = .001) are significantly related to blood glucose checks. The reference category for the Odds Ratio was daily blood glucose checks. The categories compared to the reference were self – reported as *weekly*, *monthly*, *yearly*, and *never* for blood glucose check frequency. Odds ratio estimates (Table 13) indicate that Type 1 diabetics are less likely than Type 2 diabetics to report: never checking blood glucose (OR= 0.1, 95% CI, .04 – 0.3); yearly blood glucose checks (OR=0.06, 95% CI, .02 – 0.2); monthly blood sugar checks (OR= 0.2, 95% CI, .07 – 0.5); weekly blood sugar checks (OR= 0.2, 95% CI, 0.1- 0.3). For race, Hispanic participants are more likely than whites to report daily vs. never checking their blood glucose (OR = 1.5, 95% CI, 1.1 – 2.6), and daily vs. monthly checks (OR = 2.1, 95% CI, 1.2 – 3.7). Men are more likely than women to report: never checking blood glucose

OR= 1.5 , 95% CI, 1.1 – 2.0); yearly blood glucose checks (OR=1.6, 95% CI, 1.1 – 2.5); and weekly checks (OR=1.4, 95% CI, 1.1 – 1.7).

Table 12: *Summary Type 3 Analysis of Effects for Blood Glucose Checks*

Effect	DF	Wald Chi - Square	*p*
Blood Glucose Checks			
Diabetes Type	4	77.6	<.0001
Age	4	1.2	0.9
Race	20	39.5	0.01
Sex	4	19.6	0.001
Depression	8	5.2	0.7
Marital Status	8	12.4	0.13
Income	20	20.6	0.4

Table 13: *Odds Ratio Estimates for Blood Glucose Checks*

Variable	Daily vs. Weekly Checks	Daily vs. Monthly Checks	Daily vs. Yearly Checks	Daily vs. Never Checks
Diabetes Type				
Type 2	--	--	--	--
Type 1	*.2 (.1-.3)*	*.2 (.07-.5)*	*.06 (.02-.2)*	*.11 (.04-.3)*
Age	1.0(1.0-1.0)	1.0(1.0-1.0)	1.0(1.0-1.0)	1,0(1.0-1.0)
Race				
White	--	--	--	--
Hispanic	1.4 (1-2)	*2.1 (1.2-3.7)*	.5 (.2-1.1)	*1.7 (1.1-2.6)*
AA	1 (.8-1.3)	1 (.6-1.7)	.7 (.3-1.2)	.7 (.4 – 1.1)
Multiracial	1.1 (.6-2.2)	.7 (.3-1.3)	.4 (.2-1)	.8 (.4-1.6)
Other	1.4 (.9-2.2)	.5 (.2-1.1)	.9 (.2-3.4)	1.2 (.7-2.1)
Unknown	.6 (.3 – 1.2)	.4 (.15-1.2)	.6 (.2 – 2.1)	.8 (.4 – 1.9)
Sex				
Women	--	--	--	--
Men	*1.4 (1.1-1.7)*	1.3 (.9-1.9)	*1.6 (1.1-2.5)*	*1.5 (1.1-2)*
Depression				
Major	--	--	--	--
Minor	1.1 (.8-1.6)	1.1 (.7-1.9)	1.4 (.6-3.1)	.8 (.5-1.3)
None	1 (.7-1.4)	1.3 (.8-2.1)	.8 (.5-1.4)	.9 (.6-1.3)
Marital Status				
Married	--	--	--	--
Not Married	.9 (.7 – 1.1)	.7 (.5- 1.0)	.9 (.6-1.4)	1.3 (1.0-1.7)
Unknown	.4 (.08-1.8)	.2 (.03-1.8)	1.6 (.2-13.8)	1.7 (.4-7.1)
Income				
50K	--	--	--	--
35K-49,999	1 (.7-1.3)	.9 (.6-1.5)	.5 (.3-1.1)	1 (.6-1.6)
25K-34,999	1.2 (.8-1.6)	1.1 (.6 – 2)	1.1 (.5-2.3)	1.1 (.7-1.5)
15K-24,999	.8 (.6-1.1)	1 (.6 – 1.7)	.6 (.3-1.2)	.9 (.6-1.3)
<15K	.9 (.6-1.2)	1 (.5 – 2)	.5 (.3- 1)	1 (.6 – 1.5)
Unknown	1.2 (.8-1.7)	.7 (.4-1.1)	.9 (.4 – 2)	1.2 (.8-1.8)

