Longitudinal Relationship between Depression and Diabetes Self-care in Minorities with Type 2 Diabetes

BY

ROSALBA HERNANDEZ
B.S., University of Illinois at Chicago, 2005
M.S., University of Illinois at Chicago, 2010

THESIS

Submitted as partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Public Health
in the Graduate College of the
University of Illinois at Chicago, 2012

Chicago, Illinois

Defense Committee:

Thomas R. Prohaska, Chair and Advisor
Laurie Ruggiero
Noel Chavez
Nadine R. Peacock
Arie Nouwen, University of Birmingham

I would like to dedicate this dissertation to my parents, Maria Elena and Leonardo Hernandez, who made great sacrifices so that I could pursue higher education. They emigrated from Mexico to a foreign land where they did not understand the language spoken and where navigation would prove difficult. But if asked if they would again endure the arduous journey they would undoubtedly agree that it was worth the struggle. For this I am eternally grateful. I owe all that know and posses to my wonderful parents. Thank you for your unconditional love and nurture. May God grant me the grace to emulate your faith, work ethnic, and humility!

This work is also dedicated to Drs. Noel Chavez and Young-Ku Choi. During the first semester of graduate school, when the workload seemed unbearable and my thoughts were to give up, Noel did not allow this to happen. She believed in my capacity to become a researcher and she made this known in a tangible manner. She brought to life the saying that, “A mentor is someone who sees more talent and ability within you, than you see in yourself, and helps bring it out of you.” Thank you Noel! May I develop a spirit that identifies the talent and ability of those who have commenced the arduous journey of academia. This document is also dedicated in loving memory of Young-Ku. I am honored to have had him as a teacher, mentor, and friend. Thank you for receiving me with warmth and a gentle smile as I sought statistical advice. It is my hope that this work has made you proud and that it gives testimony of your great mentorship.

Finally, this dissertation is also dedicated to those that have immigrated to the United States in search of a better life. It is not an easy decision to leave your place of birth where your extended family and friends reside. It takes great courage and faith. Take heart, with God at our side all things are possible.

ACKNOWLEDGMENTS

I would like to thank my dissertation committee—Drs. Thomas R. Prohaska, Laurie Ruggiero, Noel Chavez, Nadine Peacock, and Arie Nouwen—for their guidance and support throughout the dissertation process. Their expert guidance allowed me to craft a well developed study. I would especially like to thank my committee chair, Dr. Thomas R. Prohaska, who offered his unwavering support. Tom challenged my paradigms which allowed me to develop into a more critical thinker and researcher. I'd also like to thank Laurie Ruggiero who offered her mentorship for the last 6-years and who graciously allowed me to use her dataset for purposes of my dissertation. At this time I would also like to acknowledge Weihan Zhao and David Brand. Weihan offered the statistical support needed to successfully address the aims identified in the dissertation.

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LIST OF ABBREVIATIONS

A1C	Glycated Hemoglobin
ADL	Activities of Daily Living
BMI	Body Mass Index
CBT	Cognitive Behavioral Therapy
DES	Diabetes Empowerment Scale
DES-SF	Diabetes Empowerment Scale-Short Form
FQHC	Federally Qualified Health Center
GEE	Generalized Estimating Equations
LEP	Limited English Proficiency
MAC	Medical Assistant Self-Management Coach
MDDP	Multifaceted Diabetes and Depression Program
PGC	Poor Glycemic Control
PHQ-9	Prime MD/Patient Health Questionnaire
RCT	Randomized Control Trial
SCT	Social Cognitive Theory
SDSCA	Summary of Diabetes Self-Care Activities Measure
T2D	Type 2 Diabetes
TAU	Treatment as Usual
TPB	Theory of Planned Behavior

SUMMARY

This study evaluates the longitudinal relationship between depressive symptoms, diabetes-related self-efficacy, and diabetes self-management. The primary aims were: (1) to examine whether diabetes-related self-efficacy mediates the relationship between depression and diabetes self-care in African American and Latino adults with type 2 diabetes (T2D); (2) after controlling for intervention assignment, to examine the longitudinal association between depressive symptoms and diabetes self-management (i.e., diabetes self-care performance levels and glycemic control) and to determine if individuals with higher baseline levels of depression are less likely to increase diabetes self-care behaviors and improve A1c (glycated hemoglobin) during 6-, 12-, and 18-month follow-up; and (3) to examine biopsychosocial factors that predict change in depressive symptomatology across time, after controlling for intervention assignment. Baseline in-person survey data were collected from African American and Latinos aged greater than or equal to 18 years with T2D participating in a diabetes self-management intervention at four primary care clinics (n = 276). The sample (n = 276) had a mean age of 53.2 years; 69% were female; 54% African American and 46% Hispanic; and 74% reported incomes below $20,000. Analyses of baseline data revealed that depression was negatively correlated with the self-care behaviors of general diet, specific diet, physical activity, foot care, and smoking, with higher depression scores associated with lower self-care performance. In the African American subgroup, diabetes-related self-efficacy was an important construct in the relational pathway between depression and diabetes self-care. Longitudinal analyses using generalized estimating equations (GEE) revealed an inverse association between depressive symptoms and non-disease-specific health behaviors of diet and physical exercise. The longitudinal predictors of depression consisted of two intrapersonal constructs of diabetes-related self-efficacy and diabetes distress. These findings suggest that among Latino and African American adults with T2D, depression may adversely affect adherence to non-disease-specific health behaviors across time, but the mutable risk factors of elevated diabetes distress levels and diminished self-efficacy may be targets for public health interventions related to mental well-being.

I. INTRODUCTION

A. Study Purpose

The present study aims to further explore, both cross-sectionally and longitudinally, the relationship between depression and diabetes self-care among Latinos and African Americans. Researchers have consistently found a negative relationship between depression and the performance of self-care activities, yet the exact mechanism through which depression exerts its influence on diabetes self-care still remains uncertain. What exactly is the pathway through which depression affects and diminishes an individual's adherence to the recommended self-care behaviors? Theory alludes to the construct of self-efficacy as an important step in the pathway leading to behavior adoption, maintenance, and change. Therefore, the first goal of the current study is to examine whether diabetes-related self-efficacy mediates the relationship between depression and self-care activities in a sample of Latino and African American adults with T2D.

Another gap identified in the literature is the scarcity of studies examining the prospective association between depression and diabetes-self-care. While most of the cross-sectional studies offer convincing evidence regarding the association between depression and diabetes self-care, they cannot offer any information regarding causality. It is suggested that there is a bi-directional relationship between depression and diabetes self-care but few studies have been conducted to definitively answer this scientific query. Going beyond the limited nature of cross-sectional studies will allow us to clarify whether low self-care and poor glycemic control (PGC) lead to negative self-relevant cognitions that manifest as depression or whether depression precedes nonadherence to the recommended self-care activities. For that reason, the secondary goal of the current study employs a longitudinal study design using repeated observations to examine the change in diabetes self-care activities between depressed and non-depressed adults and to examine the variables that best predict change in depressive symptomatology across time. In summary, the benefit of the prospective design utilized in the current study is the ability to interpret causality between the constructs of depression and diabetes self-care.

B. **Problem Statement**

Diabetes is the seventh leading cause of mortality in the United States and its prevalence among Americans is rising (CDC, 2011). Individuals with diabetes have a two-fold increased risk of mortality when compared to individuals of a similar age without the chronic condition (CDC, 2011). Research has shown that diabetes is associated with an increased risk of morbidity and mortality across all ethnic groups (CDC, 2011). Among racial/ethnic minorities, Latinos and African Americans are almost at a two-fold increase risk for developing diabetes when compared to their non-Hispanic white counterparts (Carter, Pugh, & Monterrosa, 1996; CDC, 2011), and this is accompanied by higher rates of glucose dysregulation, disease-related complications, and mortality (Karter et al., 2002; Lanting et al., 2005). This health disparity has been well documented and has been attributed to several factors including restricted funding and access to care and resources, and lack of culturally appropriate programs, providers, and productive community level partnerships (CMAF, 2004). A diagnosis of diabetes has serious implications because if not properly managed it can lead to complications including blindness, renal failure, and limb amputations (CDC, 2011; Nathan, 1993). Furthermore, research has shown that approximately 15%–20% of patients with diabetes also experience comorbid depression (Ali et al., 2006; Anderson, Freedland, Clouse, & Lustman, 2001; Eaton, 2002; Katon, 2008).

In and of itself, depression has also been shown to be associated with an increased risk of morbidity and mortality (Prince et al., 2007). Existing literature has revealed that an additive effect occurs when individuals have both illnesses at once; "The health risks associated with comorbid depression and diabetes may be greater than the effects of either single condition, since depressive symptoms and poorer well-being have been associated with poor glucose control and inadequate treatment adherence" (Black, 1999, p. 56). The negative effects of comorbid depression and diabetes include lower medication adherence (Ciechanowski, Katon, & Russo, 2000; Gonzalez et al., 2007), decrease in self-care and self-management (Ciechanowski at al., 2000; Gonzalez et al., 2007), and increased medical expenditures (Ciechanowski et al., 2000) among others. The current study focuses on depression and its influence on the performance of diabetes self-care activities because diabetes self-care is deemed as the cornerstone of proper diabetes management. As much as 95% of diabetes care is performed by the patient through engagement in both non-disease-specific health behaviors and active management (Anderson, 1985; Egede & Ellis, 2008). Engagement in diabetes self-care is highly complex as it requires substantial lifestyle modifications to nutritional intake and physical activity, and the adoption of disease-specific active management behaviors (e.g., blood sugar testing).

Briefly, there are two competing bodies of research on the causal relationship between depression and diabetes management (i.e., adherence to diabetes self-care and glycemic control). The first, known as the antecedent model, suggests that depression precedes low levels of self-care regimen adherence, PGC, and adverse diabetes-related outcomes. Adverse diabetes-related health outcomes, thought to be indirectly caused by depression, are believed to manifest via behavioral and physiological mechanism. In contrast, the consequence model, proposes that depression is a result of negative self-relevant cognitions deriving from poor adherence to physician-recommended self-care behaviors (e.g., glucose monitoring, foot care, etc.) and/or development of diabetes-related symptoms and/or complications.

Although multiple studies employing an antecedent model have revealed a robust negative relationship between depression and diabetes self-care, the exact mechanism through which depression influences the performance of diabetes self-care behaviors is poorly understood. Using the information-motivation-behavioral skills (IMB) model, Egede and Osborn (2010) examined whether the relationship between depression and diabetes self-care might be indirect via behavior-specific knowledge, personal motivation, and/or social motivation. The authors hypothesized that depression exerts its influence on diabetes self-care indirectly via personal and social motivation; instead they found that depression exerts a direct influence on diabetes self-care and that the indirect influence occurs only via social motivation as measured by four domains of functional social support (emotional/information, tangible, affectionate, and positive social interaction). In addition to depressions weak association with diabetes self-care through personal motivation, the intrapersonal construct of personal motivation (i.e., self-directed thoughts and emotions associated with motivation) was not significantly associated with self-care adherence after accounting for diabetes knowledge, social motivation, and depression. This is unexpected for various reasons. First, in a study published that same year, and using the same population, Oborn and Egede (2010) found personal motivation to be a robust independent predictor of diabetes self-care ($r = -0.20$, $p < 0.05$). It is plausible that fatalism, the proxy used to measure personal motivation, conceptually overlapped with the construct of depression negating the ability to accurately measure its contribution; indeed, the operational definition used for fatalism, “a complex psychological cycle characterized by perceptions of despair, hopelessness, and powerlessness” (p. 278), seems to accurately describe the affective symptoms of depression. Second, there is a plethora of evidence linking personal motivation to health behavior change; the targeted behaviors studied are numerous, and empirical evidence is most robust in the literature examining adherence to antiretroviral therapy (Fisher et al., 1994; Fisher et al., 2000). Additionally, self-motivation has consistently been found to be predictive of physical activity and exercise (Deci & Ryan, 1985; Dishman, 1984; Frederick & Ryan, 1993; Ortis et al., 2007; Ryan et al., 1997; Sherwood & Jeffery, 2000).

A related motional construct and one that perhaps has garnered a larger body of empirical evidence for consistently predicting human behavior is Bandura’s concept of self-efficacy. Self-efficacy is the most frequently studied construct in the line of research aimed at identifying predictors of self-care regimen adherence among those with diabetes. Thus, it is proposed that the social cognitive theory (SCT) might offer insight into the mechanism through which depression affects diabetes self-care given its inclusion of the intrapersonal and motivational factor of self-efficacy which has been found to be highly predictive of human behavior. Depression has been associated with lower levels of self-efficacy, and self-efficacy is a known predictor of behavioral performance (DuCharme & Brawley, 1995; Marcus et al., 1992; McAuley, 1992; Poag & McAuley, 1992; Rodger & Brawley, 1993). Might these associations help explain the pathway through which depression lowers self-care behavior among those with diabetes? In addition to treating depression, if the SCT construct is found to elucidate the pathway through which depression influences self-care behaviors, educational efforts could further be geared toward increasing diabetes-related self-efficacy among patients with comorbid depression and diabetes. Indeed, using a variant of the Stanford Chronic Disease Self-

Management Program (CDSMP), Jerant et al. (2008) found that an intervention aimed at enhancing self-efficacy among individuals with a chronic disease was most beneficial for those with high levels of depressive symptomatology. In other words, depression served as a moderator for the relationship between chronic disease self-management training and self-efficacy. Enhancement of self-efficacy levels in the group with highest depression scores was established via a randomized control trial comparing those receiving the CDSMP variant (via home visits and phone calls) against those receiving treatment as usual (TAU). Regression analysis revealed the moderating effect of depression via the intervention-depression interaction term ($F = 8.24$, $p = 0.0003$).

In the same manuscript authored by Egede and Osborn (2010), there is a call for future research to examine the longitudinal effects of depression on individual adherence to diabetes self-care behaviors. Longitudinal studies examining this phenomenon have found baseline depression to be associated with higher odds of medication nonadherence, PGC, and problems with performing health-related behaviors (Dirmaier et al., 2010). Similarly, in a cohort of primary care patients with T2D, baseline depression prospectively predicted lower adherence to general diet, specific diet, physical activity, foot care, and medication use (Gonzalez et al., 2008). It must be noted that the above mentioned longitudinal studies often fail to include an adequate representation of minority groups, mainly African Americans and Latinos. As a result, the longitudinal effects of depression on diabetes self-care across different cultural groups are poorly understood by researchers.

One may understandably ask why ethnicity and cultural context are important and how they might affect the experience of depression and the performance of diabetes self-care activities. It is not uncommon for depression to manifest differently across socio-demographic variables (e.g., race, sex, etc). Cherrington et al. (2010) found diabetes self-efficacy to mediate the relationship between depression and glycemic control for men but not women, thereby leading the researches to hypothesize that depression is more intricately coupled with feelings of confidence among men. When it comes to ethnicity and the clinical presentation of depression, Latinos and African Americans are more likely to cite somatic (e.g., headaches, muscle aches, etc.) and anxiety-like symptoms when describing their depressive state (Cabassa et al., 2008; Kirmayer & Young, 1998; Lewis-Fernandez et al., 2005). This suggests that the differential expression of and somatization of depressive symptomatology among Latinos and African Americans may lead to divergent effects on diabetes self-care when compared to the dominant culture. Another important cultural factor identified in the literature is the notion that Latinos often identify depressive symptomatology as a normal and uncontrollable part of their diabetes diagnosis (Cherrington et al., 2006). These cultural beliefs were uncovered using qualitative research methodologies (i.e., focus groups and semi-structured interviews). Again, one can speculate that perceived behavioral control might differentially affect the performance of diabetes self-care activities in these minority groups. Finally, ethnicity and cultural context also affect an individual's performance of physician-recommended self-care activities. Olvera, Stewart, Galindo, and Stephens (2007) offer the idea that Latina women with diabetes often go against the recommendations provided by their healthcare providers because they do not want to seem selfish and/or self-centered. It is a cultural norm that Latina women, particularly Latina mothers, place the needs of their family above their own. They'd rather not impose their dietary restrictions on family members and opt instead to consume food that may not be appropriate based on their diagnosis (Oomen, Owen, & Suggs, 1999).

If baseline depression is found to be prospectively predictive of subsequent adherence to diabetes self-care behaviors, it becomes imperative to examine the set of variables that best predict change in depressive symptomatology across time. The antecedents for depression have been well established among those with diabetes and they include the non-mutable factors of female gender, lower socioeconomic status, experience of a greater number of diabetes-related complications, and the injection of insulin, among others (Carreira et al., 2010; Fisher et al., 2001; Manarte et al., 2010; Saglam et al., 2010). Less is known about socio-demographic, behavioral, clinical, and biopsychosocial factors that best predict change in depression across time. For instance, it would be of clinical importance, particularly among socially and economically disadvantaged ethnic groups, whether an individual self-injecting insulin at baseline is less likely to experience a change in depressive symptomatology when compared to a counterpart only taking oral medication. It is of scientific importance to go beyond a cross-sectional design as depression is often persistent in this population. Indeed, depression appears to be chronic among primary care patients with diabetes, as approximately 70% report persistent depression for two or more years (Katon et al., 2004). It is also important to note that a variable identified as a significant predictor of depression in a cross-sectional study design, may not be significant when examined prospectively. In a prospective study with 2,759 patient with T2D, Katon et al. (2009) found the following baseline characteristics to be associated with depressive symptomatology at five years: age (greater than 60), presence of depression 18 months prior to baseline assessment, single or cohabiting marital status, increased severity of diabetes symptoms, insulin use, and presence of retinopathy prior to baseline. Note that in this prospective analysis, gender was no longer found to be predictive of major depression.

Finally, as discussed and further highlighted when presenting the theoretical framework, the main associations of interest in the current study pertain to the constructs of depression, diabetes-related self-efficacy, and diabetes self-care. Nonetheless, additional socio-demographic and biopsychosocial variables may be important to examine, in that they are known to influence the main variables of interest (i.e., depression and self-care). For instance, researchers have repeatedly identified the nonmutable factor of age as a predictor of diabetes self-care; older age is associated with greater adherence to glucose monitoring and medication use (Albright et al. 2001). Additionally, the psychological disturbance related to diabetes distress is negatively associated with self-care adherence (Lerman et al., 2004). Lastly, as alluded in the review of the literature, it is also important to include socio-demographic and biopsychosocial factors as independent variables when attempting to predict change in depression status. Fisher et al. (2001), found education level, disease-related functional impairment, and financial stress to best predict depression in a group of Latino adults with diabetes; these three factors were also identified in the European cohort with the addition of spousal conflict.

C. <u>**Research Aims**</u>

The primary aims of this study were: (1) to examine whether diabetes-related self-efficacy mediates the relationship between depression and diabetes self-care in African American and Latino adults with T2D; (2) after controlling for intervention assignment, to examine the longitudinal association between depressive symptoms and diabetes self-management (i.e., diabetes self-care performance levels and glycemic control) and to determine if individuals with higher baseline levels of depression are less likely to increase diabetes management (i.e., self-care behaviors and A1c) during subsequent follow-up measures (i.e., 6-, 12-, and 18-months); note that the A1c test is a blood analysis done by a medical professional that provides the average blood glucose for the past 6 to 12 weeks; and (3) to examine the set of biopsychosocial factors that best predict change in depressive symptomatology across time, after controlling for intervention assignment.