Discussion

This study provides a population - based estimate of the association between depression and diabetes self-care behaviors among diabetic adults between the ages of 18 and 99 in the United States. An additional purpose of the study was to determine if impact on self-care behaviors would be related to level of depression defined as major and minor depressive episodes as determined by PHQ-8 score. The relationship between depressive episode and diabetes self-care behavior was evaluated while controlling for the effects of variables that could potentially influence the association. Significant associations were found between participants experiencing a major depressive episode and the diabetes self-care behaviors of regular physical exercise, attending diabetes education classes, and occurrence of foot sores. Depression was not related to the self-care behaviors of regular foot checks and frequency of blood sugar self-monitoring.

The current study substantially broadens understanding of the relationship between depression and diabetes and supports the hypothesis that depressive episode is associated with patient adherence to some diabetes self-care behaviors. After controlling for the effects of race/ethnicity, income, sex, marital status, education, and diabetes type respondents with no depression and those experiencing a minor depressive episode were significantly more likely to report adhering to self - care than participants experiencing a major depressive episode. These findings are consistent with findings from clinical samples (Ciechanowsky et al 2003; Lin et al, 2004; Wells et al, 1989; Ciechanowski, Katon, and Russo, 2000; Gonzalez et al, 2007; Norris et al, 2001; Rickheim et al

2002; Herber, Schnepp and Rieger, 2007; Marjolein et al, 2009), and signify that not only does comorbid diabetes and depressive symptoms negatively impact adherence to diabetes self-care behaviors, but there is a dose-response relationship between depressive symptoms and non-adherence. Diabetics experiencing a major depressive episode are less likely to adhere to exercise and diabetes education recommendations than diabetics experiencing a minor depressive episode. Likewise, diabetics experiencing a minor depressive episode are less likely to conform to these behavioral recommendations than diabetics with no depression.

Participants with no depression and those experiencing a minor depressive episode are more likely to report not having foot sores than those experiencing a major depressive episode. Previous studies have documented the impact of depression and Health Related Quality of Life (HRQOL) and foot sores. Past research also indicates that along with other quality of life factors, having a history of foot sores is significantly associated with poor psychological well-being and a low perception of health (Herber, Schnepp and Rieger, 2007) Interestingly, according to findings from the current study depressive symptoms do not impact frequency of foot checks, so unraveling factors associated with depressive symptoms and foot sores is critical for understanding this relationship. One possibility is that people who have depression are more likely to report that they have had foot sores due to recall bias. Research indicates that negative life events are remembered more frequently among depressed people (Pyszczynski, Hamilton and Herring, 1989). For example, diabetics who are currently

depressed might be more likely to recall and report foot sores because they are a perceived negative life event.

Results for foot and blood glucose check categories do not support the study's two hypotheses that (1) depression would negatively impact frequency of foot and blood glucose checks, and (2) major depression has a greater impact on these self-care behaviors than minor or major depression, because no significant effects for depression were found. These findings support prior research findings that indicate depression does not impact checking behaviors individuals conduct themselves, such as foot and blood glucose checks (Lin et al, 2004; Egede, Ellis, and Grubaugh, 2009).

A recent study evaluating the relationship between depression and diabetes self-care using the same BRFSS (2006) data found that depression impacts the self-care behaviors of leisure activities and smoking. Egede, Ellis, and Grubaugh (2009) examined the association between depression and diabetes self-care and the quality of care received. Four self-care behaviors were measured: leisure activities, smoking, blood glucose checks, and foot checks. The authors determined that both minor and major depression negatively impact diabetes self care. Their findings indicate that diabetics with depression are more likely to smoke tobacco and less likely to engage in leisure activity. Findings from the current study partially confirm Egede, Ellis, and Grubaugh (2009) in that major depression was found to impact the diabetes self-care exercise. Also, no significant effects for foot and blood glucose checks were found. In their analysis, Egede, Ellis, and Grubaugh (2009) modified the response options from *daily,*

weekly, monthly, and yearly to *daily* and *other.* Although treatment of the response options in their study and the current study are open to criticism, both studies found no relationship between depression and either frequency of foot and blood glucose checks. One criticism of the Egede, Ellis, and Grubaugh (2009) study is that the authors do not state that they weighted their analyses to population values. This would mean that estimates of depression and diabetes would not be representative of the U.S. adult population. Also, estimates of the relationship between levels of depression and diabetes would not be representative values if the models were not weighted. In addition, Egede, Ellis, and Grubaugh (2009) did not consider the occurrence of foot sores or diabetes type in their analyses.

Implications of findings

The current study findings have implications for clinicians who treat patients with diabetes and depression. Depression and diabetes self-care clinical screening instruments exist and are presently used by clinicians (Toobert and Hampson, 2000). Neglected self-care may indicate the presence of additional problems that need to appropriately evaluated ant treated. Depression may be indicative of poor self-care, and poor self-care may be indicative of depression (Anderson et al, 2001). Clinicians must pay closer attention to patients with diabetes and depression beyond screening. Primary-care physicians should ensure that patients with diabetes and depression are effectively treated for their depression Clinicians should also take in to account the impact of the differing forms of depression. Major depression has a greater impact on diabetes self-care

than minor or no depression. Although important for all diabetes patients, clinicians should recognize that adherence to self-care is a potential additional issue when treating diabetics with comorbid depression.

Health care providers such as nurses, social workers, and diabetes educators will also benefit from the current study's findings because diabetes education classes are often taught by these professionals. Findings may also benefit organizations that support and provide diabetes education classes - who can promote services through public service announcements or other forms of advertising to educate and motivate diabetics with comorbid depression to attend diabetes education classes.

Relationship of Covariates on Self-care

For the outcome variables of exercise participation, diabetes education, and foot sore occurrence, several covariates were related to the outcome-variables. Marital status and level of education were significantly related to the diabetes self-care behavior of exercise. Unmarried participants were more likely to report no exercise than married participants, and participants who did not graduate from high school were more likely than college graduates to report no exercise. Diabetes type, sex, and level of education were related to attendance at diabetes education classes. Participants with Type 1 diabetes were more likely to report attending diabetes education than those with Type 2 diabetes. Men were less likely to report attending classes than women, and participants who did not graduate from high school and graduated from high school only were less likely than college graduates to report attending diabetes education classes. With

foot sore-occurrence, African American participants were more likely to report foot sores than white participants. And participants who reported an annual income < $50,000 are less likely to report no foot sores than participants whose annual income is $50,000 +.

Limitations

The current study is limited in a few important areas. One problem is the lack of relationship between depression and the five-category foot and blood sugar monitoring variables. Research supports the current study's findings that depression does not impact these self – monitoring activities (Lin et al, 2004). However, possibility still remains that depression impacts foot and blood glucose checks, but cannot be determined using the particular five category models that were used in this study. Questions about frequency of blood sugar and foot checks admitted a variety of responses (frequency could be reported in days, weeks, months, years, or never). Rather than equating all responses on a single unit of measure, the responses were regarded as reflecting differences in perceived frequency. Therefore participants who reported any number of daily blood glucose tests were classified as *daily* testers, while those who reported any number of monthly blood glucose tests were classified as *monthly* testers, and so on. This strategy did no permit the construction of non-overlapping categories. For instance, participants who reported checking their feet four times per month were placed in the monthly check category. Obviously checking four times per month is roughly the same as checking once per week. This creates an overlap in the classification scheme of reported frequency of blood sugar and foot

checks, leading to the possibility that the failure to relate depression to these outcome variables may be an artifact of these overlapping categories. As stated, Egede, Ellis, and Grubaugh, (2009) also failed to find a relationship between these variables and depression.

Correcting the problem would require converting all responses to a common scale of measure (i.e., days, weeks, or months), and constructing non-overlapping categories. At the time that the study was proposed, it was decided to determine if a relationship existed between the outcome variables and the unit of measurement that the respondent chose to use in reporting. Determining the relationship between actual frequency of blood sugar and foot checking and depression would require a more refined approach to creating the outcome categories.