II. CONCEPTUAL FRAMEWORK/THEORY

A. Conceptual Framework

1. Social cognitive theory

The SCT was originally developed by the psychologist Albert Bandura to understand and further explore human functioning. The SCT is conceptualized as a reciprocal and triadic relationship between personal factors, human behavior, and environmental influences. Personal factors encompass an individual's cognition, affect, and biological state, while environmental influences are defined as factors external to the person and may include both social (e.g., social support) and physical environments (e.g., neighborhood characteristics). Central to the SCT is the construct of self-efficacy which is theorized to effect behavior adoption and maintenance. Self-efficacy can be thought of as an individual's confidence in performing a specific behavior, that is, the perception of whether the individual possesses or lacks the ability to perform a given behavior (e.g., glucose self-testing) that will lead to a specific goal (e.g., A1c less than 7). The theory proposes that self-efficacy can be modified through 4 information sources: (1) performance accomplishments; (2) vicarious experience; (3) verbal persuasion; and (4) physiological feedback. First, performance accomplishment increases an individual's confidence through successful engagement and/or accomplishment of the target behavior; for example, a patient with diabetes may experience an increase in their confidence to engage in the American Diabetes Association (ADA) recommended levels of physical activity after successful initiation of leisure walking for 60 minutes per week. Next, vicarious experience enhances self-efficacy through witnessing of another's successful accomplishment of the target behavior; for example, witnessing another patient's active engagement in daily blood glucose management may increase confidence in self-monitoring. Verbal persuasion suggests that encouraging and/or discouraging remarks have an influence on an individual's self-efficacy. Finally, physiological feedback proposes that emotional arousal is linked to confidence in the performance of a given behavior; for example, blood glucose self-monitoring may lead to increased emotional arousability, thereby increasing the erroneous belief in the inability to properly manage their illness.

The SCT offers a framework from which one can begin to explain and explore the association between depression and diabetes self-care. In the current study, the multiple diabetes-related self-care activities recommended include: engagement in physical activity, healthy eating, medication adherence, glucose monitoring, and foot care. Depression is hypothesized to have a direct effect on the target self-care behaviors. Individuals with depression often experience symptoms of hopelessness, pessimism, worthlessness, inability to concentrate, and suicide ideation; these feelings can prevent an individual from performing diabetes self-care activities. This is highlighted in the following statement, "Behavioral changes to increase exercise and healthy nutrition and decrease smoking require motivation, energy, confidence, and sustained effort, which are the exact attributes that depressed people lack" (Lin et al., 2004, p. 2158). Additionally, the construct of self-efficacy, thought to be more proximal to the behavior of interest, has been found to be strongly predictive of actual behavior performance. Allen (2004), employing the SCT found the construct of self-efficacy to be positively correlated with exercise among patients with diabetes and, in predictive studies, self-efficacy was found to significantly explain the variance found in the outcome of physical activity. Note that within a given individual, self-efficacy may differ depending on the self-care activity of interest, suggesting that self-efficacy be assessed across the multiple self-care behaviors, and for the role of depression to be examined separately for each self-care activity.

Although environmental barriers will not be examined in the current study, I offer a brief discussion in an effort to acknowledge their importance. There has been an upsurge in the literature examining environmental barriers that may influence the health of a community. The social and physical environments are extensive and include factors such as social support, neighborhood characteristics (e.g., availability of exercise facilities and healthy foods), stressors (e.g., financial, disease-related, etc.) Neighborhood characteristics are particularly relevant to the study of diabetes self-care regimen adherence as they can facilitate or constrain lifestyle modifications in the areas of diet and physical activity. As recently published in their Standards of Medical Care in Diabetes—2011, adherence to the ADA's recommendation of 150 minutes per week of moderate-intensity physical activity requires resource availability within a person's contextual/neighborhood environment. Research has found that adults who have a positive perception of their physical environment tend to engage in more transport and recreational walking. For example, walking, the most common form of physical activity was most frequently reported by those living in neighborhoods having nearby shopping areas, public transportation stops within a 15-min walking distance, absence of dead-end streets, presence of interesting scenery, and more affordable exercise facilities (Taylor, Leslie, Plotnikoff, Owen, & Spence, 2008). In a focus group study by Mier, Medina, and Ory (2007) thirty-nine Mexican American adults identified traffic, absence of sidewalks, absence of recreation facilities and transportation, inadequate street lighting, and gang activity as barriers to physical activity. This inequity also exists when it comes to the acquisition of healthy foods. Horowitz et al. (2004) identified a disparity in the availability of healthy foods in an East Harlem neighborhood predominated by racial/ethnic minorities, as only 18% of the stores stocked the recommended food items (i.e., low-carbohydrate or whole wheat bread, low-fat milk, diet soda beverages, and fresh fruits and vegetables). Discussion and acknowledgment of the barriers associated with a person's structural environment suggests that certain diabetes self-care behaviors may not be under the volitional control of the individual.

2. **Biopsychosocial model of glycemic control**

The biopsychosocial model of glycemic control was described by Peyrot et al. (1999) in an effort to examine the effects of stress, coping, and regimen adherence on metabolic control. The biopsychosocial model considers it conceptually imperative to integrate both behavioral and psychophysiologic factors when examining metabolic control. The behavioral model posits metabolic control to be determined by regimen adherence to both non-disease-specific health behaviors and active management behaviors; this includes controlling peak levels of blood glucose by reducing caloric intake, performance of physical activity to increase glucose metabolism, and medication adherence. In contrast, the psychophysiologic model suggests that independent of regiment adherence, psychosocial stress can elevate blood glucose levels though hepatic production, as a direct consequence of the stress hormones released (e.g., cortisol). In addition, Peyrot's model recognizes chronic, transient and momentary processes in which stress and coping operate and co-operate to affect biological integrity and adherence to self-management.

As previously mentioned, stressors are thought to influence glycemic control through a direct effect on an individual's physiology, but also by exerting an indirect effect on diabetes self-care adherence. Elevated levels of stress are hypothesized to compromise regimen adherence as pressures of daily life out-compete the performance of demanding self-care behaviors. In addition to the role of stress, Peyrot et al. (1999) propose that the behavioral and psychophysiologic processes synergistically affecting glycemic control are also influenced by coping resources and emotional arousability. Stress management and diabetes education, aimed at increasing coping resources and decreasing emotional arousability, are believed to modulate an individual's psychosocial response to a particular stressor thereby directly and indirectly affecting the performance of diabetes self-care behaviors; the mechanism through which this modulation is achieved, includes an increase in awareness, cognition, and empowerment.

3. **<u>Synthesis of the two theories</u>**

Figure 1 illustrates the integration of the SCT and Peyrot's biopsychosocial model and serves as the proposed conceptual framework guiding the current study. Synthesis of the

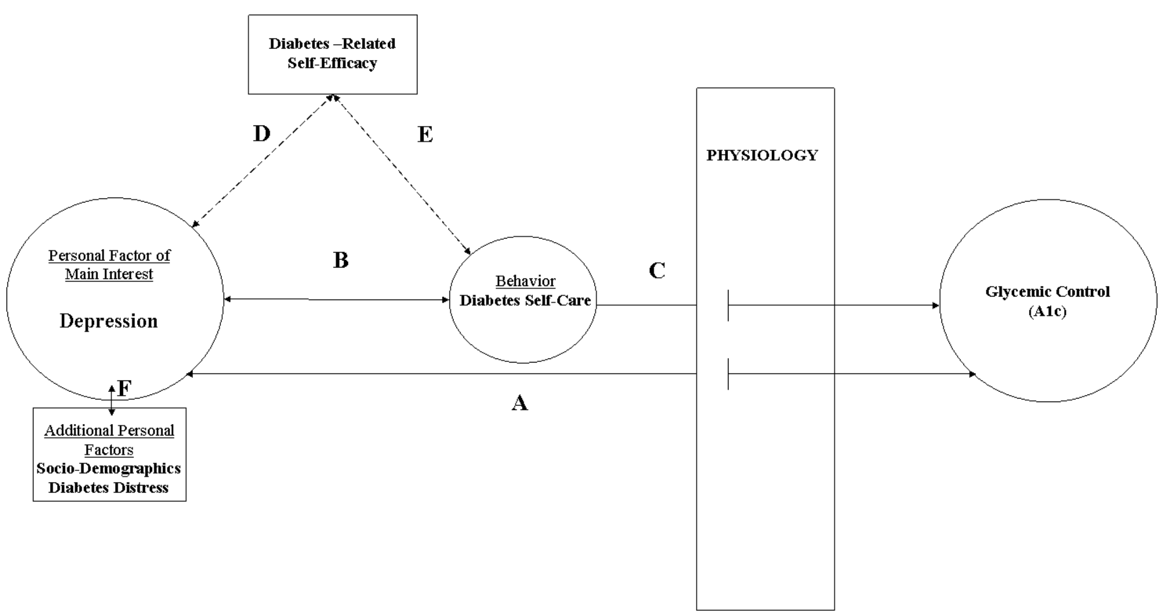

Figure 1. SCT and Peyrot's biopsychosocial model of glycemic control.

SCT and Peyrot's biopsychosocial model of glycemic control offers a new and more nuanced theoretical perspective. This theoretical integration is possible given the shared conceptual constructs relating to environment (i.e., stressors), behavior, and personal factors (i.e., psychosocial response). The *personal factor* of main interest is depression. Additional personal factors to consider, both theoretically and to be used as control variables during data analysis, are socio-demographic (e.g., age, gender), biological (e.g., body mass index (BMI)), and additional psychological factors (e.g., diabetes distress). The *behaviors* of interest are the diabetes self-care activities of healthy eating, physical activity, foot care, medication use, glucose monitoring, and smoking. Finally, although not to be examined in the current study, and therefore omitted from Figure 1, Peyrot posits that *environmental* stressors, stress management, and diabetes education all interact to influence a person's psychosocial response, and consequently, that the unique combination of these factors (i.e., stressor, stress management, and diabetes education) dictate the manifestation of elevated levels of anger, distress, anxiety, or depression. Below I offer a more detailed description of the integrated model and how it serves to inform the current study. Reference is made to the antecedent and consequence models as previously discussed as these are implicitly captured in the proposed theoretical framework; note that the term "model" in this case is used loosely to describe a theory and/or line of research.

The antecedent model, more central to the purpose of this study, puts forward the notion that the resulting negative psychosocial responses are predicted to have a direct effect on glycemic control through its dysregulation of internal physiology and indirectly via performance of self-care activities. Consistent with the antecedent model, depression has repeatedly been found to be associated with PGC, lower medication adherence, and lower adherence to the diabetes self-care activities of diet and exercise. Ciechanowski et al. (2000) found higher levels of depressive symptomatology to be cross-sectionally associated with lower adherence to dietary recommendations and lower adherence to oral hypoglycemic medication. Gary et al. (2000) conducted a cross-sectional study with 186 African American patients with T2D. They examined the prevalence of depression in this cohort along with the association between depression and metabolic control, as measured through A1c, blood pressure, blood lipids, and BMI. Although not statistically significant, associations were found between depression and higher levels of A1c ($p = 0.104$). The proposed antecedent model is depicted in Figure 1 (pathways A, B, and C). The proposed theoretical model guiding this study goes further by proposing that the mechanism through which depression exerts its force on diabetes self-care is explained by increased negative self-relevant cognitions (i.e., low self-efficacy); labeled as D and E. Indeed, the current framework suggests that depression leads to low levels of diabetes self-efficacy which further discourages engagement in both non-disease-specific health behaviors and active self-management behaviors.

Conversely, we can make use of the consequence model that posits PGC and low adherence to diabetes self-care behaviors, to have an adverse effect on self-relevant cognitions, thus leading to depressive symptoms. In other words, and as evidenced by the literature, PGC and low adherence to self-care behaviors may result in a negative psychosocial response in the form of depressive symptomatology (pathways A and B). For example, feelings of guilt and shame for not carrying-out physician recommendations (e.g., failure to take antihyperglycemic agents) may lead to negative cognitive, motivational, and affective responses. In addition to the use of glycemic control, adherence to the self-care regimen, and diabetes self-efficacy, as predictor variables for depressive symptomatology, the literature has identified additional socio-demographic and biopsychosocial factors (Carreira et al., 2010; Fisher et al., 2001; Manarte et al., 2010; Saglam et al., 2010). Therefore as depicted in Figure 1, additional personal factors such as age, gender, and diabetes-related distress, also have the potential to influence depression status (pathway F). These additional personal factors not only have the potential to exert an influence on depression, but also on the constructs of self-efficacy, diabetes self-care, and glycemic control and must be taken into consideration. Therefore, depicted in Figure 1 are the demographic and biopsychosocial factors that must be adjusted and controlled for in the mediation and regression models.

B. **Hypothesis**

First, using the above-mentioned theoretical framework/theory as a guide, the proposed study hypothesizes that the relationship between depression and diabetes self-care will be mediated by self-efficacy among a sample of African Americans and Latinos with T2D. Second, given the consistent negative relationship between depression and diabetes self-management found in the literature, there will be an inverse longitudinal association between depressive symptoms and diabetes self-management and those with higher baseline depression scores will be significantly less likely to engage in diabetes self-care activities and will have poorer glycemic control (A1c) across time. Lastly, it is hypothesized that a decrease in depressive symptomatology across time will be best predicted by diabetes-related psychological (e.g., diabetes distress) and biological factors (e.g., glycemic control, BMI, etc.). Note that the first aim requires a cross-sectional data analysis using baseline data, while aims two and three require a longitudinal design (i.e., baseline, 6-, 12-, 18-months).

C. **Parent Study**

As previously mentioned, data for the proposed research will come from a large parent study that employs the transtheoretical model along with multiple other conceptual and theoretical frameworks to guide its randomized intervention (Ruggiero, 2000). “Diabetes Self-Management in Minorities,” whose principal investigator is Dr. Laurie Ruggiero, is a randomized control trial with a sample of low-income Latino and African American patients with T2D. Study participants were randomized into either the intervention group, which received individualized diabetes education and support from a Medical Assistant self-management coach (MAC), or the TAU which received usual care with the addition of a standard educational booklet; stratification according to race/ethnicity, gender, and insulin use, occurred prior to the randomization process. It is hypothesized that the innovative inclusion of medical assistants as part of the diabetes care team to support diabetes self-care may prove to be an effective and inexpensive way to intervene on diabetes self-care adherence and diabetes management. The intervention, delivered by certified medical assistants, was administered for 12-months and consisted of individualized patient-centered diabetes self-care education and support.

Participants of African American and Latino descent with T2D were recruited from four Federally Qualified Health Centers (FQHCs) located in medically underserved Chicago urban areas. Inclusion criteria for the parent study were as follows: African American or Latino; aged 18 years or over (total sample includes 58.7% who are 50 years of age or older); fluency in English or Spanish; previous A1c values over 6.5; able to provide informed consent; currently prescribed diabetes medications (i.e., insulin and/or pills), and T2D diagnosis for at least 6 months. Individuals were excluded if pregnant or planning pregnancy; if they were diagnosed within the past two years with kidney disease, cardiovascular disease, cancer, or advanced diabetes complications (e.g., severe retinopathy); had a medical history of cognitive (e.g., dementia) or emotional impairment; and if they, or a household member were currently enrolled in a research study addressing a diabetes-related topic.

Participant recruitment was done by the clinic research staff who had access to patient charts. Prior to the beginning of each clinic workday, clinic staff would identify the scheduled patients who had a physician-confirmed diagnosis of diabetes. The patient would then be referred to the study research specialist who would confirm eligibility, describe the study and confirm that the patient was interested in participating. If so, the informed consent process was implemented and then the assessment was administered using an interactive computer-delivered approach. This interactive approach used Digivey software, created by Diatouch, which allows researchers to easily generate computerized surveys that are administered using touch screen Tablet PCs. Each screen contains a survey item along with possible response choices, which the participant is able, see, read, and hear through audio presentation. After visual and audio presentation of the survey item and response choices, the participant is instructed to touch the appropriate answer on the screen. The survey, including audio, was available in English and Spanish. It is believed that being able to hear the questions may be of help to those with low levels of literacy. Those not being able to complete the computerized questionnaire on their own, due to literacy level were still allowed to participate given that they were able to receive assistance from the research specialist throughout the participation process.

The primary outcome of the parent study is glycemic control as measured through A1c. In addition to the main outcome of interest, there are ten different survey instruments administered to all participants which include: (1) Background questionnaire (e.g., Demographic Information, diabetes history); (2) Summary of Diabetes Self-Care Activities Measure (SDSCA);

(3) Diabetes Self-Efficacy Scale; (4) Stages of Change and Confidence Scales (for each self-care measure); (5) Diabetes Empowerment Scale (DES); (6) Diabetes Distress Scale (DDS); (7) Lipid Research and Physical Activity Scale; (8) Patient Health Questionnaire—PHQ-9; (9) Systems of Belief Inventory; and (10) Short Test of Functional Health Literacy in Adults (S-TOFLA). The surveys are administered at baseline, 6-, 12-, and 18-months. Approval for the parent study was obtained through the Institutional Review Board (IRB) at the University of Illinois at Chicago.

III. LITERATURE REVIEW

What follows is a review of the literature on depression, diabetes, diabetes management, and their comorbidity. First, a brief review on the epidemiology of depression, particularly as it pertains to ethnic minority groups (i.e., African Americans and Latinos) will be presented. This is followed by a presentation of the prevalence and etiology among older adults and the treatment options available. Inclusion of literature specific to older adults is warranted as 58.7% of the total sample in the current proposed study is 50 years of age or older, with a median age of 53 years. Second, again focusing on older adults and ethnic minority groups, the etiology and epidemiology of diabetes will be offered. This will be followed by a discussion of the comorbid effects that depression has on multiple diabetes-related outcomes, with special emphasis on self-care and glycemic control. This third section is structured around the research aims of the study and summarizes the current state of knowledge as follows: 1) Self-efficacy—the role and mediating effects of diabetes self-efficacy in the association between depression and diabetes self-care, 2) Baseline depression—the longitudinal effects of baseline depression on diabetes management (i.e., diabetes self-care and A1c), and 3) identification of the longitudinal predictors of change in depressive symptomatology.

A. Depression

1. Epidemiology of depression

Depression is defined as "a spectrum of mood disorders characterized by persistent periods of sadness or lack of interest in usual activities" (Ruggiero, Wagner, & De Groot, 2006, p. 65). It is often identified when individuals display a combination of the following symptoms or characteristics as defined by the National Institute of Mental Health (NIMH, 2011):

> • Persistent sad, anxious or "empty" feelings;
> • Feelings of hopelessness and/or pessimism;
> • Feelings of guilt, worthlessness and/or helplessness;
> • Irritability, restlessness;
> • Loss of interest in activities or hobbies once pleasurable, including sex;
> • Fatigue and decreased energy
> • Difficulty concentrating, remembering details and making decisions;
> • Insomnia, early-morning wakefulness, or excessive sleeping;
> • Overeating, or appetite loss;
> • Thoughts of suicide, suicide attempts;
> • Persistent aches or pains, headaches, cramps or digestive problems that do not ease even with treatment. (p.4)

A person with depression may or may not feel all of the symptoms described above, and may often experience them in various combinations and to varying degrees. Three major types of depression have been identified: major depression, dysthymia, and bipolar disorder (NIMH, 2011).