Other limitations have to do with the restricted data available through the PHQ-8 and the BRFSS (2006) as a telephone survey. The PHQ-8 is an effective tool for identifying episodes of depression, but without a clinical interview or a more detailed list of questions it is not possible to separate cases of depression from cases of other mental illnesses that share similar symptomatology (e.g. bipolar disorder, generalized anxiety, schizophrenia, etc.). The PHQ-8 is also unable to discriminate between a depressive episode and transient states of negative emotion (LoBello & Zachar, 2009). It is important to recognize that when using the PHQ-8 the possibility exists that patients with a chronic medical illness like diabetes answer questions based on the physically-oriented symptoms of depression. This may cause participant scores to add up to a diagnosis of

depression ($5 \leq$ PHQ-8 ≤ 9) in the absence of one of the required emotional symptoms (i.e., sadness and feelings of worthlessness) (APA, 2000). In such cases, the physical discomforts associated with diabetes (e.g. abdominal pain, increased hunger, and altered states of consciousness) are captured, but neglect emotional aspects associated with depression (American Diabetes Association, 2009). The BRFSS does not ask participants if they are currently undergoing any form of treatment for depression (LoBello & Zachar, 2009).

The nature of the BRFSS (2006) as a telephone survey creates limitations. Telephone surveys can lead to biased outcomes because they exclude households without telephones. Also, a segment of the population may have been excluded because they have abandoned the land-line telephone in favor of the cell phone. This is especially true for the 18 – 25 year old demographic and because the study is a cross–sectional design, the determination of causal relationships is precluded. Specifically, it is impossible to determine if depression precedes or follows problems in managing self-care among diabetics.

Additional Research

Methods for the current study made it impossible to analyze some self-care behaviors that may be of interest when researching the impact of depression on diabetes self-care. Prior studies indicate that diabetes self-care behaviors such as medication and vaccination adherence may also be affected by depression, while other studies have looked at depressions impact on diabetes self-care of healthy HbA1C levels, with varied results (Egede, Ellis, and

Grubaugh, 2009; Lin et al, 2004; Ciechanowski, 2003). The BRFSS (2006) does not ask about medication adherence, but additional studies using the BRFSS (2006) could measure depressions impact on other diabetes self-care behaviors that are not necessarily behaviors patients conduct themselves. Potential categories with corresponding BRFSS (2006) questions include: vaccinations, eye exams, and HbA1C.

Conclusion

In summary, the current study expands understanding of the relationship between depression and diabetes, and confirms that depression is associated with patient adherence to diabetes self-care behaviors. It provides a population - based estimate of the impact of depression on diabetes self-care behaviors among diabetic adults in the United States, and determined that major depressive episodes have a greater impact than minor depressive episodes or no depression on diabetes self-care behaviors. Significant associations were found between depressive symptoms and the diabetes self-care behaviors of regular physical exercise, attending diabetes education classes, and occurrence of foot sores.

Taking into account the links between diabetes and depression, the potential impact of depression on diabetes self-care should not be dismissed. Misconceptions regarding this relationship may prevent the recognition of depressions impact on diabetes self-care. Health care providers treating diabetes are directed to routinely employ screening measures to identify patients who may meet the criteria for depression. These screening measures should incorporate

questions regarding patient's perception of health related quality of life, the amount of emotional support they receive, and their mental health history. Increased awareness of depressions impact on diabetes will hopefully encourage more mental – health intervention and lead to better diabetes health outcomes.

References

American Diabetes Association (2009). Standards of Medical Care in *Diabetes Care (32),* S13-S61.

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text revision). Washington, DC: Author.

Anda, R. F., Williamson, D. F., Escobedo, L. G., Mast, E. E., Giovino, G. A., & Remington, P. L. (1990). Depression and the dynamics of smoking. A national perspective. *Journal of the American Medical Association, 264*, 1541–1545.

Anderson, R. J., Freedland, K. E., Clouse, R. E., & Lustman, P. J. (2001). The prevalence of comorbid depression in adults with diabetes: A meta-analysis. *Diabetes Care, 24*, 1069–1078

Atkinson, M.A., & Maclaren, N.K. (1994). The pathogenesis of insulin dependent diabetes. *New England Journal of Medicine, 331*, 1428 – 1436.