Although the exact etiology of depression is still largely unknown, it is believed to be caused by a chemical imbalance in the brain consisting of low levels of the neurotransmitter serotonin (Coppen, 1967; Grimsley & Jann, 1992). "In over thirty years of research, the same finding has emerged over and over again: depressed persons have abnormally low levels of serotonin in their brains" (Friedewald, 1998, p. 9). Genetic predispositions, socio-demographic characteristics, psychological (e.g., anxiety), and social factors are also believed to play a role (NIMH, 2011). A nonexhaustive list of the mutable and non-mutable risk factors for depression, identified through cross-sectional research designs, include: gender (female), low income, low levels or lack of social support and/or human relatedness, low socioeconomic levels, impairments of cognition or function, prior history of depression and/or family history of mental health (Barry et al., 1998; Djernes, 2006; Friedewald, 1998; Vanderhorst & McLaren, 2005).

Longitudinal studies have identified similar antecedents for depressive symptoms. A 9-year prospective study done in an urban community setting found baseline depression, low socioeconomic status as measured by education and presence of financial hardships, joblessness, social isolation, chronic illness and disability, among others, to be predictive of depressive symptoms (Kaplan et al., 1987); unrelated to incident depression at 9-years follow-up, were the factors of age, income, ethnicity, marital status, and adherence to health behavior practices.

Numerous studies have identified antecedents of depressive symptomatology among the elderly. In a fairly recent review of the literature, higher rates of depression were linked to the following factors: gender (higher risk for females), prior depression history, low levels or loss of social support, cognitive and functional impairment, and presence of somatic disorders (Djernes, 2006). Subsyndromal depression, estimated to affect about 5 million older adults, has also been identified as a risk factor for subsequent development of major depression (Horwath et al., 1992). Chiriboga et al. (2002) conducted a study with 3,050 Mexican American elders to examine the rate of depression and its predictors; predictors included socio-demographic characteristics, cognitive status, acculturation, social resources and supports, and three stressor domains (i.e., life events, chronic strains, and recent health events). Approximately 25% of the variance observed in depression was explained by the variables of gender (i.e., female), low income, recent decrease in income, chronic financial strain, and health stressors associated with hospitalization days and limited activities. In a meta-analysis conducted by Cole and Dendukuri (2003) five risk factors were identified for depression among community-dwelling older adults. Three of the identified risk factors are modifiable (and thus amenable to intervention through public health measures); these include: (1) bereavement; (2) sleep disturbance; and (3) disability.

The authors recommend that these findings be used to identify and target populations at risk for depression and to target treatment efforts toward bereavement, sleep disturbance, and disability.

In the U.S. adult population, the 12-month prevalence of major depressive disorder (MDD) is approximately 6.7% (Kessler, Chiu, Demler & Walters, 2005; NIMH, 2005). Among these cases of major depression, 30.4% are categorized as severe. The average age-of-onset for major depression in the U.S. population is 32 years of age (Kessler, Berglund, Demler, Jin, & Walters, 2005; NIMH, 2005). Ethnicity has not been identified as a risk factor for the development of depression in the U.S. adult population, as the risk of depression is similar and/or only slightly elevated for Latinos and 40% lower among African Americans when compared to non-Hispanic Whites (Gary, Grum, Cooper-Patrick, Ford, & Brancati, 2000; Gross et al., 2005). Contrary to these findings, higher prevalence rates for depression have been documented for older Mexican American adults with reported rates of 25.6% when using the Center for Epidemiologic Studies of Depression scale (CES-D) (Black, Markides, & Miller, 1998) As will be discussed in a later section of the literature review examining treatment therapies, although the prevalence of depression in the African American and Latino general adult population is similar to those of non-Hispanic white origin, attention is warranted due to the low levels of recognition and lack of guideline-congruent treatment among the African American and Latino minority groups (Alegria et al., 2008; Cabassa & Hansen, 2007; Simpson, Krishnan, Kunik, and Ruiz, 2007).

2. **Depression and aging**

Although the current proposed study includes African American and Latino adults of all ages (aged 18 years or over), a sizable number are 50 years of age or older (58.7%), warranting discussion of depression as experienced by the elderly population. The reported prevalence of major depression among community-dwelling older adults ranges from as low as 0.9% to as high as 9.4% (Djernes, 2006; Hybels & Blazer, 2003; Koenig & Blazer, 1992); rates of major depression are significantly higher among institutionalized older adults ranging from 14% to 42%. Among those residing in private households and/or institutions, between 7.2% and 49% have clinically relevant depressive symptoms. Note that these rates were derived from a literature review conducted in 2006, which included studies that established depressive disorders using either clinical interviews or structured diagnostic interview scales. Studies suggest that rates of mental illness may be highest among older adults who belong to a racial/ethnic minority group (Gonzalez et al., 2001; Sorkin et al., 2009). After adjusting for health status and socio-demographic variables, Sorkin et al. (2009) found higher prevalence of serious mental illness among African Americans, Asians, and Latinos when compared to non-Hispanic Whites of a similar age (4.1%–7.7% vs. 2.5%, $p = 0.001$). In a study with 1,789 older Mexican Americans, 25% had a score equal to or above the 16-point cut-off set by the CES-D, indicating presence of depressive symptomatology (Gonzalez et al., 2001). Similary, Aranda et al., (2001) found a prevalence rate of 24.1% in a sample of older Latinos attending a primary care facility in Los Angeles County; those classified as depressed meet the criteria as set by the PHQ-9. Finally, Falcon & Tucker (2000) found a higher prevalence of major depression among Puerto Rican and Dominican elders when compared to non-Hispanic Whites.

Depression in the elderly has been linked to multiple negative health consequences including cognitive decline, functional disability, loneliness, reduced quality of life, and impairments in the performance of activities of daily living (ADLs) (Covinsky, Fortinsky, Palmer, Kresevic, & Landefeld, 1997; Palsson & Skoog, 1997; Unutzer et al., 2000). Unfortunately, reports have consistently documented low diagnostic and treatment rates for depression among the elderly population; more than 30% of those diagnosed with major depression don't seek treatment (Crystal, Sambamoorthi, Walkup, & Akincigil, 2003). While there are a number of factors that may contribute to the low treatment rates in this population, "age attribution" may explain low rates of diagnosis and treatment. This attribution of disease-related symptoms to normal ageing may lead to symptom acceptance, thereby elevating underreporting to healthcare providers and negating secondary and tertiary prevention (Leventhal & Prohaska, 1986; Prohaska et al., 1987). For instance, in a sample composed of community-dwelling older adults (n = 90), Sarkisian et al. (2003) found that those who attribute depression to aging are 4.3 times more likely to believe that discussing feelings of depression with their healthcare providers is not very important. The authors conclude that public health interventions are needed to dispel the misconception that depression is part of the normal aging process. Crystal et al. (2003) identified factors associated with depression non-treatment among a nationally representative sample of Medicare recipients and found that the depression diagnosis rate increased by 107% from 1992 to 1998 (2.8% versus 5.8%). Among those diagnosed with depression, approximately two-thirds (67.7%) received treatment. Multivariate analysis revealed that the "oldest old" (75+), those in the ethnicity category of "Hispanic or other," and those without supplemental insurance were less likely to receive treatment after diagnosis. These disadvantaged subgroups were also less likely to receive psychotherapy and/or psychotherapy in combination with anti-depressants. Finally, Unutzer (2002) reported that among older adults visiting a primary care provider, approximately 5%–10% suffer from major depression, and when compared to younger age groups, older adults are less likely to visit a specialty mental health facility.

3. **<u>Treatment therapies</u>**

Discussion of the treatment therapies for depression offers the reader a glimpse of the current state of knowledge. Although the proposed study does not intend to intervene on depressive symptomatology, the information provided in this section may offer points for discussion when attempting to alleviate depression in patients with diabetes, particularly if it is found to adversely affect diabetes self-management (i.e., self-care adherence and A1c) across time.

Effective treatments for depression have been extensively studied and identified for the general U.S. population. Wolf and Hopko (2008) conducted a thorough review of the literature on the available psychosocial and pharmacological therapies to treat depression in adults in a primary care setting. They described problem-solving therapy, cognitive therapy, cognitive behavioral therapy (CBT), counseling approaches, interpersonal therapy, and various modes of pharmacotherapy. All modes of psychotherapy have proven to be effective when compared to "usual care" and/or placebo although some therapies have proven to be more effective than others. When it comes to treatment of depression in primary care settings, which is usually the case for subgroups such as the elderly and ethnic minority groups, the most efficacious options include problem-solving therapy, interpersonal therapy, and pharmacotherapy due to their ease in implementation; for example, cognitive-behavioral therapy requires more extensive training that often is lacking among primary care physicians (Wolf & Hopko, 2008). Data also exist showing similar effectiveness between the use of psychotherapy and medication (Wolf & Hopko, 2008). What follows is a brief discussion of the efficacy and effectiveness studies that have explored treatment options for depression in the older adult and minority subpopulations. Additional discussion will be offered about the possible effects of cultural norms and existing explanatory models of disease on treatment rates among racial/ethnic minority groups.

a. **<u>Older adults</u>**

The results obtained by Wolf and Hopko are more relevant and have greater generalizability to the general adult U.S. population. But literature does exist that examines the most effective treatment options for depression among older adults. A panel of mental health and public health experts recently developed a set of evidence-based recommendations for the treatment of depression in community-dwelling older adults. Based on their review of the literature, only two therapies, depression care management and individual CBT, were found to have sufficient evidence to warrant recommendation (Steinman et al., 2007). Depression care management offered both at home and/or the primary care setting showed improvements in depressive symptomatology and quality of life among older adults when compared to usual care. Likewise, individual CBT demonstrated short-term (less than 1 year) improvements in depressive symptomatology. Treatments that were not recommended by the panel of experts included interventions such as education and/or skills training (i.e., chronic disease management education) and exercise interventions treating depression as a secondary outcome. Similar findings were obtained in a literature review conducted by Frederick et al. (2007) where the only therapy receiving a rating of "Effective" was depression care management, both clinic and home based.

b. **<u>Ethnic minorities</u>**

As discussed previously, in the U.S. adult population, Latinos and African Americans have a depression rate similar to that of non-Hispanic Whites. Nonetheless, there exists a disparity in depression treatment in these populations. In a study that included 6,082 participants of African American, black Caribbean, and non-Hispanic white descent, it was found that only 58% of the African Americans and 22% of the Caribbeans received the needed medical treatment for major depressive disorder (MDD) (Williams et al., 2007). Similarly, Lagomasiano et al. (2005) found that Latinos are half as likely to receive guideline-concordant treatment for depression when compared to Whites of similar age (31% versus 50%). This health inequity has been attributed to poor access to mental health care. Indeed, individuals of an ethnic minority group are more likely to be treated for depression in a primary care setting and not by a mental health specialist (Vega, Kolody, & Aguilar-Gaxiola, 2001; Wells, Klap, Koeke, & Sherbourne, 2001).

It is hypothesized that beliefs, attitudes, and treatment preferences for depression are entrenched within an individual's cultural norms. The existing explanatory models of disease may further help elucidate the low diagnostic and treatment rates for these socially and economically disadvantaged minority groups. For instance, antidepressant medication is often seen as unacceptable by those of African American and Latino descent (Cooper et al., 2003). In an appropriately titled piece, "Azucar y Nervios: Explanatory Models and Treatment Experience of Hispanics with Diabetes and Depression," Cabassa et al. (2008) use focus groups and in-depth interviews to explore the personal models of depression among Latinos with T2D. When describing the treatment associated with depression the Latinos in this sample expressed a negative opinion regarding antidepressant medication as it was often seen as addictive or harmful; "I don't know a lot about that [referring to antidepressants] but I've heard from a program on the radio … that they have hurt people … and sometimes they haven't come out better" (p. 2419). Stigma was also associated with antidepressant medication as it was seen to be used only by individuals with severe mental health problems and those considered to be "crazy" (locos). Furthermore, focus group participants identified revelation of antidepressant use as a source of shame for the family. In a similar qualitative study that included Latinos diagnosed with T2D, participants identified self-help, social support, and professional aid as the major resources for depression treatment (Cherrington et al., 2006). Although all three sources were mentioned, participants rarely spoke of their depressive state with their physicians. Clearly, from our above discussion, cultural beliefs and norms may help elucidate the low diagnosis and treatment rates among minority groups, and may serve as an impetus to further explore culturally tailored treatment options.

Although, as discussed above, low levels of guideline-concordant care in minority groups have been reported, randomized control trials (RCTs) have shown evidence-based treatment therapies using antidepressant medication and psychotherapy (i.e., CBT and problem solving therapy) to be effective methods for the treatment of depression among low income minority patients (Arean et al., 2005; Cabassa & Hansen, 2007; Miranda, Azocar, Organista, Dweyer, & Areane, 2003; Miranda, Chung et al., 2003; Miranda et al., 2006). Indeed, as early as 1981, cognitive and behavioral group therapy was found to effectively treat depression in Puerto Rican women (Comas-Diaz, 1981). Miranda et al. (2003) randomized 267 young low-income minority women to receive antidepressant medication, CBT, or community referral (i.e., treatment as usual). Women randomized to the groups receiving antidepressant medication ($p = 0.001$) and/or cognitive behavior therapy ($p = 0.006$), saw greater reductions in depressive symptoms when compared to those receiving a community referral. The researchers found that simply providing a referral to a community mental health facility was ineffective in reducing depressive symptomatology because this did not guarantee that the patient would follow through with scheduling an appointment with a mental health care specialist. Miranda et al. (2003)

conclude that guideline-based care is effective even among minority groups and that ethnic differences may not be as important as often believed. They suggest that the major barrier continues to be the issue of access to appropriate care. Once this access is obtained existing evidence-based interventions are effective in the treatment of depression among low-income minority populations. Finally, speaking to the important role of cultural norms and existing explanatory model of disease, while depression treatment therapies were available to this group of women, the researchers expressed demanding engagement as clinicians spent a large amount of time gaining sufficient trust before being able to offer treatment therapy.

Despite the suggested success of evidence-based interventions, researchers and practitioners should be cautious not to use a “cookie-cutter” approach. Researchers have explored ethnicity-specific treatment options for depression. Takeuchi et al., (1995) found that minorities receiving ethnicity-specific mental health treatment options had higher return rates when compared to those receiving mainstream treatment. Studies have also suggested a positive effect on length and outcome of treatment when there is a provider-patient match on ethnicity and language. Indeed, in their comprehensive review of RCTs examining depression treatment in Latino adults, Cabassa and Hansen (2007) call for further exploration into the cultural and linguistic adaptations that may further enhance treatment outcomes; the RCTs included in the review of the literature ranged on a spectrum of minimal to comprehensive cultural adaptation. In their concluding remarks, and as a call for future research, they ask readers to carefully consider the following question, “How are these cultural and linguistic adaptations linked to treatment effectiveness” (p. 502)?

B. **Diabetes**

1. **Epidemiology of diabetes**

Diabetes is the seventh leading cause of mortality in the United States and its prevalence among Americans is rising (CDC, 2011). Diabetes is a disease that results when the body is not able to adequately utilize blood glucose. Instead of being captured and subsequently processed by the body's cells, it remains in the blood stream and over time can begin to cause damage. It is estimated that 25.8 million, roughly 8.3% of Americans, suffer from the disease, 7 million of whom remain undiagnosed (CDC, 2011). About 2 million were newly diagnosed in 2010. Additionally, it is estimated that 35% of the U.S. adult population is at the pre-diabetes stage, which translates to approximately 79 million people (CDC, 2011). Individuals with diabetes have a two-fold increased risk of mortality when compared to individuals of a similar age without the chronic condition (CDC, 2011). Research has shown that diabetes is associated with an increased risk of morbidity and mortality across all ethnic groups (CDC, 2011).

Reports from the Behavioral Risk Factor Surveillance System show that racial/ethnic minorities have the highest prevalence of diabetes (Mokdad, Bales, Greenlund, & Mensah, 2003). Latinos and African Americans have a two-fold increased risk for developing diabetes when compared to their non-Hispanic White counterparts (Carter, Pugh, & Monterrosa, 1996; CDC, 2011). More specifically, among those 20 years of age or older, 11.8% of Latinos and 12.6% of non-Hispanic Blacks have been diagnosed with diabetes as compared to 7.1% of non-Hispanic Whites (CDC, 2011). The prevalence of diagnosed diabetes is not homogenous within the Latino subgroups but instead ranges from 7.6% for Cubans, 13.3% for Mexican Americans, and 13.8% for Puerto Ricans (CDC, 2011); note that the diabetes disparity is not applicable to Cubans, as they have a similar rate to that of non-Hispanic Whites. This health disparity has been well documented and has been attributed to several factors including restricted funding and access to care and resources, lack of culturally appropriate programs, providers, and productive community level partnerships (CMAF, 2004). These socially and economically disadvantaged subgroups also disproportionately experience worse glycemic control and higher incidence of diabetes-related complications (e.g., kidney disease, blindness and eye problems, lower-extremity amputations, and circulation problems) and mortality (Black et al., 1999; Cowie et al., 1989; Karter et al., 2002).

Diabetes poses a serious health hazard to the individual due to physical problems which may not be evident until complications arise. Common complications are heart attacks, strokes, kidney disease, neuropathy and nerve damage, depression, digestive problems, vision complications, skin disorders and sores (e.g., foot sores) that do not heal (CDC, 2011; Nathan, 1993). Individuals with diabetes are two to four times as likely to experience heart disease and/or a stroke when compared to those without the chronic illness (CDC, 2011; NIDDK, 2008). Each year between 12,000 and 24,000 new cases of blindness are caused by diabetic retinopathy (NIDDK, 2008). Diabetes accounts for more than 60% of non-traumatic lower-limb amputations. In 2006, among individuals with diabetes, a reported 65,700 lower-limb amputations were performed (CDC, 2011). In the last decades the prevalence of risk factors associated with diabetes (e.g., obesity, lack of physical activity, and poor dietary habits) has risen dramatically. Approximately 37.5% of the U.S. population is considered to be obese (Ogden, Carroll, Kit, & Flegan, 2012), lack of physical activity is pervasive throughout all age groups (Marcus, 2000), and very few Americans follow all recommendations for healthy nutrition (Kumanyika, 2000). In a survey administered during the periods of 1999–2002 among persons with T2D, the estimated the rate of obesity was 54.8%; obesity rates were slightly elevated for non-Hispanic Blacks

(63%) and Mexican Americans (59.5%) when compared to non-Hispanic Whites (57.9%) (CDC, 2004). Finally, costs due to chronic care and complications of diabetes have escalated to $174 billion per year, including 116 billion in direct costs, and 58 billion in indirect costs (i.e., lost productivity, etc.) (CDC, 2011; NIDDK, 2008).