Awad, N, Gagnon, M., Messier, C. (2004) The relationship Between impaired glucose tolerance, diabetes, and cognitive function. *Journal of Clinical and Experimental Neuropsychology (26)*, 1044 – 1080.

Callahan, C. M., Hui, S. L., Nienaber, N. A., Musick, B. S., & Tierney, W. M. (1994). Longitudinal study of depression and health services use among elderly primary care patients. *Journal of the American Geriatrics Society, 42*, 833–838.

Carney, R. M., Freedland, K. E., Eisen, S. A., Rich, M. W.,&Jaffe, A. S. (1995). Major depression and medication adherence in elderly patients with coronary artery disease *Health Psychology, 14*, 88–90.

Centers for Disease Control (2006a). *2006 Behavioral Risk Factors Surveillance System.*(http://www.cdc.gov/brfss/technical_infodata/surveydata/2006.htm)

Centers for Disease Control (2006b). *Behavioral Risk Factor Surveillance System 2006 Codebook Report.* Centers for Disease Control and Prevention: Atlanta, GA.

Ciechanowski, P. S., Katon, W. J., & Russo, J. E. (2000). Depression and diabetes: Impact of depressive symptoms on adherence, function, and costs. *Archives of Internal Medicine 160*, 3278–3285.

Ciechanowski, P. S., Katon, W.J., Russo, J. E.,& Hirsch, I. B. (2003). The relationship of depressive symptoms to symptom reporting, self-care and glucose control in diabetes. *General Hospital Psychiatry, 25*, 246–252.

Coons, S. J., Kaplan, R. M. (1992). Assessing health-related quality of life: Application to drug therapy. *Clinical Therapy*, 14, 850–858.

De Groot M., Anderson R., Freedland K.E., Clouse R.E., Lustman P.J. (2001). Association of Depression and diabetes complications: A meta – analysis. *Psychosomatic Medicine 63(4)*, 619 – 630.

DiMatteo, M.R. (1994). Enhancing patient adherence to medical recommendations. *The Journal of the American Medical Association,* 271, 79-83.

DiMatteo, M. R. (2004). Social support and adherence to medical treatment: a meta analysis. *Health Psychology, 23*, 207-218.

Dunbar - Jacob, J., & Schlenk, E. (2001). Patient Adherence to Treatment Regimens. In A. Baum, T. A. Revenson, & J. E. Singler (Eds.), *Handbook of health psychology* (pp. 571-580). Mahwah, N.J.: Lawrence Erlbaum Associates.

Egede, L.E. Ellis, C. & Grubaugh, A.L. (2009). The effect of depression on self-care behaviors and quality of care in a national sample of adults with diabetes.*General Hospital Psychiatry, 31*, 422-427.

Egede, L.E., Zheng, D. (2003). Independent factors associated with major depressive disorder in a national sample of individuals with diabetes. *Diabetes Care, 26,* 104-111.

Engum, A., Mykletun, A., Midthjell, K. Holen A., Dahl, A. A. (2005). Depression and Diabetes: a large socio demographic study of lifestyle, and clinical factors associated with depression in type 1 and type 2 diabetes. *Diabetes Care, 28,* 1904-1909.

Eren, I., Erdi, O., Sahin, M. (2008). The effect of depression on quality of life of patients with type 2 diabetes mellitus. *Depression and Anxiety, 25,* 98-106.

Everson, S. Maty, S. Lynch, J, Kaplan, G. (2002). Epidemiologic evidence for the relation between socioeconomic status and depression, obesity, and diabetes. *Journal of Psychosomatic Research, 53,* 891-895.

Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (2002). Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care (25)*, S5-S20.

Fan, A. Z., Strine, T. W. Huang, Y. Murray, M. R., Musingo, S., Jiles, R., Mokdad, A. H. (2009). Self-rated depression and physician-diagnosed depression and anxietyin Florida adults: Behavioral Risk Factor Surveillance System, 2006. *PreventingChronic Disease, 6*, 1-14.