2. **Diabetes and aging**

Diabetes as experienced by the elderly population will be explored below as 58.7% of the total sample included in the currently proposed study is 50 years of age or older. The elderly population experiences the greatest impact of diabetes and its associated complications as it is often underdiagnosed and undertreated in this population. Approximately 57.9% of individuals with diabetes are 60 years of age or older, with the median age being 63 years (Cowie et al., 1995). The prevalence of diabetes is seen to rise with age, reaching estimates as high as 26.9% among those aged greater than or equal to 65 years (CDC, 2011; Cowie et al., 2006). In developing countries, a 220% increase in the prevalence of diabetes among older adults is expected by the year 2050 (Narayan et al., 2006). Most cases of diabetes among this population—approximately 90%—are T2D; we may see a rise in the number cases of Type 1 diabetes in this population if more technologically advanced treatment options for those with Type 1 diabetes equates to survival into older adulthood. Diabetes in the older adult population is associated with higher levels of physical and functional disability, particularly in the areas related to mobility and activities of daily living (Gregg et al., 2000; Gregg et al., 2002). Additionally, time since diagnosis and illness-related complications have been linked to cognitive decline in older adults (Stewart & Liolitsa, 1999). Mortality is also two-to-threefold higher in this population, with a 5–10 year reduction in age-adjusted life expectancy. Finally, in

2004, among those 65 years of age or older, diabetes-related death certificates revealed that 68% were due to heart disease and 16% were related to a stroke (NIDDK, 2008).

As previously mentioned diabetes is the seventh leading cause of mortality in the United States, but it is the fourth leading cause of death among Hispanic elderly (NIDDK, 2008). The Latino elderly population is currently experiencing an elevated diabetes health burden as measured by prevalence and diabetes-related morbidity and mortality. In a sample of 3050 community-dwelling Latino elders, the prevalence of diabetes was found to be 22% (Black, Ray, & Markides, 1999) and between 1993 and 2001, the prevalence of diabetes increased by 38.5% among elderly Latino Medicare recipients (McBean, Li, Gilbertson, & Collins, 2004). In 2001, Latino elderly had the highest prevalence of diabetes (334/1000) when compared to the White, Black, and Asian subpopulations (McBean et al., 2004). Not only does this cohort with low socioeconomic resources have an increased prevalence of diabetes but they also have significantly higher levels of diabetes related complications and higher use of diabetes medication (Black et al., 1999; McBean et al., 2004). Espino et al. (1994) found that Mexican American elders are more likely to experience mortality due to diabetes and renal failure when compared to their non-Hispanic White counterparts. Clearly, diabetes is disproportionately affecting the elderly population, particularly those of Latino descent/origin.

The elderly African American population is also disproportionately affected by this illness. Among African American women 60 years of age or older, slightly over 20% have been diagnosed with diabetes (Bell, 2001). This older adult population not only experiences a higher prevalence rate, but also experiences higher rates of disease-related complications, associated disability, and mortality when compared to Whites of similar age (Office of Minority Health, 2009). Researchers attribute this increase in morbidity and mortality to existing ethnic disparities in glycemic control. Using data from the Health and Retirement study, it was found that older African American adults were less likely to be adherent to their antihyperglycemic medication, and more likely to experience PGC (Heisler et al., 2007). Finally, using the Medicare Current Beneficiary Survey, Chin et al. (1998) found that older African Americans adults with diabetes had lower health perceptions (i.e., "In general, compared with other people your age, would you say that your health is excellent, very good, good, fair, or poor?") and quality of care (i.e., objective measure of the delivery of disease-specific care as prescribed by the ADA, higher emergency room visits, and less frequent annual physician visits when compared to non-Hispanic White patients. The authors hypothesize that improved access to preventive care may enhance health perceptions and quality of care in this cohort. This is important as low health perceptions and quality of care may be linked to self-care non-adherence, PGC, and development of diabetes-related complications.

C. Comorbidity of Depression and Diabetes

1. Prevalence and cross-sectional association

Over the last several decades there has been a proliferation of research examining the association between depression and various diabetes-related outcomes. In part, this research has been undertaken because the prevalence of depression is higher among individuals with diabetes. Both Ali et al. (2006) and Anderson et al. (2001) conducted meta-analyses to determine the prevalence of comorbid depression in adults with diabetes. After examining 42 eligible studies, Anderson et al. (2001) found that when compared to those without diabetes, individuals with diabetes were two times more likely to experience depression (OR = 2.0, 95% CI 1.8–2.2); this was true after controlling for variables such as age, diabetes type, subject recruitment source, and methods of depression assessment. Similar results were obtained by Ali et al. (2006) in which a total of 51,331 individuals were examined across the 10 controlled studies reviewed. The prevalence of depression was 17.6% among those with diabetes and 9.8% among those without diabetes. Again, the odds ratio indicated higher odds of depression among those with diabetes (OR = 1.6, 95%CI 1.2–2.0). The findings from these meta-analyses are, for the most part, applicable to the general diabetes population; less is known about the prevalence of depression among older adults and minority groups. However, we can find hints as to the prevalence of depression among older adults and/or Latinos with diabetes from various independent studies that have focused exclusively on these cohorts. Black (1999) conducted a study to examine the prevalence of depression among a group of Latino elderly with and without diabetes. Overall, 31.1% of the older adults with diabetes reported high level of depressive symptomatology compared to 24.2% of those without diabetes. In a study that included 209 Latino primary care patients with diabetes, the prevalence of moderate to severe depression was found to be 35.5% as measured by PHQ-9 (Gross et al., 2005). In a study conducted by Olvera et al. (2007) the prevalence of depression among a sample of 96 Latinas with diabetes was found to be approximately 32.3%, a value similar to that found by Gross et al. (2005).

As stated above, given the almost two-fold increased risk of depression among patients with diabetes, researchers have increasingly become interested in whether depression is associated with worse diabetes-related outcomes. A continuum of diabetes-related outcomes has been examined ranging from the intermediate (behavior) to the long term (quality of life). What follows is a brief summary of the research that has been undertaken examining the association and/or effects of depression on various diabetes-related outcomes. For a fuller picture of the literature on this topic, studies are presented that are predominantly composed of non-Hispanic

White participants, but care has been taken to include those studies that examine the comorbidity of depression and diabetes among older adults, Latinos, and/or African Americans. It must be noted that a limited number of these studies have included patients that belong to a minority population, and as result, a number of authors have called for an increase in the inclusion of minority populations in studies examining the additive and/or synergistic effects of comorbid depression and diabetes.

a. **Diabetes self-care/self-management**

In a sample of primary care patients with type 1 and type 2 diabetes, Ciechanowski et al. (2000) found higher levels of depressive symptomatology to be associated with lower adherence to dietary recommendations, lower physical and mental functioning, as measured by the Short-Form 12 Health Survey (SF-12), lower adherence to oral hypoglycemic medication, and higher healthcare costs. Egede and Ellis (2008) examined the association between depression and diabetes knowledge, self-management and perceived control in a sample of 201 individuals with T2D. Basic statistics including t-tests and $\chi 2$ test were performed to examine differences in demographic characteristics, diabetes knowledge, self-care, and perceived control between depressed and non-depressed patients with T2D. Differences in the expected directions between depressed and non-depressed subjects were found in the areas of self-care control problems, positive attitudes, self-care ability, self-care adherence, and perceived control of diabetes; no differences were seen in self-care understanding or perceived importance of self-care. Furthermore, patients with depression had more negative attitudes and were less likely to feel in control of the complications associated with diabetes. Finally, Gonzalez et al. (2007) examined the relationship between depression and diabetes self-care in a clinical sample of 909 individuals with T2D. The self-care activities examined included diet, exercise, blood sugar testing, foot care, and medication adherence. During analysis, depression was treated as both a dichotomous clinical variable and a continuous score. Approximately 19% of the 909 individuals were found to have probable major depression. After controlling for various socio-demographic factors, individuals with depression were less adherent to their medication regimen (2.3 times more likely to miss a medication dose), diet, exercise, and glucose self-testing; similar results of nonadherence to diet, exercise, and medication were found among those with higher depression scores when depression was treated as a continuous variable.

Only two studies examining the association between depression and diabetes self-care included Latino/Hispanic participants. Lerman et al. (2004) examined the association of diabetes self-care with various psychosocial factors, among which they included depression. This cross-sectional study was composed of 176 Mexican patients with T2D. After performing a logistic regression analysis, it was found that those experiencing depressive symptomatology were 2.38 times more likely to have poor adherence with two or all of the measured self-care activities (i.e., meal plan, physical activity, and medication adherence). In a similar study, Lerman et al. (2009) examined the association between various psychosocial factors and insulin adherence. Among this group of patients attending a healthcare center in Mexico City it was found that nonadherence to insulin was more common among those exhibiting depressive symptomatology ($p = 0.05$).

b. **Metabolic control**

Gary et al. (2000) conducted a cross-sectional study with 186 African American patients with T2D. They examined the prevalence of depression in this cohort along with the association between depression and metabolic control, as measured by A1c, blood pressure, lipids, and BMI. Approximately 30% of this cohort was found to have depressive symptomatology. After adjusting for various socio-demographic factors depression was found to be associated with higher levels of cholesterol and triglycerides. Although not statistically significant, associations were found between depression and higher levels of A1c, diastolic blood pressure, and LDL cholesterol. In a sample of 209 Latinos with T2D, it was found that the probability of PGC, as measured by levels of A1c, rose with increasing depression severity categories. Individuals with moderate to severe levels of depression were almost at a 3-fold increase risk for PGC when compared to those without depressive symptomatology. Finally, Olvera et al. (2007) conducted a cross-sectional study examining the relationship between depression and metabolic control in a group of Latinas with diabetes. She found that depression was significantly correlated with years living with diabetes, A1c, and social support; a t-test revealed a statistically significant difference between depressed and non-depressed individuals in A1c values (9.06% vs. 7.94%), social support ($\mu = 40.52$ vs. $\mu = 51.94$; μ represents the mean score as measured by the Interpersonal Support Evaluation List-Short Form [ISEL-SF]), and years living with diabetes (9.70 years vs. 6.67 years). Age was found to be negatively correlated with metabolic control as measured by A1c (older adults in less control), and those with longer duration of diabetes exhibited poorer metabolic control.

c. **Diabetes-related complications and functional disability**

Depression among individuals with diabetes has also been found to be associated with greater diabetes-related complications. A meta-analysis that included 27 studies found a significant association between depression and the diabetes complications of retinopathy, nephropathy, neuropathy, sexual dysfunction, and macrovascular complications; the effect sizes were all moderate for these diabetes complications and ranged in value from 0.17 to 0.32. Egede (2004) examined and compared the prevalence and odds of functional disability among adults with diabetes alone, depression alone, comorbid diabetes and depression, and neither diabetes nor depression. The prevalence of functional disability was highest among the group that reported having both depression and diabetes (78%). After performing multiple logistic regression, the odds of functional disability were also greater among those with comorbid depression and diabetes (OR 6.15); the odds went beyond a simple additive effect but instead displayed a synergistic effect. Finally, Black (1999) conducted a study examining the health burden associated with comorbid depression and diabetes among Mexican American elders. He found that among individuals with diabetes, those with comorbid depression were at higher risk of developing diabetes-related complications (i.e., kidney, eye, and circulation problems).

In summary, existing literature has revealed that an additive effect occurs when individuals have both illnesses at once; "The health risks associated with comorbid depression and diabetes may be greater than the effects of either single condition, since depressive symptoms and poorer well-being have been associated with poor glucose control and inadequate treatment adherence" (Black, 1999, p. 56). Based on the empirical evidence presented above, the negative effects of comorbid depression and diabetes include lower medication adherence (Ciechanowski, Katon, & Russo, 2000; Gonzalez et al., 2007), decrease in self-care and self-management (Ciechanowski at al., 2000; Gonzalez et al., 2007), and increased medical expenditures (Ciechanowski et al., 2000) among others. But as can be seen through the brief review of the literature, few studies have focused on elderly, African American, and Latino populations. The current literature review also confirms that very few studies have examined the association between various psychosocial factors and diabetes self-care across different cultural groups, particularly Latino adults residing in the United States. This contrasts dramatically with the large sample size of 47 studies uncovered and reviewed in a meta-analysis conducted by

Gonzalez et al. (2008) which examined the effects of depression on diabetes self-care in mostly non-Hispanic White populations.

From the above discussion we see mounting evidence regarding the negative effects of depression on multiple diabetes-related outcomes, although there continues to be a call for greater inclusion of participants from ethnic minority groups. An additional gap exits. We still lack an understanding of the exact mechanism through which depression affects adherence to diabetes self-care behaviors and glycemic control. As will be argued in the next section, the construct of self-efficacy may be the missing piece to the puzzle.

2. **Literature related to aim 1: Mechanisms of association**

a. **Self-efficacy**

Evidence supports Bandura's construct of self-efficacy to be a good predictor of diabetes self-care regimen adherence (Bandura, 1986; Wu et al., 2007; Wang & Shiu, 2004). Previous research has included studies with both cross-sectional and longitudinal designs, which have found higher levels of self-efficacy to be associated with greater self-care adherence. For instance, research has consistently found a positive association between self-efficacy and physical activity levels among patients with diabetes (Delahanty et al., 2006; Kim et al., 2008). Allen et al. (2004), employing the SCT found the construct of self-efficacy to be positively correlated with exercise among patients with diabetes and, in predictive studies, self-efficacy was found to explain significant proportions of the variance found in the outcome of physical activity. Significant positive correlations have also been found between self-efficacy and the self-care activities of medication use, glucose monitoring, and diet (Aljasem et al., 2001; Mishali et al., 2011). Controlling for race/ethnicity and health literacy levels, the association between self-efficacy and diabetes self-management remains consistent (Sarkar, 2006). More recently, randomized control trials are being used to examine the mediating effects of self-efficacy on the relationship between diabetes education and improvements in self-care adherence. For instance, Dutton et al. (2009) found self-efficacy to mediate the relationship between a physical activity intervention and self-reported physical activity levels. Finally, and to further illustrate the impact of this SCT construct, the positive effects associated with increased levels of self-efficacy go beyond the performance of self-care behaviors as evidence also documents improvements in glycemic control. In a sample composed of medically underserved older adults with diabetes, Trief, Teresi, Eimiche, Shea, and Weinstock (2009) found a positive association between self-efficacy and glycemic control, measured via levels of A1c, such that higher self-efficacy scores were associated with lower A1c scores. They also found that after enrollment into a 2-year telemedicine intervention, improvements in self-efficacy were accompanied by reductions in A1c scores.

Thus far, the discussion has focused on the well-known construct of self-efficacy as originally presented by Bandura. But the scientific significance of this construct continues to emerge regardless of the theory employed and/or the label used to capture individual confidence when performing a given health-promoting behavior. Multiple theories have been used to study patient adherence to the diabetes self-care regimen, and they all consistently point to the importance of self-efficacy. Although the differing theoretical perspectives use different scientific terminology to capture and measure the construct of self-efficacy (e.g., perceived behavioral control, perceived competence, etc.), they are all conceptually and theoretically similar. For instance, Gatt and Sammut (2008) used constructs from the theory of planned behavior (TPB) to predict self-care behavior among individuals with T2D. The TPB posits that attitudes toward behavior, perceived subjective norms, and perceived behavioral control predict behavioral intention which in turn predicts actual behavioral performance. Of the constructs included within the TPB only perceived behavioral control was found to be predictive of the behavioral intent and actual performance of the self-care behaviors. Williams et al. (2004) tested the self-determination theory (SDT) to assess and further understand diabetes self-management and glycemic control among patients with T2D. According to the SDT, health behavior change is influenced by the presence and/or level of autonomous motivation (i.e., existence of volitional control) and feelings of competence in reference to the target behavior. William et al. (2004) found perceived autonomy support to be related to both autonomy motivation and perceived competence. Autonomy motivation was found to affect levels of A1c through the mediation of the variable measuring perceived competence. A final model (see Figure 2), using structural equation modeling (SEM), was constructed that depicted the pathway to glycemic control through use of variables consistent with the SDT: Perceived autonomy support [from physician] →Patient Autonomous motivation→ Patient Perceived competence→Diabetes self-management behaviors→A1c. Based on the brief overview of theories focused on diabetes self-care and glycemic control, the constructs conceptually related to self-efficacy that appear to be important include perceived behavioral control, autonomous motivation, and perceived competence. These findings provide the rationale behind the exploration of whether diabetes-related self-efficacy mediates the effect of depression on glucose management.

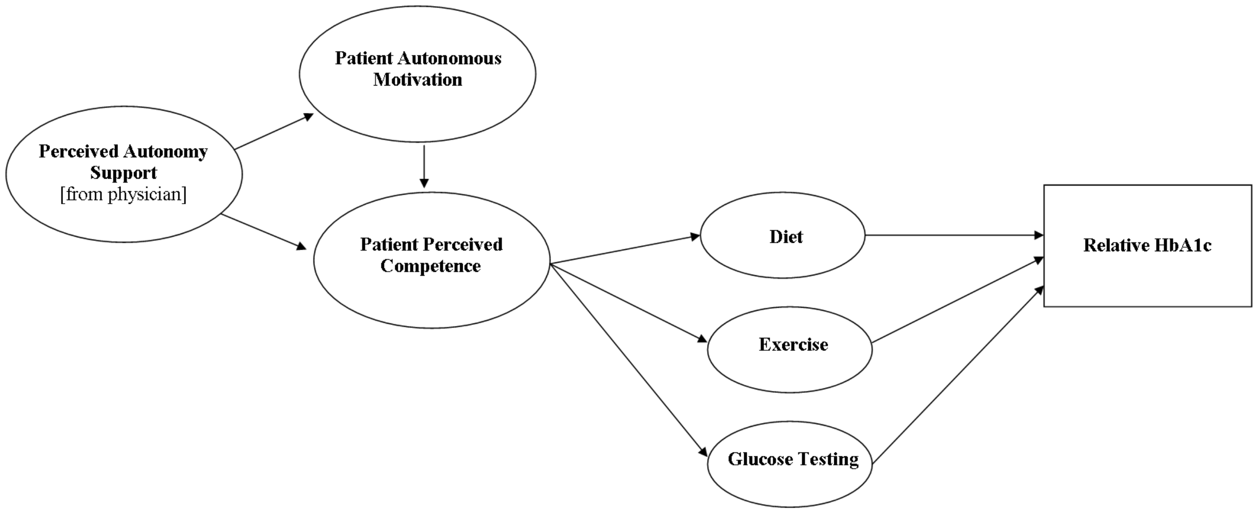

Figure 2. Pathway to glycemic control: The self-determination theory.

b. **Mediating effect of self-efficacy**

As can be gleaned from the above discussion, the construct of self-efficacy is very important when considering diabetes regimen adherence, yet very few studies have examined how this construct might elucidate the mechanism underlying the association between depression and regimen adherence. To date, most of the literature has focused on the "consequence model" suggesting that depression arises from negative self-relevant cognitions resulting from low levels of regimen adherence and PGC, and that this association is further mediated by the construct of self-efficacy. For instance, the indirect effect of higher BMI and poor self-care adherence on depression scores was found to be mediated by diabetes-related self-efficacy (Sacco et al., 2007). More recently, using Baron and Kenny's mediation analysis, Sacco and Bykowski (2010) found self-efficacy to mediate the effect of A1c level on depression status ($Z = 2.21$, $p < 0.05$) in a clinical sample with type 1 diabetes.

Changing the directionality of the association by considering the antecedent model, it is hypothesized that depression can lead to low levels of regimen adherence by increasing negative self-relevant cognitions (i.e., low self-efficacy). Indeed, the antecedent model is more central to the current proposed study and is implicitly captured in Figure 1 (pathways D and E) by the causal arrows emanating from depression and leading to diabetes self-care via diabetes-related self-efficacy. Yet the studies employing the antecedent model to investigate the mediating effects of self-efficacy are virtually non-existent, negating the ability to thoroughly understand the mechanism underlying the association between depression and diabetes self-care adherence. To our knowledge only three studies have addressed this topic and the findings are inconclusive. The most recent evidence available comes from a meeting abstract published in 2011 in the Annals of Behavioral Medicine (Mysore et al., 2011). Using a sample of 121 participants with T2D, the authors found that self-efficacy did not serve as a mediator in the pathway though which depression effects diabetes self-management. But, they did find an overlapping effect between depression and self-efficacy when examining medication adherence. Cherrington et al. (2010) found diabetes self-efficacy to mediate the effect of depressive symptoms on glycemic control (A1c) among men with T2D, but they did not include a measure of diabetes self-care when employing Baron and Kenny's mediation analysis. This is a serious omission as self-care adherence is highly predictive of glycemic control, and thus, may serve as the pathway through which self-efficacy influences the self-care behaviors that affect A1c (Osborn & Egede, 2010). The only other study examining the mediating role of self-efficacy used the IMB model. The IMB model proposes that behavior-related knowledge, personal motivation, and social motivation influence behavioral performance. Thus, Egede and Osborn (2010) examined whether the relationship between depression and self-care adherence was direct or indirect via diabetes-specific knowledge, personal motivation, and/or social motivation. They found that personal motivation did not act as a mediator in the relationship between depression and diabetes self-care adherence; instead, a direct effect was observed, along with an indirect effect via social motivation. Clearly, more research is needed on the mediating role of self-efficacy.

3. **Literature related to aim 2: Baseline depression**

As we have seen, numerous studies have examined the cross-sectional association between depression and diabetes self-care. Only recently has research emerged examining the longitudinal effect of baseline depression on subsequent diabetes management. These scarce prospective studies have primarily focused on patient adherence to self-care behavior, glycemic control, incidence of diabetes-related complications, and mortality. This gap in the literature calls for researchers to go beyond reliance on cross-sectional designs so that causal inferences can be made regarding depression and diabetes management (i.e., diabetes self-care and glycemic control).

a. **Self-care behaviors**

There is a lack of prospective studies in this area of research, as only a handful of studies have examined the longitudinal effects of depression on diabetes self-care behaviors. The limited number of prospective studies offers inconclusive evidence. First, a handful of studies indicate poorer adherence to the diabetes self-care regimen among patients with concomitant depression (Dirmaier et al. 2010; Gonzalez et al., 2008; Katon et al., 2010). A twelve-year longitudinal study found baseline depression to be predictive of medication nonadherence (OR 2.67; $p = 0.0003$) and lower performance levels of diabetes-related health behaviors (β = 0.96; R2 = 0.30) (Dirmaier et al. 2010). Similarly, in a cohort of primary care patients with T2D, baseline depression prospectively predicted lower adherence to general diet, specific diet, physical activity, foot care, and medication use (Gonzalez et al., 2008). Katon et al. (2010) examined the 5-year association between change in depression status and change in health risk behaviors in a sample of 2,759 patients with diabetes. Individuals with persistent or worsening depression were engaged in lower amounts of self-care in the areas of healthy eating and physical activity when compared to those with no depression at both time points (i.e., baseline and 5-year follow-up). Furthermore, adherence to the recommended self-care behaviors remained low and/or further deteriorated among those with persistent or emergent depression (Katon et al. 2010). Despite the findings presented above, not all prospective studies have uncovered a negative effect on self-care adherence. In a 12-month prospective study examining the influence of numerous psychosocial factors on glycemic control, Nakahara et al. (2006) employed structural-equation modeling techniques and found that only self-efficacy directly influence adherence and glycemic control; the construct of depression was included within the model and was found to have neither a direct nor indirect effect on adherence and/or glycemic control.

b. **<u>Glycemic control</u>**

There is currently insufficient evidence concerning the longitudinal effects of depression on glycemic control. Things are further complicated by conflicting findings. McKeller et al. (2004) examined the longitudinal effect of depression on self-reported diabetes symptom burden and whether this relationship was mediated by adherence to self-care behaviors. Structural equation modeling revealed baseline depression to be predictive of change in glucose dysregulation at 1 year, but this relationship was no longer significant once adherence to self-care behaviors was included in the model. In contrast, a prospective cohort study found baseline depression status not to be predictive of glycemic control at 18-months (Ismail et al., 2007).

c. **Morbidity and mortality**

Baseline depression has also been linked to increased rates of morbidity, particularly diabetes-related complications, across time (Black et al., 2003; Lin et al., 2010). Presence of concomitant depression in patients with diabetes was found to be prospectively associated with a higher risk of incident macro- and microvascular complications (36% vs. 25% higher risk) (Lin et al., 2010). Depression was also found to be predictive of incident foot ulceration over an 18-month period, and this direct relationship was not attenuated after inclusion of the hypothesized mediator of foot self-care (Gonzales et al., 2010). Similar results were obtained by Williams et al. (2010) who report a twofold increase risk for incident foot ulceration among patients with major depression when compared to those without comorbid depression. Finally, in a 5-year prospective cohort study, Katon et al. (2010) found rates of dementia to be significantly higher in patients with comorbid major depression and diabetes (7.9%) compared to those with diabetes alone (4.8%). Finally, emerging evidence also suggests that depression is linked to a decrease in cumulative survival among patients with diabetes. Persons with late stage chronic kidney disease (CKD) and depression were almost three times more likely to experience mortality in a 5-year period (HR = 2.85; 95% CI = 1.23–7.02) when compared to those with CKD alone (Young et al. 2010). Similarly, a threefold increase risk for mortality was observed among depressed patients presenting their first foot ulcer (Ismail et al., 2007).

4. **Literature related to aim 3: Longitudinal antecedents for depression**

As examined earlier in this document, the antecedents for depression in the general U.S. population have been extensively documented. This line of research has been followed by inquiry as to whether factors associated with depression in the general nondiabetic population, are similar and/or different in people with comorbid type 1 and type 2 diabetes. Could it be that disease-specific factors play a greater role in the development of depressive symptomatology in those diagnosed with diabetes? Or is depression brought about in this population from a combination of disease-specific, personal, social, and environmental factors? Must clinicians go beyond a disease-related perspective and instead adopt a life-centered approach when attempting to treat depression in this population? Evidence suggests that the answer is "yes." Research examining the predictors of depression among patients with diabetes has uncovered a combination of socio-demographic, lifestyle, and clinical factors. Keep in mind that the majority of these studies have been cross-sectional in nature, precluding inferences about causality.

a. **Cross-sectional studies**

This section summarizes the risk factors associated with depression in patients with diabetes as identified through cross-sectional research studies. As will be discovered from the discussion, no one single factors stands out as the most highly predictive, as a combination of socio-demographic, health-related, and psychosocial stressors consistently emerge. The socio-demographic factors associated with higher rates of depression in patients with diabetes include: female gender, belonging to an ethnic minority group, being unmarried, middle age or older, low socio-economic status (i.e., education and income), and unemployment (Carreira et al., 2010; Fisher et al., 2001; Katon et al., 2004; Manarte et al., 2010; Saglam et al., 2010; Tellez-Zenteno & Cardiel, 2002). Health-related factors have also been associated with higher odds of depressive symptomatology and they include having a BMI greater than or equal to 30 kg/m^2, presence of comorbidities and chronic somatic disease(s), and disease-related complications and functional impairment (Carreira et al., 2010; Fisher et al., 2001; Katon et al., 2004; Tellez-Zenteno & Cardiel, 2002). Finally, psychosocial stressors were also uncovered and included existence of psychological disturbances (e.g., anxiety, negative life events), low levels of social support, and financial stress (Carreira et al., 2010; Fisher et al., 2001).

b. **Longitudinal studies**

As mentioned above, most of the studies examining this phenomenon have been cross-sectional in nature precluding the ability to examine the temporal order of association. Only a handful of longitudinal studies have explored the factors associated with incident major depression among patients with diabetes (i.e., development of depression after the diagnosis of diabetes), and the results have not been consistent (Bot et al., 2010). Indeed, there is still room for debate as to the strongest longitudinal predictor(s) of depression; socio-demographic factors, versus disease-related factors, versus emotional factors. Among patients with diabetes, baseline characteristics found to be prospectively associated with incident major depression include: age (greater than 60), high levels of anxiety and depression, single or cohabiting marital status, increased severity of diabetes symptoms, occurrence of coronary procedures, one or more macrovascular events, insulin use, and presence of retinopathy (Bot et al., 2010; Katon et al., 2009). For instance, in sample with subthreshold depression, Pibernik-Okanovic et al. (2008) found the baseline characteristics of depression, diabetes distress, and social/physical quality of life to predict incident depression at 1-year follow-up. In a prospective cohort study with a Medicare enrolled sample of older adults (greater than or equal to 65 years) with T2D, risk of depression was elevated in those with lower self-reported quality of life and greater impairments with instrumental activities of daily living (IADLs).

Even less is known about the predictors of change in depressive symptomatology among patients with diabetes. Examining *predictors of depression* versus *predictors of change in depression* has significantly different research implications. A factor found to be predictive of depression does not equate to the notion that patients possessing that specified characteristic will be more or less likely to experience a decrease in depression level across time. For example, females are at higher risk for depression when compared to their male counterparts of similar age. But this does not imply that females are less likely to experience a change in depressive symptoms (i.e., if females are more at risk, one might also predict that they experience increased severity over time), when compared to their male counterparts. With this in mind, below I provide a summary of the literature examining predictors of change in depression in patients with diabetes.

In a sample of patients diagnosed with diabetic peripheral neuropathy, Vileikyte et al. (2009) found presence of neuropathic disability and ADL restrictions at baseline to be predictive of higher depression levels at 18-months follow-up. The relationship between neuropathic disability and increased depressive symptomatology was mediated by the diabetic peripheral neuropathy (DPN) symptom of unsteadiness. Also predictive of increased levels of depressive symptomatology at 18-months, were 9-month increases in negative social self-perceptions, pain, unsteadiness, and ADL restrictions. Note that none of the socio-demographic (e.g., sex, age, education) or disease-related variables (e.g., diabetes type) were predictive of 18-month increase in depression level.

Although not specifically attempting to identify predictors of change in depression, Lustman et al. (1998) conducted a study to examine the factors that predicted treatment outcomes (remission vs. nonremission of depression) among diabetic patients receiving CBT.

For the total sample, treatment group (i.e., receiving CBT) and control group (TAU), the factors associated with nonremission of depression status were lower glycemic control, lower adherence to glucose monitoring, higher weight, and previous history/treatment of depressive symptomatology. In the group receiving CBT, depression remission was compromised in those with existing diabetes-related complications and those with low adherence to blood glucose monitoring. Again, similar to the study by Vileikyte et al. 2009, socio-demographic factors were not found to predict change in depressive symptomatology as measured through remission of depression status. Although this time, diabetes characteristics (i.e., glycemic control, adherence to glucose monitoring, diabetes-related complications) were predictive of depression outcome. Although these factors are similar to those identified when using cross-sectional research designs, they are not identical, and the limited number points to a gap in the literature.

In conclusion, and given the above mentioned gaps in the literature, the primary aims of the current study were: (1) To examine whether diabetes-related self-efficacy mediates the relationship between depression and diabetes self-care in African American and Latino adults with T2D. (2) After controlling for intervention assignment, to examine the longitudinal association between depressive symptoms and diabetes self-management (i.e., diabetes self-care performance levels and glycemic control) and to determine if individuals with higher baseline levels of depression are less likely to increase diabetes management (i.e., self-care behaviors and A1c) during subsequent follow-up measures (i.e., 6-, 12-, and 18-months); note that the hemoglobin A1c test is a blood analysis done by a medical professional that provides the average blood glucose for the past 6 to 12 weeks. (3) To examine the set of biopsychosocial factors that best predict change in depressive symptomatology across time, after controlling for intervention assignment.

IV. METHODS

A. **Study Design**

The present study was a secondary data analysis conducted utilizing baseline, 6-, 12-, and 18-month in-person survey data collected from African American and Latino adults with T2D participating in the RCT entitled "*Diabetes Self-Management in Minorities*." This included data for all study participants regardless of intervention assignment (i.e., treatment group: TAU vs. MAC intervention); note that the MAC intervention group received individualized diabetes education and support from a MAC, while the control group (TAU) received usual care with the addition of a standard educational booklet. The original RCT's repeated measures design [2 (treatment group) X 4 (time)] allowed for examination of the cross-sectional and longitudinal associations between the constructs of depression, diabetes self-care, and diabetes-related self-efficacy among adults with diabetes. First, using baseline data, Baron and Kenny's mediation analysis method was used to cross-sectionally examine whether diabetes-related self-efficacy served as a mediator between depression and diabetes self-care. Secondly, taking advantage of the longitudinal study design of the original RCT, repeated observations taken at baseline, 6-, 12-, and 18-months were used to examine the change, over time, in diabetes management (i.e., self-care behavior and A1c) between depressed and non-depressed adults and to examine the variables that best predicted change in depressive symptomatology.

B. **Target Population and Setting**

The target population and setting were identical to those of the larger parent study (i.e., RCT entitled, "*Improving Diabetes Self-Management in Minorities*") from which the dataset was obtained. Briefly, and as already mentioned when describing the parent study, participants with T2D of African American and Latino descent were recruited from four FQHCs located in medically underserved Chicago urban areas. The sites included Kling Professional Medical Center, Madison Family Health Center, Access Plaza Family Health Center, and Servicios Médicos La Villita, all part of the Access Community Health Network (ACCESS). Inclusion criteria for the study were as follows: African American or Latino; aged 18 years or over; fluency in English or Spanish; previous A1C values over 6.5; able to provide informed consent; currently taking diabetes medications (i.e., insulin and/or pills), and T2D diagnosis for at least 6 months. Individuals were excluded if pregnant or planning pregnancy, if they were diagnosed within the past two years with kidney disease, cardiovascular disease, cancer, advanced diabetes complications (e.g., severe retinopathy), had a medical history of cognitive (e.g., dementia) or emotional impairment, and if they, or a household member were currently enrolled in a research study addressing a diabetes-related topic.

It was not possible to directly calculate and determine the exact desired sample size for each group given the nature of a secondary data analysis and that no pilot study data were available that included the constructs of interest. Therefore, determination of an appropriate sample size was obtained through the utilization of a computer power analysis program known as G-Power which provided a framework number of 128 from which to determine a sample estimate; using G-Power, *a priori* power analysis was conducted where the alpha value was set to 0.05, the power = 0.8, and effect size = 0.5.

C. **<u>Assessment Methods</u>**

1. **<u>Outcome measures</u>**

Based on the conceptual framework integrating the SCT and Peyrot's biopsychosocial model of glycemic control, the main constructs of interest in this study were (1) depression; (2) diabetes self-care (general diet, specific diet, physical activity, blood glucose monitoring, medication use, foot care, and smoking status); (3) diabetes-related self-efficacy; and (4) glycemic control as measured via A1c. These were collected via in-person surveys using computer delivered assessment methods at baseline, 6-, 12-, and 18-months. Offered below are descriptions of the empirical evidence establishing validity and reliability of the survey tools.

a. **<u>Depressive symptomatology</u>**

There are many tools available to measure the construct of depression; they include but are not limited to the following: Beck Depression Inventory (BDI), Symptoms Checklist—Revised (SCL-90-R), CES-D, and the PHQ. After examination of the various depression scales it was determined that the PHQ-9 survey tool would be used for the study; it was favored due to its brevity and its availability in both the English and Spanish language and was incorporated at the recommendation of the author prior to the commencement of the parent study. Table I presents the statements that are included in the PHQ. The response scale for questions 1–9 is as follows: "0"—Not at all, "1"—Several days, "2"—More than half the days, "3"—Nearly every day.

Kroenke et al., (2001) determined that the PHQ-9 was able to identify depressive symptomatology and severity level. Additionally in the same study, construct validity was determined by examining the association between the PHQ-9 and 6 different items measuring functional status. The six subscales measuring functional status included the following health related areas: (1) mental health; (2) social functioning; (3) role functioning; (4) general health perceptions; (5) pain; and (6) physical health. As predicted, those with higher levels of depressive symptoms scored lower on all six functional status subscales. When examining diagnostic validity, the authors found the depression diagnoses resulting from the administration of the PHQ-9 to be similar to diagnoses obtained by mental health professionals. Reliability was obtained by calculating Cronbach's α which yielded values of 0.89 and 0.86, respectively. Thus Kroenke et al., (2001) determined that the PHQ, "in addition to making criteria-based diagnoses of depressive disorders, the PHQ-9 is also a reliable and valid measure of depressive severity. These characteristics plus its brevity make the PHQ-9 a useful clinical research tool" (p. 606). The PHQ-9 has also undergone testing for validity and reliability in the older adult population. A study conducted with nursing home residents found the PHQ-9 to be more effective and accurate when compared to both the Geriatric Depression Scale and the Minimum Data Set 2.0 (Saliba, 2008).

Administered in an interview format, the Spanish-version PHQ depression module PHQ-9 showed a sensitivity of 77% and a specificity of 100% in a sample of Honduran women (N = 199) (Wulsin et al., 2002). Another study examined the validity of the Spanish version PHQ-9 in a population of Spanish hospital inpatients and found adequate agreement between depression status as diagnosed by the PHQ-9 and that provided by a mental health professional (sensitivity = 87% and specificity = 88%) (Diez-Quevedo et al., 2001).

TABLE I
PATIENT HEALTH QUESTIONNAIRE (PHQ-9)

Statement number
1. Little interest or pleasure in doing things
2. Feeling down, depressed, or hopeless
3. Trouble falling or 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 are a failure or have let yourself or family down
7. Trouble concentrating on things, such as reading the newspaper or watching television
8. Moving or speaking so slowly that other people could have noticed. Or the opposite—being so fidgety or restless that you have been moving around a lot more than usual.
9. Thoughts that you would be better off dead, or of hurting yourself in some way

b. **Self-care scale**

The SDSCA is a 13-item scale (see Table II) that assesses six different self-care subcomponents that include healthy eating, physical activity, blood sugar testing, medication use, foot care, and smoking. The SDSCA was developed by Toobert et al. (2000). An examination of reliability and validity of the original 5-subscale SDSCA was conducted from seven different studies that used the SDSCA, and was found to have adequate internal reliability within the identified subscales (means = 0.47), moderate test-retest reliability (mean = 0.40), and adequate construct validation when correlated to multiple scales measuring both diet and exercise. The authors modified the existing instrument based on the analysis which resulted in the 13-item scale. The questions probe the individual regarding the past seven days or the last week or month. Finally, the Spanish version SDSCA was evaluated for reliability and validity and was found to have equivalency with the English version as they had correlation values ranging from 0.78 to 1.00 (Vincent et al., 2008). Test-retest reliability for the Spanish version ranged from 0.51 to 1.00 and Cronbach's alpha was found to have a value of 0.68.