Fisher, L., Chesla, C. A., Skaff, M. M., & Kanter, R. A. (2001). Contributors to depression Latino and European American patients with type 2 diabetes. *Diabetes Care, 24*, 1751-1757.

Funnell, M. M., Anderson, R.M. (2003). Changing office practice and health care systems to facilitate diabetes self-management. *Current Diabetes Reports, 3*, 2127-2133.

Glasgow, R. E., & Eakin, E. G. (1998). Issues in diabetes self management. In S. A. Shumaker, E. B. Schron, J. K. Ockene, & W. L. McBee (Eds.), *The handbook of behavior changes* (pp. 435-461). New York: Springer Publishing Co.

Gonzalez J.S., Safren S.A., Cagliero E., Wexler D.J., Delahanty L.M., Wittenberg M.A., Meigs J.B., Grant R.W (2007): Depression, self-care, and medication adherence in type 2 diabetes: Relationships across the full range of symptom severity. *Diabetes Care*, *30*, 1-6.

Guyatt, G., Feeny D., Patrick D. (1993). Measuring health-related quality of life. Analysis *of Internal Medicine*, *118*, 622–629.

Hays, Kravitz, Mazel, Sherbourne, DiMatteo, Rogers, Greenfield. (2005). The impact of patient adherence on health outcomes for patients with chronic disease in the medical outcomes study. *Journal of Behavioral Medicine, 17*, 347-360.

Heo, M., Murphy, C. Fontaine, K. Bruce, M. Alexopoulos, G. S. (2008). Population projection of US adults with lifetime experience of depressive disorder by age and sex from year 2005 to 2050. *International Journal of Geriatric Psychiatry, 12,* 1266-1270.

Herber, O.R., Schnepp, W., Reiger, M.A. (2007). A systematic review on the impact of leg ulceration on patients' quality of life. *Health and Quality of Life Outcomes*, *5*, 1-12.

Honish, A., Westerfield, W., Ashby, A., Momin, S., Phillipi, R. (2006). Health related quality of life and treatment compliance with diabetes care. *Disease Management, 9,* 195-200.

Kahn, C.R. (1994). Insulin action, diabetogenes, and cause of type II diabetes, *Diabetes Care, 43*, 1066 – 1084.

Kaholokula, J. K., Haynes, S. N., Grandinetti, A., & Chang, H. K. (2003). Biological, psychosocial, and socio demographic variables associated with depressive symptoms in persons with type 2 diabetes. *Journal of Behavioral Medicine, 26*, 435–458.

Katon, w. von Korff, M. Ciechanowski, P. et al. (2004) Behavioral and clinical factors associated with depression among individuals with diabetes. *Diabetes Care, 27,* 914-920.

Fan, A. Z., Strine, T. W. Huang, Y. Murray, M. R., Musingo, S., Jiles, R., Mokdad, A. H. (2009). Self-rated depression and physician-diagnosed depression and anxietyin Florida adults: Behavioral Risk Factor Surveillance System, 2006. *PreventingChronic Disease, 6*, 1-14.

Fisher, L., Chesla, C. A., Skaff, M. M., & Kanter, R. A. (2001). Contributors to depression Latino and European American patients with type 2 diabetes. *Diabetes Care, 24*, 1751-1757.

Funnell, M. M., Anderson, R.M. (2003). Changing office practice and health care systems to facilitate diabetes self-management. *Current Diabetes Reports, 3*, 2127-2133.

Glasgow, R. E., & Eakin, E. G. (1998). Issues in diabetes self management. In S. A. Shumaker, E. B. Schron, J. K. Ockene, & W. L. McBee (Eds.), *The handbook of behavior changes* (pp. 435-461). New York: Springer Publishing Co.

Gonzalez J.S., Safren S.A., Cagliero E., Wexler D.J., Delahanty L.M., Wittenberg M.A., Meigs J.B., Grant R.W (2007): Depression, self-care, and medication adherence in type 2 diabetes: Relationships across the full range of symptom severity. *Diabetes Care*, *30*, 1-6.

Guyatt, G., Feeny D., Patrick D. (1993). Measuring health-related quality of life. Analysis *of Internal Medicine*, *118*, 622–629.