TABLE II

THE SUMMARY OF DIABETES SELF-CARE ACTIVITIES MEASURE (SDSCA)

Question Number
Diet
1. How many of the last SEVEN DAYS have you followed a healthful eating plan?
2. On average, over the past month, how many DAYS PER WEEK have you followed your eating plan?
3. On how many of the last SEVEN DAYS did you eat five or more servings of fruits and vegetables?
4. On how many of the last SEVEN DAYS did you eat high-fat foods such as red meat or full-fat dairy products?
Physical Activity
5. On how many of the last SEVEN DAYS did you participate in at leas 30 minutes of physical activity? (Total minutes of continuous activity, including walking)
6. On how many of the last SEVEN DAYS did you participate in a specific exercise session (such as swimming, walking, biking) other that what you do around the house or as part of your work?
Blood Sugar Testing
7. On how many of the last SEVEN DAYS did you test your blood sugar?
8. On how many of the last SEVEN DAYS did you test your blood sugar the number of times recommended by your health care provider?
Medication Use
9. On how many of the last SEVEN DAYS did you take your recommended insulin injections?
10. On how many of the last SEVEN DAYS did you take your recommended number of diabetes pills?
Foot Care
11. On how many of the last SEVEN DAYS did you check your feet?
12. On how many of the last SEVEN DAYS did you inspect the inside of your shoes?
Smoking Status
13. Have you smoked a cigarette—even one puff—during the past SEVEN DAYS?

c. **Diabetes Empowerment Scale-Short Form**

The 8-item Diabetes Empowerment Scale-Short Form (DES-SF), created by Anderson et al. (2003), measures the psychosocial self-efficacy of individuals with diabetes (see Table III). The original 28-item DES underwent psychometric testing in a sample of 375 community-dwelling adults diagnosed with either type 1 or T2D (Anderson et al., 2000). Factor analysis found this instrument to contain a 3-factor solution corresponding to three subscales; (1) "Managing the Psychosocial Aspects of Diabetes"; (2) Assessing Dissatisfaction and Readiness to Change"; and (3) "Setting and Achieving Goals." The correlation coefficient calculated among the subscales ranged in value from 0.64 to 0.75. Both content validity and concurrent validity were assessed. Correlations in the expected directions were found between the DES and the self-reported measures of the Diabetes Care Profile (measures positive and negative attitudes toward diabetes), education level, and the Diabetes Understanding scale; for example, there was a positive relationship found between diabetes-related self-efficacy and diabetes understanding. Finally, test-retest validity conducted over a 6-week span of time yielded an acceptable correlation coefficient value of 0.79 (Anderson et al., 2000). In 2003, the DES-SF was created by including items with the greatest subscale correlation. The DES-SF is composed of 8-items and has a Cronbach's alpha of 0.84. Content validity was observed in a sample of 229 subjects receiving a patient-education intervention as A1c levels and self-efficacy scores were found to have changed in a similar, positive direction. Anderson et al. (2003) conclude that the short 8-item DES validly and reliably measures psychosocial self-efficacy among patients with diabetes.

TABLE III
DIABETES EMPOWERMENT SCALE-SHORT FORM (DES-SF)

Question number

In general, I believe that I:

1. ...know what part(s) of taking care of my diabetes that I am **dissatisfied** with.
2. …am able to turn my diabetes goals into a workable plan.
3. ...can try out different ways of overcoming barriers to my diabetes goals.
4. ...can find ways to feel better about **having** diabetes.
5. ...know the **positive** ways I cope with diabetes-related stress.
6. ...can ask for support for having and caring for my diabetes when I need it.
7. ...know what helps me stay motivated to care for my diabetes.
8. ...know enough about myself as a person to make diabetes care choices that are right for me.

d. **Glycemic control**

Glycemic control was captured using A1c and was obtained through two different methods. If it was ordered by the patient's provider within two weeks of the scheduled baseline or follow-up date, this A1c test was used. Values of A1c obtained from the medical charts used the Bio-Rad Variant II A1c assay for blood glucose testing. When not conducted as part of routine care at the baseline or follow-up time points, an A1c value was obtained using a finger stick method by a medical assistant solely for research purposes using a DCA 2000+ machine.

2. **Covariates and/or additional predictor variables**

The theoretical framework guiding the current study presents multiple socio-demographic and biopsychosocial factors that may directly or indirectly affect depression status and self-care adherence; these variables must be taken into account for data analysis purposes.

In-person surveys were administered to capture these additional items to be subsequently used as covariates and/or predictor variables during data analysis. The details for these instruments and/or individual items are found below and they include: (1) socio-demographic factors; (2) BMI; (3) disease-related factors (i.e., medication type and length of disease diagnosis); (4) family history/healthcare access; and (5) diabetes related distress.

a. **<u>Demographic information and body mass index</u>**

The Demographic Information Survey was administered at baseline and captures age, gender, race/ethnicity, marital status, education, income, and employment status (Table IV). Note that not all of the demographic information collected from the participants for the original RCT was used for this study; multiple items inquiring about race were omitted and the quality of life item was not used due to extensive missing data. Body Mass index was calculated from self-reports of height and weight.

TABLE IV
DEMOGRAPHIC INFORMATION SURVEY

Question number
1. What is your age?
2. What is your gender?
3. How do other people usually classify you in this country? Would you say White, Black or African American, Hispanic or Latino, Asian, Native Hawaiian or Pacific Islander, American Indian or Alaska Native, or some other group?
4. What is your marital status?
5. What is your annual household income from all sources?
6. What is the highest grade or year of school you completed?
7. What is your current employment status?

b. **Disease-related factors**

Two items were used to capture diabetes-related disease factors that have the potential to influence the outcome measures explored in the current study. The first item, included within the randomization program for purposes of blocking/stratification, inquired as to whether the patient was currently using prescription insulin. This item had a dichotomous response choice giving the participant the opportunity to either affirm or deny the use of insulin. The second self-report item asked the participant to estimate the number of months and/or years since receiving their diabetes diagnosis from a healthcare provider.

c. **Family history/healthcare access**

Participants were asked to identify the number of people with diabetes currently living within their household; the categorical response options were as follows: (1) none; (2) one; (3), more than one; or (4) don't know/not sure. The second item, used to gauge healthcare access, inquired as to whether the participant had any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare.

d. **Diabetes distress**

The DDS was used to assess diabetes-related emotional distress among patients with diabetes (Polonsky et al., 2005). Participants were asked to rate a statement (e.g., not feeling confident in my day-to-day ability to manage diabetes) on a six-point Likert Scale ranging from "not a problem" to "a very serious problem." This 17-item instrument originally underwent testing for reliability and validity in a diverse study population: 50.4% non-Hispanic White, 19.6% Asian American or Pacific Islander, 13.2% African American, and 7% were Hispanic. Reliability was examined by internal item consistency which resulted in a Cronbach's alpha of 0.93 indicating good reliability. Construct validity was determined by conducting correlational analysis between the DDS and the following constructs: depression (CES-D), diabetes self-care (SDSCA), and metabolic variables (i.e., A1c and lipid profiles). All correlations were significant in the expected direction (see Table V).

TABLE V
DIABETES DISTRESS SCALE

Question number
1. Feeling that diabetes is taking up too much of my mental and physical energy every day.
2. Feeling that my doctor doesn't know enough about diabetes and diabetes care.
3. Feeling angry, scared, and/or depressed when I think about living with diabetes.
4. Feeling that my doctor doesn't give me clear enough directions on how to manage my diabetes.
5. Feeling that I am not testing my blood sugars frequently enough.
6. Feeling that I am often failing with my diabetes regimen.
7. Feeling that friends or family are not supportive enough of my self-care efforts (e.g., planning activities that conflict with my schedule, encouraging me to eat the "wrong" foods).
8. Feeling that diabetes controls my life.
9. Feeling that my doctor doesn't take my concerns seriously enough.
10. Not feeling confident in my day-to-day ability to manage my diabetes.
11. Feeling that I will end up with serious long-term complications, no matter what I do.
12. Feeling that I am not sticking closely enough to a good meal plan.
13. Feeling that friends or family don't appreciate how difficult living with diabetes can be.
14. Feeling overwhelmed by the demands of living with diabetes.
15. Feeling that I don't have a doctor who I can see regularly about my diabetes.
16. Not feeling motivated to keep up my diabetes self-management.
17. Feeling that friends and family don't give me the emotional support that I would like.

D. **Data Analysis**

1. **Specific associations of interest**

The main constructs of interest included depressive symptoms, diabetes self-care, diabetes-related self-efficacy, and glycemic control. As detailed below, adjusted regression models controlled for a combination of demographic characteristics (e.g., age, race/ethnicity, income), biopsychosocial factors, and intervention assignment. The following associations were examined: (1) the relationship between depression and diabetes self-care after inclusion of the hypothesized mediator variable of self-efficacy; (2) the effects of depressive symptoms on diabetes self-care and glycemic control during subsequent follow-up measures (i.e., baseline, 6-, 12-, and 18-months); and (3) examination of the set of biopsychosocial factors associated with change in depressive symptomatology across time, after controlling for intervention assignment.

2. **Descriptive and inferential statistics**

Data analysis was performed through the use of statistical software (SAS 9.1 for Windows; SAS, Inc, Cary, North Carolina). Descriptive statistics summarizing baseline characteristics for the total sample, accompanied by stratification by depression status and race/ethnicity, are reported for the socio-demographic factors, biomedical measures (i.e., BMI and A1c), self-care performance levels, and the psychological factors of diabetes-related self-efficacy and diabetes distress. To identify between-group differences across the socio-demographic and biopsychosocial variables by depression status (depressed vs. non-depressed) and race/ethnicity (African American vs. Latino), t-tests and chi-square tests were performed.

As recommended by Toobert et al. (2000), self-care was examined separately by its subcomponents of healthy eating, physical activity, medication use, blood glucose self-testing, foot care, and smoking status. Normal probability plots for the variable(s) measuring adherence to diabetes self-care behaviors were examined prior to specification of variable distribution. Across all data analysis procedures, given the distribution of the self-care measures corresponding to healthy eating, physical activity, blood sugar self-testing, and foot care (i.e., Poisson), these self-care subcomponents were treated as count (i.e., discrete) data. The medication use variables (i.e., insulin or oral medication/pills) required zero inflated Poisson regression, while the dichotomous outcome measure establishing smoking status required logistic regression techniques. The construct of depression was treated as either a continuous or dichotomous variable depending on the research question addressed. For the first research question, pertaining to the mediational effect of self-efficacy, depression was be treated as a continuous variable ranging on a truly defined scale from 0 to 27. When examining the longitudinal effects of depressive symptomatology on diabetes management and glycemic control, the depressive symptomatology scores were first dichotomized. Patients were categorized into two distinct groups of non-depressed (PHQ-9 < 10) versus depressed (PHQ-9 ≥ 10). These cutoffs have been established as the thresholds when identifying probably clinical depression. This was followed by treatment of the depression scale score as a continuous variable (i.e., 0–27). Finally, when predicting the change in depressive symptomatology across time, it was once again treated as a continuous variable ranging from 0 to 27.

3. **Aim 1: Mediational effect of diabetes-related self-efficacy**

To test whether diabetes self-efficacy served as a mediator in the relationship between depression and diabetes self-care, a mediation analysis was performed through use of the classic Baron and Kenny method (Baron & Kenny, 1986). This method consisted of cross-sectional analyses using baseline data. The predictor variable of depression was treated as a continuous variable and based on variable distribution the self-care subcomponents were treated as count data (i.e., healthy eating, physical activity, glucose self-testing, foot care) or dichotomous data (i.e., smoking status). As previously identified, the medication use variables displayed a pronounced ceiling effect requiring the use of a zero inflated Poisson method.

The Baron and Kenny framework uses the causal steps approach to establish occurrence of mediation, with requirements as follows: (1) first, there must be a significant relationship between the dependent (i.e., diabetes self-care) and independent (i.e., depressive symptomatology) variables; (2) next, there must be a significant relationship between the mediator variable and both the independent and dependent variables; and (3) the last step is to control for the mediating variable (i.e., diabetes self-efficacy) and to examine whether the association between the dependent (i.e., diabetes self-care) and the independent variable (i.e., depressive symptomatology) is significantly weakened or loses significance altogether. We can safely say that a variable acts as a mediator if, after controlling for it, the association between the dependent and independent variable goes to zero. Partial mediation occurs when the association between the dependent and independent variable lessens but does not go to zero. Based on existing literature that explores the factors associated with performance of diabetes self-care behaviors, the following covariates were included in the adjusted regression models: age, race/ethnicity, income, and BMI. Mediation analysis was conducted for the total sample (n = 276), and separately by race/ethnicity (i.e., African Americans versus Latinos) and gender (i.e., male vs. female).

4. **Aim 2: Longitudinal effects of baseline depression on diabetes management**

For this research aim the outcome variables of interests were (1) glycemic control as measured via levels of A1c and (2) adherence to the diabetes self-care subcomponents (i.e., general diet, specific diet, physical activity, blood glucose monitoring, medication use, foot care, and smoking status). As in the previous analysis, based on the results from normal probability plots the self-care subcomponents were treated as count data, with the exception of the binary response variable establishing smoking status. The construct of depression as measured using the PHQ-9 was the main predictor of interest. As previously mentioned, depression was first treated as a dichotomous variable, followed by its treatment as a continuous variable with scores ranging on a truly defined scale (0–27).

Prior to employment of longitudinal data analysis methods, bivariate comparisons between the depressed and non-depressed subgroups were examined for each of the diabetes self-management outcome measures at baseline, 6-, 12-, and 18-months. This was followed by GEE analyses to examine the longitudinal relationship between depressive symptoms and diabetes self-management (i.e., diabetes self-care behaviors and glycemic control). The GEE approach was the appropriate analytic technique because it avoids biased parameter estimates by allowing specification of within subject correlation. Additionally, the GEE method has a number of advantages. First, it is a method suitable for a diverse range of longitudinal responses, such as continuous, ordinal, polychotomous, binary, and count-dependent data. Second, subjects need not be measured at common sets of occasions nor are they required to have an equal set of measurement points; data missing completely at random is also viable. Two required specifications were made prior to fitting the GEE model: (1) identification of the link function; and (2) specification of the working correlation matrix. Because the non-dichotomous self-care activities (i.e., diet, physical activity, glucose monitoring, medication adherence, and foot care) were treated as count data, the log link was used. The logit link was used for the binary outcome of smoking. Specification of the compound symmetry correlation matrix was determined by examining the empirical correlation matrix.

First, GEE were used to examine change in diabetes self-management across time to identify significant differences by baseline depressions status. This statistical method required dichotomization of the depression measure. GEE methods were used separately for each of the self-care management measures (i.e., healthy eating, physical activity, glucose self-testing, medication use, foot care, and A1c) to estimate the contrast between depressed and non-depressed subgroups at 6-, 12-, and 18-months. Due to the differences in levels of self-management between the depressed and non-depressed subgroups, baseline values were subtracted from each follow-up estimate. Both an unadjusted model and adjusted model were employed. The adjusted model controlled for age, race/ethnicity, income, BMI, and intervention assignment.

The second set of GEE analyses treated the depression score as a continuous measure. The first procedure used a standard GEE model to examine the longitudinal association between depression and diabetes self-management. The second procedure used GEE change models (model of changes; Twisk, 2004). Specifically, using adjacent time points, this method examined the effects of changes in depression scores on changes in self-care management levels. As before, a compound symmetry correlation matrix was specified given the uniform within-subject correlation. The multivariate GEE models adjusted for the following potential confounder variables: age, race/ethnicity, income, BMI, and intervention assignment.

Although GEE is the preferred statistical method for longitudinal data analysis as it uses all non-missing pairs of data in the estimates, it does have limitations. Thus, multiple retention analyses were conducted as differential program attrition by depressions status was possible. Logistic regression and Log-Rank tests were used to identify whether depressive symptoms were associated with overall program attrition.

5. **Aim 3: Predictors of change in depression level**

The final aim sought to examine the longitudinal association between depressive symptomology and multiple demographic, biomedical (i.e., BMI, A1c), behavioral, disease-related (i.e., length of diabetes diagnosis and insulin regimen), and psychosocial factors (e.g., diabetes distress). Depressive symptomatology was treated as a continuous variable, ranging on a truly defined scale from 0 to 27. As before, two GEE models were used. The standard GEE model was used to examine the longitudinal association between depression and the following independent variables: age, gender, race/ethnicity, marital status, education, income, employment, family disease history, healthcare access, BMI, A1c, diabetes self-care, diabetes-related self-efficacy, diabetes distress, and intervention assignment. The second method involved a GEE change model, where changes in depressive symptoms were examined as a consequence of change in the predictor variables. Univariate and multivariate analyses were conducted for both GEE methods. The multivariate analyses involved a backward model selection procedure that initially included all predictor variables and systematically removed factors with a *p*-value over 0.10 until the final prediction model was determined. As before, a compound symmetry correlation matrix was specified.

V. RESULTS

A secondary data analysis was conducted using a dataset collected as part of a randomized control trial employing a prospective study design with participant information gathered at baseline, 6-, 12-, and 18-months. Using baseline, 6-, 12-, and 18-month participant survey data, the current study examined the longitudinal relationship between depression and diabetes self-care in minority patients with T2D. For clarity, this section is organized around the previously identified research aims. Baseline characteristics for the total sample, along with stratification by depression status and race/ethnicity are presented for socio-demographic characteristics (Table VI) and biopsychosocial factors (Table VII).

A. **Sample Characteristics**

Table VI presents the baseline socio-demographic characteristics for the total sample with T2D (n = 276), along with a stratified summary by depression status and race/ethnicity. Note that the sample size for the baseline factors may differ given missing data issues and differing data collection sources (i.e., interactive computer delivered approach vs. medical chart abstraction) (see table footnotes); specifically, the sample size was larger for variables that did not require direct patient interaction and thus could be collected via medical chart abstraction.

The sample was evenly distributed by race/ethnicity with 146 self-identified African Americans (53.7%) and 126 Latinos (46.3%). The sample was primarily female (68.4%) and ranged in age from 25 to 86 years (*M* = 53.2, SD = 12.3). This clinical sample was of low socio-economic status based on education and income. Overall, 60.0% had less than a high school education, which included individuals with no formal schooling or kindergarten attendance only.

Approximately three-fourths of the participants reported an income below $20,000 (74.0%). Marital status was treated as a nominal variable with self-identification into the subgroups of married (38.4%), never married (24.0%), divorced (13.2%), widowed (13.2%) and separated (11.2%). A total of 95 (38.4%) patients reported being currently employed and 60.3% had some type of medical care coverage. Finally, slightly over 80% of individuals reported at least one family member with diabetes living within their household.