Hays, Kravitz, Mazel, Sherbourne, DiMatteo, Rogers, Greenfield. (2005). The impact of patient adherence on health outcomes for patients with chronic disease in the medical outcomes study. *Journal of Behavioral Medicine, 17*, 347-360.

Heo, M., Murphy, C. Fontaine, K. Bruce, M. Alexopoulos, G. S. (2008). Population projection of US adults with lifetime experience of depressive disorder by age and sex from year 2005 to 2050. *International Journal of Geriatric Psychiatry, 12,* 1266-1270.

Herber, O.R., Schnepp, W., Reiger, M.A. (2007). A systematic review on the impact of leg ulceration on patients' quality of life. *Health and Quality of Life Outcomes*, *5*, 1-12.

Honish, A., Westerfield, W., Ashby, A., Momin, S., Phillipi, R. (2006). Health related quality of life and treatment compliance with diabetes care. *Disease Management, 9,* 195-200.

Kahn, C.R. (1994). Insulin action, diabetogenes, and cause of type II diabetes, *Diabetes Care, 43*, 1066 – 1084.

Kaholokula, J. K., Haynes, S. N., Grandinetti, A., & Chang, H. K. (2003). Biological, psychosocial, and socio demographic variables associated with depressive symptoms in persons with type 2 diabetes. *Journal of Behavioral Medicine, 26*, 435–458.

Katon, w. von Korff, M. Ciechanowski, P. et al. (2004) Behavioral and clinical factors associated with depression among individuals with diabetes. *Diabetes Care, 27,* 914-920.

Knol, M. J., Twisk, J. W., Beekman, A. T., Snoek, F. J., & Pouwer, F. (2006). Depression as a risk factor for the onset of type 2 diabetes mellitus: A meta analysis. *Diabetologia,49*, 837–845.

Kroenke, K. & Spitzer, R. L. (2002). The PHQ-9: A new depression diagnostic and severity measure. *Psychiatric Annals, 32*, 1-8.

Kroenke, K., Spitzer, R. L., Williams, J. B. W. (2001). The PHQ-9: validity of a brief depression severity measure. *Journal of General Internal Medicine, 16*, 606-613.

Kroenke, K., Strine, T. W., Spitzer, R. L., Williams, J. B. W., Berry, J. T., Mokdad, A. H. (2009). The PHQ-8 as a measure of current depression in the general population. *Journal of Affective Disorders, 114,* 163-173.

Kurts, S. (1990). Adherence to diabetes regimens: empirical status and clinical applications. *The Diabetes Educator, 16*, 50-56.

Lane, J. D., McCaskill, C. C.,Williams, P. G., Parekh, P. I., Feinglos, M. N., & Surwit, R. S. (2000). Personality correlates of glycemic control in type 2 diabetes. *Diabetes Care, 23*, 1321–1325.

Lee, H. J., Chapa, D., Kao, C.W., Jones, D., Kapustin, J, Smith, J., Krichten, C., Donner, T. Thomas, S.A., Friedmann, E. (2009). Depression, quality of life, and glycemic control in individuals with type 2 diabetes. *Journal of the American Academy of Nurse Practitioners, 4*, 214-224.

Li, C., Ford, E.S. Strine, T.W., Mokdad, A.H. (2008). Prevalence of depression among U.S. adults with diabetes. *Diabetes Care, 31*, 105-107.

Lin EH, Katon W, Von Korff M, Rutter C,Simon GE, Oliver M, Ciechanowski P, Ludman EJ, Bush T,Young B. (2004) Relationship of depression and diabetes self-care, medication adherence, and preventive care. *Diabetes Care*, *27*, 2154–2160.

LoBello, S. G., & Zachar, P. (2009). Prevalence estimates and correlates of major and minor depressive episodes in the U.S. population. Unpublished Manuscript.

Lustman P. J., Griffith LS, Freedland, K.E., Griffith L.S., Clouse R.E. (2000) Fluoxetine or depression in diabetes – A randomized double – blind placebo – controlled trial. *Diabetes Care 27(9)*, 2154 – 2160.

Lynne, D. (2004). Diabetes disease management in managed care organizations. *Disease Management, 7*, 47–60.

Murray, C.J., & Lopez, A. D. (1997). Alternative projections of mortality and disability by causes 1990 – 2020: Global burden of disease study. *Lancet 349 (9064)*, 1498-1504.

National Institute of Health, Diabetes Information Clearinghouse (2007). [Diabetes Information Database]. Retrieved October 11, 2009, from National Institute of Health website: http://diabetes.niddk.nih.gov/.

Norris SL, Engelgau MM, Narayan KMV. Effectiveness of self-management training in type 2 diabetes: a systematic review of randomised controlled trials. *Diabetes Care*, *24*, 561–87.

Paschalides, C.,Wearden, A. J., Dunkerley, R., Bundy, C., Davies, R., & Dickens, C.M. (2004). The associations of anxiety, depression and personal illness representations with glycemic control and health-related quality of life in patients with type 2 diabetes mellitus. *Journal of Psychosomatic Research, 57*, 557–564.

Peyrot, M. Rubin, R.R. (1999). Persistence of depressive symptoms in diabetic adults. *Diabetes Care, 22,* 448-452.

Pyszczynski, T., Hamilton, J. H., Herring, E, & Greenberg, J. (1989). Depression, self-focused attention, and the negative memory bias. *Journal of Personality and Social Psychology, 57,* 351-357

Reiber, G.E. (1994). Who is at risk of limb loss and what to do about it? *Journal of Rehabilitation Research and Development, 31*, 357—362.

Rickheim PL, Weaver TK, Flader JL, Kendall DM (2002). Assessment of group versus individual education: a randomized study. *Diabetes Care*, *25,* 269–274.

Ryerson, B. Tierney, E.Thompson, T. Engelgau, M. Wang, J. Gregg, E. Geiss, L. (2003) Excess physical limitations among adults with diabetes in the U.S. population,1997–1999. *Diabetes Care, 26,* 206-210.

Simon, G. E., VonKorff, M., & Barlow, W. (1995). Health care costs of primary care patients with recognized depression. *Archives of General Psychiatry,* 52, 850–856.

Talbot, F., & Nouwen, A. (2000). A review of the relationship between depression and diabetes in adults: Is there a link? *Diabetes Care, 23,* 1556–1562.

Toobert, D.J., Hampson, S.E., Glasgow, R.E. (2000). The summary of diabetes self care measure: results from 7 studies and a revised scale. *Diabetes Care, 23,* 943-950.

US Department of Health and Human Services, Agency for Health Care Research and Quality (AHRQ) Improving Care for Diabetes Patients through Intensive Therapy and a Team Approach. *Diabetes findings* [Research in Action]. Retrieved October 27, 2009, from website: http://www.ahrq.gov/research/diabria/diabetes.html

U.S. Department of Health and Human Services (2000). *HHS Target Efforts on Diabetes* (HHS Fact Sheet). Government Printing Office, Washington, DC.

U.S. Department of Health and Human Services (1999). *Mental health: A report of the Surgeon General.* Rockville, MD: U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Mental Health Services, National Institutes of Health, National Institute of Mental Health.

U.S. Department of Health and Human Services (2001). *Mental health: Culture, race, and ethnicity – A supplement to Mental health: A report of the Surgeon General.* Rockville, MD: U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Mental Health Services.

Van Dulman S.,Sluijs E.,van Dijk L. (2007). Patient adherence to medical treatment: A review of reviews. *BMC Health Services, 7,* 55.

Van Tilburg, M. A., McCaskill, C. C., Lane, J. D., Edwards, C. L., Bethel, A., Feinglos, M. N, et al. (2001). Depressed mood is a factor in glycemic control in type 1 diabetes. *Psychosomatic Medicine*, *63*, 551–555.

Wells, K.B., Stewart, A., Hays, R.D., Burnam, A. Rogers, W. Daniels, M. Berry, S. Greenfield, S.Ware, J. (1989). The functional well being of depressed people. *The Journal of the American Medical Association, 262*, 914 - 919.

World Health Organization (2009, November). *Diabetes fact sheet.* Retrieved December 12, 2009, from World Health Organization website: http://www.who.int/mediacentre/factsheets/fs312/en/.