Dichotomization of the continuous measure of depressive symptomatology was accomplished using the previously established PHQ-9 cutoff scores. Those with a PHQ-9 score greater than or equal to 10 were categorized as depressed, all others (i.e., PHQ less than or equal to 9) were considered to be within the non-depressed range. A PHQ-9 score greater than or equal to 10 is the threshold used to identify individuals with probable clinical depression. Use of this threshold when identifying major depression has shown a positive likelihood ratio of 7.1 with an accompanied sensitivity and specificity of 88%. Based on these criteria, approximately 24.8% (n = 62) were considered to have moderate to severe depression (i.e., probable clinical depression) as measured by the PHQ-9 (i.e., PHQ-9 greater than or equal to 10). Between-group differences for the socio-demographic factors based on depression status can be found in Table VI. Those classified as depressed were significantly younger (50.3 years vs. 53.9 years), more likely to be of African American descent, have self-reported lower levels of annual income, and were less likely to be married. Differences by race/ethnicity can also be found in Table VI. Pearson chi-square tests revealed that the African American subgroup reported significantly higher educational attainment levels with only 37.9% reporting less than high school education versus 85.2% of Latinos. Additionally, African Americans were more likely to be insured and were less likely to be married. Finally, although not statistically significant, trends indicate that the African

American subgroup was younger (51.8 yrs. vs. 54.7 yrs.) and less likely to be employed (31.9% vs. 46.1%).

TABLE VI

BASELINE SOCIO-DEMOGRAPHIC FACTORS OF THE STUDY SAMPLE, BY DEPRESSION STATUS AND RACE/ETHNICITY[a]

Variable	Total (N = 276)	Depressed (n = 62)	Non-depressed (n = 188)	*p*	African American (n = 146)	Latino (n = 126)	*p*
Demographics**							
Age, *M* (SD)	53.2 ± 12.3	50.3 ± 12.1	53.8 ± 12.1	0.04*	51.8 ± 13.0	54.7 ± 11.5	0.06
Female, (%)	68.4	70.5	67.6	0.63	65.8	71.4	0.32
Race/Ethnicity							
African American	53.7	67.2	48.4	0.01*	--	--	--
Latino	46.3	32.8	51.6		--	--	--
Education, %							
< High School	60.0	58.0	61.1	0.64	37.9	85.2	0.000*
High School Graduate	18.8	22.6	17.3		29.5	7.0	
> High School	21.2	19.4	21.6		32.6	7.8	
Annual household income							
Less than $20,000	74.0	85.4	70.7	0.04*	70.9	78.9	0.21
More than $20,000	26.0	14.6	29.3		29.1	21.1	
Employment Status[b]							
Currently Employed	38.4	38.7	38.4	0.98	31.8	46.1	0.06
Unemployed	21.6	21.0	22.2		22.7	20.9	
Other	40.0	40.3	39.4		45.5	33.1	
Health Insurance							
Yes	60.3	69.0	57.1	0.11	66.4	53.5	0.04*
No	39.7	31.0	42.9		33.6	46.5	
Marital Status[c], %							
Married	38.4	27.4	42.2	0.012*	22.7	56.5	0.000*
Never Married	24.0	37.1	19.5		38.6	7.0	
Other	37.6	35.5	38.4		38.6	36.5	
Household with Diabetes							
None	18.4	15.3	19.8	0.28	20.3	16.8	0.74
One	60.3	55.9	61.0		59.4	60.2	
More than one	21.3	28.8	19.2		20.3	23.0	

*$p \leq 0.05$.
** Sample size approximation of n = 257.
[a] Data are (%) or means ± standard deviation.
[b] Employment status category of "other" includes homeworkers, students, and those retired and/or unable to work.
[c] Marital status category of "other" includes separated, divorced, and widowed.

Descriptive baseline information for the biomedical variables, disease-related factors, diabetes self-care scores, and psychological factors (i.e., diabetes distress, diabetes-related self-efficacy, and depression severity) can be found in Table VII. These are again presented for the total sample and stratified by depression status and race/ethnicity. Baseline biomedical profiles and disease-related characteristics for this sample (n = 276) include: mean BMI of 33.2 (SD = *7.1*); mean A1c score of 8.6 (SD = *2.4*); and an average length of diagnosis of 8.1 years (SD = *6.7*). Additionally, at baseline 35.3% self-reported use of insulin as part of their diabetes regimen. Over a 7-day period, self-reported diabetes self-care rates across multiple self-care behaviors ranged from doing the activity an average of 2.5 days to 6.2 days per week. Participants reported the highest diabetes self-care scores for oral medication use (6.2 days/week) and the lowest for physical activity (2.5 days/week). Note that when examining levels of medication adherence, only patients who self-reported that they receive a prescription from a healthcare provider were taken into account when examining both insulin (n=126) and oral medication (n = 239) self-care adherence.

Baseline differences on biopsychosocial factors by depression status and race/ethnicity are also presented in Table VII. Those with depression symptoms reported significantly lower diabetes self-care scores for the behaviors corresponding to general diet, specific diet, and oral medication use. As a brief reminder, general diet includes two items that inquire about adherence to a healthful eating plan, while specific diet inquires about consumption of fruits, vegetables, and high-fat foods; note, reverse coding was required for the item inquiring about high-fat food consumption. Patients with depression were also more likely to self-identify as smokers and had a higher mean score for diabetes-related distress. Finally, although not statistically significant, trends show higher self-care scores for insulin use in the non-depressed subgroup (5.2 days vs.

4.2 days; p = 0.07). Between-group differences by race/ethnicity show that African Americans have higher means scores for BMI (p = 0.001) and poorer glycemic control (A1c) (p = 0.003), and that they are more likely to endorse insulin use as part of their prescribed medication regimen (p = 0.002). The African American subgroup shows higher self-care scores for blood sugar self-testing, but lower scores for the self-care behavior associated with specific diet and oral medication use. African Americans were also more likely to self-identify as smokers, they had lower diabetes-related self-efficacy scores, and they were more likely to have PHQ-9 scores in the mild to severe range.

Finally, and justifying the decision not to collapse the diabetes self-care subscales into a single self-care score, the Spearman Rank Order test was used to create a correlation matrix to determine the relationship between the diabetes self-care behaviors (see Table VIII). In general, the correlation coefficients indicated weak positive associations between the self-care behaviors with associated magnitudes in the range of $r_s = 0.005$ to $r_s = 0.41$. Not surprisingly, and as healthcare professionals often stress the importance of glucose monitoring among insulin users, the strongest association was found between the behaviors of insulin use and blood sugar testing ($r_s = 0.41$, $p = <0.001$). The low correlation coefficients among the self-care behaviors are consistent with that reported by Toobert et al. (2000) who identified a mean coefficient value of r = 0.23. Generally low inter-item correlations across subscales led to the decision of calculating discrete scores for each of the regimen areas.

TABLE VII
BASELINE BIOPSYCHOSOCIAL FACTORS OF THE STUDY SAMPLE, BY DEPRESSION STATUS AND RACE/ETHNICITY[a]

Variable	Total (N = 276)	Depressed (n = 62)	Non-depressed (n = 188)	*p*	African American (n = 146)	Latino (n = 126)	*p*
Biomedical Variables							
BMI, *M* (SD)**	33.2 ± 7.1	34.4 ± 9.2	32.8 ± 6.2	0.21	34.6 ± 7.7	31.6 ± 5.9	0.001*
Glycemic Control (A1c)***	8.6 ± 2.4	8.8 ± 2.7	8.5 ± 2.2	0.39	9.0 ± 2.6	8.2 ± 2.1	0.003*
Diabetes-related Factors							
Length of Diabetes**	8.1 ± 6.7	8.8 ± 7.0	8.0 ± 6.8	0.46	8.3 ± 6.8	8.1 ± 6.7	0.86
Insulin Regimen***							
Yes	35.3	42.6	31.7	0.12	43.8	25.4	0.002*
No	64.7	57.4	68.3		56.2	74.6	
Diabetes Self-Care Behavior**							
General Diet	3.7 ± 2.3	3.1 ± 2.2	3.8 ± 2.3	0.031*	3.6 ± 2.2	3.7 ± 2.4	0.89
Specific Diet	4.0 ± 1.6	3.1 ± 1.3	4.2 ± 1.7	0.000*	3.7 ± 1.4	4.3 ± 1.8	0.008*
Physical Activity	2.5 ± 2.1	2.3 ± 1.9	2.6 ± 2.2	0.41	2.7 ± 1.9	2.3 ± 2.3	0.20
Blood Glucose Testing	3.6 ± 2.7	3.7 ± 2.4	3.6 ± 2.8	0.77	4.1 ± 2.5	3.0 ± 2.8	0.001*
Medication							
Insulin[b]	4.9 ± 2.9	4.2 ± 3.1	5.2 ± 2.8	0.07	5.2 ± 2.7	4.3 ± 3.2	0.12
Oral Medication/Pills[c]	6.2 ± 2.0	5.5 ± 2.6	6.5 ± 1.6	0.005*	5.7 ± 2.4	6.8 ± 1.1	0.000*
Foot Care	4.5 ± 2.5	4.3 ± 2.5	4.6 ± 2.4	0.39	4.6 ± 2.4	4.5 ± 2.5	0.84
Smoking							
Yes	21.3	32.3	18.1	0.019*	27.6	14.7	0.013*
No	78.7	67.7	81.9		72.4	85.3	
Diabetes-related Self-efficacy**	4.2 ± 0.7	4.2 ± 0.6	4.2 ± 0.7	0.46	4.1 ± 0.7	4.4 ± 0.6	0.004*
Diabetes Distress**	2.6 ± 1.2	3.6 ± 1.2	2.3 ± 1.1	0.000*	2.6 ± 1.2	2.6 ± 1.3	0.65
PHQ-9 Total Score	6.0 ± 5.7	14.3 ± 4.1	3.3 ± 2.8	< 0.001*	6.9 ± 5.8	4.8 ± 5.0	0.003*
PHQ-9 Score Cutoff**							
0–4 None	51.2	--	68.1	--	44.3	60.3	0.08
5–9 Mild	24.0	--	31.9		24.4	22.4	
10–14 Moderate	14.8	59.7	--		18.3	11.2	
15–19 Moderately Severe	7.2	29.0	--		9.9	4.3	
20–27 Severe	2.8	11.3	--		3.1	1.7	

*$p \leq 0.05$.
** Sample size approximation of n = 257.
*** Sample size approximation of n = 276.
[a] Data are (%) or means ± standard deviation.
[b] Participants self-endorsing a prescribed insulin regimen: n = 126.
[c] Participants self-endorsing a prescribed oral medication regimen: n = 239.

TABLE VIII
UNADJUSTED BIVARIATE CORRELATIONS (*P*-VALUES) BETWEEN THE DIABETES SELF-CARE BEHAVIORS FOR THE TOTAL SAMPLE

Variable	General Diet	Specific Diet	Physical Activity	Glucose Self-testing	Insulin	Pills	Foot Care	Smoking
General Diet	1.00							
Specific Diet	0.375* *(p < 0.001)*	1.00						
Physical Activity	0.267* *(p < 0.001)*	0.169* *(p = 0.007)*	1.00					
Glucose Self-Testing	0.242* *(p < 0.001)*	0.153* *(p = 0.02)*	0.241* *(p < 0.001)*	1.00				
Insulin	0.159 *(p = 0.08)*	0.235* *(p = 0.008)*	0.140 *(p = 0.12)*	0.413* *(p < 0.001)*	1.00			
Pills	0.195* *(p = 0.002)*	0.225* *(p < 0.001)*	0.037 *(p = 0.57)*	0.048 *(p = 0.46)*	0.345* *(p < 0.001)*	1.00		
Foot Care	0.168* *(p = 0.01)*	0.211* *(p = 0.001)*	0.221* *(p < 0.001)*	0.071 *(p = 0.26)*	0.206* *(p = 0.02)*	0.096 *(p = 0.14)*	1.00	
Smoking	0.008 *(p = 0.90)*	-0.065 *(p = 0.30)*	-0.006 *(p = 0.92)*	0.008 *(p = 0.91)*	0.041 *(p = 0.65)*	-0.031 *(p = 0.63)*	-0.005 *(p = 0.94)*	1.00

*$p < 0.05$.

B. Aim 1: The Mediational Role of Self-efficacy in the Relationship Between Depression and Diabetes Self-care

1. Mediational analysis for the total sample

Figure 3 presents the proposed mediational model depicting the association between depressive symptoms, diabetes-related self-efficacy, and diabetes self-care. The Baron

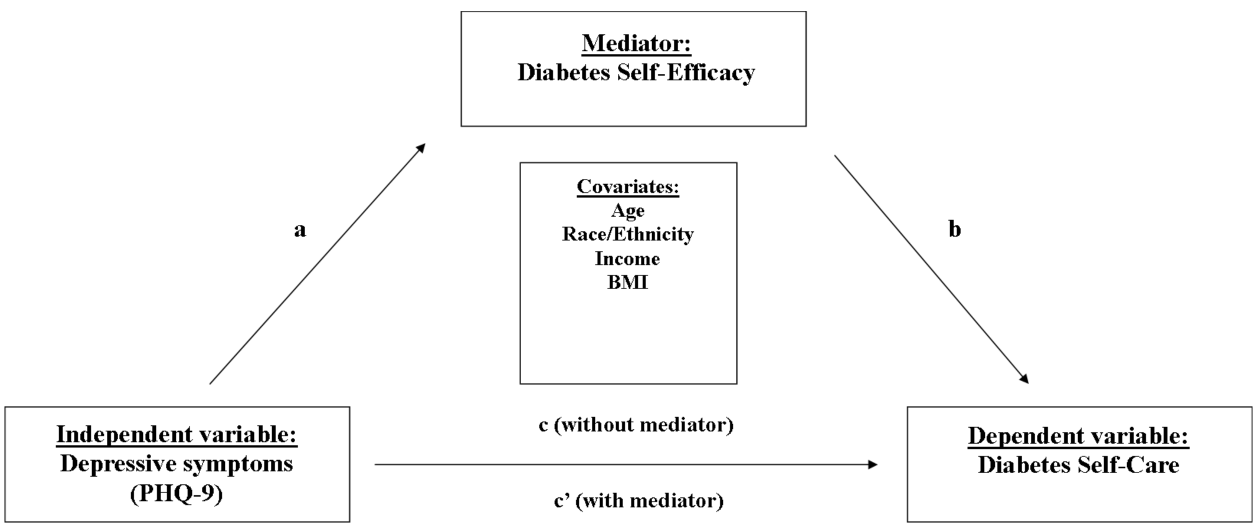

Figure 3. Mediational model tested.

and Kenny (Baron & Kenny, 1986) method was used to cross-sectionally examine the potential mediating effect of diabetes-related self-efficacy in the relationship between depression and each of the self-care subcomponents (i.e., diet, physical activity, glucose self-testing, medication use, foot care, and smoking status). Baseline data collected as part of the original RCT (i.e., *Diabetes*

Self-Management in Minorities) was used for mediational testing. In Step 1 (path c in Fig. 3), using multivariate regression techniques, each of the self-care subcomponents was regressed on the independent variable of depression while controlling for age, ethnicity/race, income, and BMI. Table IX presents the self-care measures of general diet, specific diet, physical activity, glucose self-testing, foot care, and smoking as regressed on the select *a priori* list of covariates and depressive symptomatology. With the exception of smoking status, which employed logistic regression techniques, the remaining self-care behaviors required the Poisson method due to their distribution. As seen in Table IX, depression was found to be significantly associated with the self-care subcomponents of general diet, specific diet, physical activity, foot care, and smoking. Negative parameter estimates reveal an inverse relationship between depressive symptomatology and the abovementioned self-care behaviors, suggesting that higher depression scores are associated with lower self-care performance levels for diet, physical activity, and foot care. Additionally, those with higher depression scores were more likely to self-identify as smokers. Across these five self-care subcomponents, the level of significance capturing the effect of depressive symptomatology ranged in value from $p = 0.0001$ to $p = 0.04$. The self-care behavior of glucose self-monitoring did not undergo further mediational testing, as there was no statistical evidence establishing a direct main effect on this behavioral outcome by depression level.

Statistical results for medication use (i.e., insulin or oral medication/pills) are presented separately as they required a more complex statistical method due to a ceiling effect generated by a high proportion of the population reporting optimum medication adherence rates (see Table X). Therefore, a zero inflated Poisson regression was used when examining the outcome variable of medication use. Table X presents the standardized regression weights for medication-specific self-care regressed on depression status and relevant covariates. Depression had no significant direct main effect on the outcome measures of medication use, with associated *p*-values of 0.07 (oral medication/pills) and 0.32 (insulin). Although, there is a suggested trend toward significance for oral medication use, lack of a direct main effect by the construct of depression negated further mediational testing on the self-care measures associated with medication use.

TABLE IX

STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR DIABETES SELF-CARE MEASURES REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9) AMONG A SAMPLE OF AFRICAN AMERICAN AND LATINO PATIENTS WITH TYPE 2 DIABETES

Characteristics	General Diet[b] (n = 240)	Specific Diet[b] (n = 240)	Physical Activity[b] (n = 240)	Glucose Self-testing[b] (n = 240)	Foot Care[b] (n = 240)	Smoking Status [c] (n = 240)
Age	0.005	0.003	-0.005	0.003	0.0008	0.017
	(*p* = 0.09)	(*p* = 0.32)	(*p* = 0.11)	(*p* = 0.31)	(*p* = 0.77)	(*p* = 0.24)
Race						
Latino[a]	1.00	1.00	1.00	1.00	1.00	1.00
African American	-0.031	0.078	-0.303*	-0.253*	-0.058	0.624
	(*p* = 0.67)	(*p* = 0.28)	(*p* = 0.001)	(*p* = 0.0008)	(*p* = 0.39)	(*p* = 0.09)
Income						
≥ $20,000[a]	1.00	1.00	1.00	1.00	1.00	1.00
< $20,000	-0.105	0.028	-0.071	0.065	0.124	-0.159
	(*p* = 0.22)	(*p* = 0.75)	(*p* = 0.50)	(*p* = 0.46)	(*p* = 0.13)	(*p* = 0.71)
Don’t know/Not Sure	-0.165	-0.011	0.228	-0.311*	0.120	0.778
	(*p* = 0.14)	(*p* = 0.92)	(*p* = 0.08)	(*p* = 0.01)	(*p* = 0.24)	(*p* = 0.21)
BMI	-0.012*	-0.006	-0.021*	-0.008	0.005	0.063*
	(*p* = 0.02)	(*p* = 0.23)	(*p* = 0.0008)	(p = 0.11)	(*p* = 0.29)	(p = 0.01)
Depressive symptoms	-0.026*	-0.024*	-0.027*	-0.009	-0.017*	-0.060*
	(*p* = 0.0001)	(*p* = 0.0003)	(p = 0.001)	(*p* = 0.19)	(*p* = 0.005)	(*p* = 0.04)

*$p < 0.05$.

[a] Value of 1.00 is used to identify the referent group.

[b] Covariates include age, race/ethnicity, income, and BMI.

[c] The regression equation is modeling the probability of being a non-smoker.

TABLE X

STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR MEDICATION USE MEASURES REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9) AMONG A SAMPLE OF AFRICAN AMERICAN AND LATINO PATIENTS WITH TYPE 2 DIABETES

Characteristics	Oral Medication (n = 226)	Insulin (n = 117)
Age	-0.008 *(p = 0.28)*	-0.003 *(p = 0.64)*
Race		
Latino	1.00	1.00
African American	-0.018 *(p = 0.95)*	0.262 *(p = 0.07)*
Income		
≥ $20,000	1.00	1.00
< $20,000	-0.300 *(p = 0.17)*	-0.180 *(p = 0.40)*
Don’t know/Not Sure	-0.062 *(p = 0.80)*	-0.076 *(p = 0.72)*
BMI	0.006 *(p = 0.56)*	0.002 *(p = 0.89)*
Depressive symptoms	0.026 *(p = 0.07)*	0.010 *(p = 0.32)*

*$p < 0.05$.

In Step 2 (path a in Fig. 3), multiple linear regression was used to explore the association between the mediator variable (i.e., diabetes-related self-efficacy) and the main independent variable of interest (i.e., depression). Although depression was significantly associated with the construct of self-efficacy in the bivariate unadjusted model ($p = 0.02$), this significant association was no longer evident after controlling for the covariates of age, race/ethnicity, income, BMI, and insulin use ($p = 0.17$) (see Table XI).

TABLE XI

STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR DIABETES SELF-EFFICACY REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9) AMONG A SAMPLE OF AFRICAN AMERICAN AND LATINO PATIENTS WITH TYPE 2 DIABETES

	Self-efficacy Main effects model: *b* (Standard Error)
Depression Status	Total Sample (n = 240)
Univariate/ Unadjusted Model	-0.017 (0.008) $p = 0.02$*
Adjusted Model[a]	-0.011 (0.008) $p = 0.17$

*$p < 0.05$.
[a] Adjusted for age, race/ethnicity, income, and BMI.

Given that Step 2 (i.e., path a in Fig. 3) was not significant for the total sample after inclusion of the *a priori* select list of covariates, further mediational tests were not attempted on the sample as a whole. Instead, exploratory subpopulation analyses were conducted by race/ethnicity and gender. Only statistically significant results and/or those showing trends toward significance within each of the mediational steps are provided for the subgroup analyses for purposes of clarity and parsimony.

2. **Mediational analysis by race/ethnicity**

As before, the first step of the mediation analysis (path c) regressed each of the self-care outcome measures on the covariates and depressive symptoms for the Latino and African American subgroups separately. As before, analyses for the self-care outcome variables with a Poisson and/or logistic regression distribution are presented first; this includes general diet, specific diet, physical activity, glucose self-testing, foot care, and smoking. Using the adjusted model, only specific diet (p = 0.004) was significantly associated with depressive symptoms in the Latino subpopulation with a negative beta suggesting an inverse relationship (see Table XII). Again, suggesting that higher depression scores are associated with lower self-care performance levels (i.e., poorer adherence to specific diabetes diet), trends toward significance were observed for the self-care behaviors of general diet (p = 0.06) and foot care (p = 0.06). In the African American subgroup, after controlling for age, income, and BMI, depression was significantly associated with the self-care activities of general diet (p = 0.0006), specific diet (p = 0.02), physical activity (p < 0.0001), and glucose self-testing (p = 0.01) (see Table XII). Once more, negative beta values suggest an inverse relationship between depression scores and self-care performance levels. Finally, as seen in Table XII, there is a trend toward significance for the outcome measure of foot care (p = 0.09) in the African American subgroup.

Results of path c for the medication use variables stratified by race/ethnicity are presented in Table XIII. As was true for the total sample, when the analysis was performed separately by race/ethnicity, depression status was not significantly associated with medication use after inclusion of relevant covariates. Given the robust lack of association, with *p*-values much higher than the pre-established 0.05 cutoff, the directionalities of association as determined by the beta coefficients are not discussed. Given these results, further mediational analyses were not attempted for the self-care behaviors relating to medication use.

TABLE XII

STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR DIABETES SELF-CARE MEASURES REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9), BY RACE/ETHNICITY

	Latino Subgroup			African American Subgroup				
Characteristics	General Diet (n = 112)	Specific Diet (n = 112)	Foot Care (n = 112)	General Diet (n = 128)	Specific Diet (n = 128)	Physical Activity (n = 128)	Glucose Self-Testing (n = 128)	Foot Care (n = 128)
Age	-0.0006	0.002	0.002	0.008*	0.003	-0.010*	-0.002	-0.002
	(p = 0.88)	*(p = 0.65)*	(p = 0.67)	*(p = 0.04)*	*(p = 0.49)*	*(p = 0.03)*	*(p = 0.59)*	*(p = 0.58)*
Income								
≥ $20,000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
< $20,000	-0.256	0.027	0.198	-0.008	0.028	0.092	0.182	0.096
	(p = 0.08)	*(p = 0.85)*	*(p = 0.19)*	*(p = 0.94)*	*(p = 0.79)*	*(p = 0.47)*	*(p = 0.08)*	*(p = 0.33)*
Don't know/Not Sure	-0.210	0.041	0.313	-0.356	-0.242	0.209	-0.503*	-0.215
	(p = 0.17)	*(p = 0.79)*	*(p = 0.05)*	*(p = 0.10)*	*(p = 0.23)*	*(p = 0.32)*	*(p = 0.02)*	*(p = 0.23)*
BMI	-0.025*	-0.013	0.013	-0.003	-0.001	-0.016*	-0.006	-0.002
	(p = 0.006)	*(p = 0.11)*	(p = 0.10)	(p = 0.69)	*(p = 0.85)*	*(p = 0.03)*	(p = 0.37)	*(p = 0.77)*
Depressive symptoms	-0.021	-0.030*	-0.019	-0.032*	-0.020*	-0.046*	-0.020*	-0.013
	(p = 0.06)	*(p = 0.004)*	*(p = 0.06)*	*(p = 0.0006)*	*(p = 0.02)*	*(p < 0.0001)*	*(p = 0.01)*	*(p = 0.09)*

*$p < 0.05$.

TABLE XIII
STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR MEDICATION USE MEASURES REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9), BY RACE/ETHNICITY

	Latino Subgroup		African American Subgroup	
Characteristics	Oral Medication[a] Insulin (n = 111)	Insulin (n = 39)	Oral Medication (n = 115)	(n = 78)
Age	-0.040 (*p* = 0.42)	0.002 (*p* = 0.84)	-0.003 (*p* = 0.70)	-0.003 (*p* = 0.71)
Income				
≥ $20,000	--	1.00	1.00	1.00
< $20,000	--	0.155 (*p* = 0.66)	-0.322 (*p* = 0.15)	-0.334 (*p* = 0.25)
Don’t know/Not Sure	--	-0.029 (*p* = 0.93)	-0.006 (*p* = 0.98)	-0.150 (*p* = 0.65)
BMI	0.024 (*p* = 0.88)	-0.008 (*p* = 0.71)	0.009 (*p* = 0.42)	0.002 (*p* = 0.92)
Depressive symptoms	-0.004 (*p* = 0.97)	-0.010 (*p* = 0.67)	0.024 (*p* = 0.12)	0.016 (*p* = 0.22)

[a] Covariate capturing income was excluded from this model as its inclusion resulted in a violation as the iteration limit was exceeded when using the zero inflated Poisson regression procedure; note that despite the absence of this covariate in this model, depression remained a non-significant variable.

Step 2 of the mediational analysis (path a) required examination of the direct effect of depression on self-efficacy with the inclusion of covariates. As can be seen in Table XIV, depression showed a trend toward significance in the African American subgroup with an associated *p*-value of 0.06. Specifically, in the unadjusted bivariate model, depression was significantly associated with self-efficacy with a *p*-value of 0.01, this association showed a trend toward significance after the addition of relevant covariates ($p = 0.06$). Given the results for path c and a, final regression steps were conducted for the African American subgroup for the self-care activities of general diet, specific diet, physical activity, glucose self-testing, and foot care.

TABLE XIV
STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR DIABETES SELF-EFFICACY REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9), BY RACE/ETHNICITY

	Self-efficacy Main effects model: *b* (SE)	
Depression Status	Latino Subgroup (n = 112)	African American Subgroup (n = 128)
Univariate/ Unadjusted Model	0.004 (0.012) $p = 0.73$	-0.024 (0.010) $p = 0.01$*
Adjusted Model[a]	0.004 (0.012) $p = 0.75$	-0.019 (0.010) $p = 0.06$

*$p < 0.05$.
[a] Adjusted for age, income, and BMI.

Table XV presents the results for the final step of the mediational analysis (path b and c' in Fig. 3) for the African American subsample. After inclusion of depressive symptomatology and the covariates, diabetes-related self-efficacy was not significantly associated with the self-care behaviors of general diet ($p = 0.09$), specific diet ($p = 0.43$), and glucose self-testing ($p = 0.62$). Instead the association between depression and these self-care behaviors remained statistically significant, suggesting absence of a mediational effect by self-efficacy. For the self-care behaviors associated with diet and glucose self-testing, consistency and robustness of statistical significance for the construct of depression after inclusion of the hypothesized mediator of self-efficacy suggest that complete and partial mediation, as proposed by Baron and Kenny, was not achieved.

Self-efficacy was found to be significantly associated with physical activity ($p = 0.02$) and foot care ($p = 0.02$), with larger self-efficacy scores associated with higher self-care performance levels. In the mediational model, diabetes-specific self-efficacy was significantly associated with physical activity with an observed decrease in magnitude for the *p*-value corresponding to depressive symptomatology. Nonetheless, the Sobel test confirmed that partial mediation was not achieved for the outcome measure of physical activity given the minor change in magnitude in the *p*-value for the construct of depression; not depicted in the tables, the Sobel test resulted in an associated *p*-value of 0.12. For the outcome measure of foot care, depressive symptomatology was no longer significant after the inclusion of diabetes-related self-efficacy, suggesting a significant mediational role via the construct of self-efficacy.

TABLE XV

STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR DIABETES SELF-CARE MEASURES REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9), WITH THE ADDITION OF DIABETES SELF-EFFICACY (DES-SF) IN THE MEDIATIONAL MODEL FOR THE AFRICAN AMERICAN SUBGROUP

Characteristics	General Diet (n = 128)	General Diet (Mediational Model) (n = 128)	Specific Diet (n = 128)	Specific Diet (Mediation Model) (n = 128)	Physical Activity (n = 128)	Physical Activity (Mediation Model) (n = 128)
Age	0.008*	0.008*	0.003	0.003	-0.010*	-0.010*
	(*p* = 0.04)	(*p* = 0.04)	(*p* = 0.49)	(*p* = 0.49)	(*p* = 0.03)	(*p* = 0.03)
Income						
≥ $20,000	1.00	1.00	1.00	1.00	1.00	1.00
< $20,000	-0.008	-0.010	0.028	0.028	0.092	0.089
	(*p* = 0.94)	(*p* = 0.93)	(*p* = 0.79)	(*p* = 0.80)	(*p* = 0.47)	(*p* = 0.48)
Don't know/Not Sure	-0.356	-0.301	-0.242	-0.218	0.209	0.291
	(*p* = 0.10)	(*p* = 0.16)	(*p* = 0.23)	(*p* = 0.28)	(*p* = 0.32)	(*p* = 0.17)
BMI	-0.003	-0.002	-0.001	-0.0009	-0.016*	-0.014
	(*p* = 0.69)	(*p* = 0.77)	(*p* = 0.85)	(p = 0.89)	(*p* = 0.03)	(p = 0.06)
Depressive symptoms	-0.032*	-0.029*	-0.020*	-0.019*	-0.046*	-0.042*
	(*p* = 0.0006)	(*p* = 0.002)	(p = 0.02)	(*p* = 0.04)	(*p* < 0.0001)	(*p* = 0.0002)
Self-Efficacy (DES-SF)	-----	0.132	-----	0.059	-----	0.207*
		(*p* = 0.09)		(*p* = 0.43)		(*p* = 0.02)

*$p < 0.05$.

TABLE XV (continued)

Characteristics	Glucose Self-Testing (n = 128)	Glucose Self-Testing (Mediation Model) (n = 128)	Foot Care (n = 128)	Foot Care (Mediation Model) (n = 128)
Age	-0.002 (*p* = 0.59)	-0.002 (*p* = 0.59)	-0.002 (*p* = 0.58)	-0.002 (*p* = 0.57)
Income				
≥ $20,000	1.00	1.00	1.00	1.00
< $20,000	0.181 (*p* = 0.08)	0.182 (*p* = 0.08)	0.096 (*p* = 0.33)	0.097 (*p* = 0.33)
Don't know/Not Sure	-0.503* (*p* = 0.02)	-0.488* (*p* = 0.03)	-0.215 (*p* = 0.23)	-0.14 (*p* = 0.42)
BMI	-0.006 (*p* = 0.37)	-0.005 (*p* = 0.39)	-0.002 (*p* = 0.77)	0.003 (p = 0.63)
Depressive symptoms	-0.020* (*p* = 0.01)	-0.020* (*p* = 0.02)	-0.013 (p = 0.09)	-0.010 (*p* = 0.22)
Self-Efficacy (DES-SF)	-----	0.035 (*p* = 0.62)	-----	0.163* (*p* = 0.02)

*$p < 0.05$.

3. **Mediational analysis by gender**

Conducted separately by gender, Step 1 of the mediational analysis (path c in Figure 3) revealed that depression was significantly associated with general diet ($p < 0.0001$), specific diet ($p = 0.03$), physical activity ($p = 0.0001$), and oral medication use ($p = 0.02$) for the male subsample (see Table XVI and XVII). Trends toward significance were further observed for the self-care behaviors of foot care ($p = 0.05$) and insulin use ($p = 0.07$). With the exception of the medication use variables, higher depression scores were associated with lower self-care engagement levels. For the female subsample, depressive symptomatology was inversely associated with specific diet ($p = 0.004$) and foot care ($p = 0.02$). Additionally, females with higher depression scores were more likely to self-identify as smokers ($p = 0.02$). In Step 2, for both the male and female subgroups, depression did not exhibit a direct main effect on self-efficacy after controlling for age, race/ethnicity, income, BMI, and insulin use (see Table XVIII). Because the required second step of the mediational analysis was not met for either subgroup, further mediational analyses stratified by gender were not attempted.

TABLE XVI

STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR DIABETES SELF-CARE MEASURES REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9), BY GENDER

	Male Subgroup				Female Subgroup		
Characteristics	General Diet (n = 76)	Specific Diet (n = 76)	Physical Activity (n = 76)	Foot Care (n = 76)	Specific Diet (n = 164)	Foot Care (n = 164)	Smoking[b] Status (n = 164)
Age	0.006 *(p = 0.26)*	0.005 *(p = 0.40)*	-0.002 *(p = 0.73)*	0.001 *(p = 0.81)*	0.002 *(p = 0.57)*	-0.0005 *(p = 0.87)*	0.046* *(p = 0.03)*
Race							
Latino	1.00	1.00	1.00	1.00	1.00	1.00	1.00
African American	-0.094 *(p = 0.47)*	0.139 *(p = 0.30)*	-0.250 *(p = 0.12)*	-0.196 *(p = 0.13)*	0.054 *(p = 0.53)*	-0.024 *(p = 0.77)*	0.422 *(p = 0.39)*
Income							
≥ $20,000	1.00	1.00	1.00	1.00	1.00	1.00	1.00
< $20,000	0.299* *(p = 0.04)*	0.09 *(p = 0.54)*	0.209 *(p = 0.24)*	0.235 *(p = 0.11)*	-0.024 *(p = 0.82)*	0.057 *(p = 0.57)*	-1.36 *(p = 0.09)*
Don't know/Not Sure	0.156 *(p = 0.40)*	-0.043 *(p = 0.82)*	0.235 *(p = 0.29)*	0.160 *(p = 0.39)*	-0.030 *(p = 0.82)*	0.083 *(p = 0.50)*	0.293 *(p = 0.78)*
BMI	-0.016 *(p = 0.13)*	-0.0003 *(p = 0.97)*	-0.023 *(p = 0.07)*	-0.005 *(p = 0.65)*	-0.009 *(p = 0.14)*	0.005 *(p = 0.32)*	0.090* *(p = 0.01)*
Depressive symptoms	-0.053* *(p < 0.0001)*	-0.025 *(p = 0.03)*	-0.058* *(p = 0.0001)*	-0.021 *(p = 0.05)*	-0.024* *(p = 0.004)*	-0.017* *(p = 0.02)*	-0.092* *(p = 0.02)*

*$p < 0.05$.

[b] The regression equation is modeling the probability of being a non-smoker.

TABLE XVII
STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR MEDICATION USE MEASURES REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9), BY GENDER

	Male Subgroup		Female Subgroup	
Characteristics	Oral Medication (n = 71)	Insulin (n = 39)	Oral Medication (n = 155)	Insulin (n = 78)
Age	0.010 ($p = 0.67$)	-0.023 ($p = 0.09$)	0.002 ($p = 0.925$)	-0.007 ($p = 0.682$)
Latino	1.00	1.00	1.00	1.00
African American	0.925 ($p = 0.24$)	0.276 ($p = 0.46$)	0.139 ($p = 0.795$)	0.089 ($p = 0.723$)
Income				
≥ $20,000	1.00	1.00	1.00	1.00
< $20,000	-1.49* ($p = 0.001$)	-0.616 ($p = 0.10$)	-0.541 ($p = 0.124$)	0.231 ($p = 0.640$)
Don’t know/Not Sure	-4.10* ($p < 0.0001$)	-0.424 ($p = 0.38$)	-0.073 ($p = 0.908$)	0.116 ($p = 0.800$)
BMI	0.334* ($p < 0.0001$)	-0.004 ($p = 0.91$)	0.002 ($p = 0.947$)	0.002 ($p = 0.940$)
Depressive symptoms	0.164* ($p = 0.02$)	0.033 ($p = 0.07$)	0.019 ($p = 0.590$)	-0.006 ($p = 0.784$)

*$p < 0.05$.

TABLE XVIII
STANDARDIZED REGRESSION WEIGHTS (P VALUES) FOR DIABETES SELF-EFFICACY REGRESSED ON COVARIATES AND DEPRESSIVE SYMPTOMS (PHQ-9), BY GENDER

	Self-efficacy Main effects model: *b* (SE)	
Depression Status	Male Subgroup (n = 76)	Female Subgroup (n = 164)
Univariate/ Unadjusted Model	-0.014 (0.013) p = 0.27	-0.019 (0.009) p = 0.04
Adjusted Model[a]	-0.010 (0.014) p = 0.45	-0.012 (0.010) p = 0.22

*$p < 0.05$.
[a] Adjusted for age, race/ethnicity, income, BMI, and insulin use.

C. **Aim 2: Longitudinal Effect of Baseline Depression on Diabetes Self-care Behavior and Glycemic Control**

Prior to using generalized estimating equations to examine the longitudinal effect of baseline depression on diabetes management (i.e., performance of self-care practices and glycemic control), independent sample t-test were conducted to compare mean self-care scores and glycemic control between the depressed and non-depressed subgroups, as identified at baseline, for the time points associated with baseline, 6-, 12-, and 18-months (see Table XIX).

TABLE XIX

INDEPENDENT SAMPLE T-TEST LONGITUDINALLY COMPARING DEPRESSED AND NON-DEPRESSED PATIENTS AS IDENTIFIED AT BASELINE[a]

Outcome	Baseline[b]	*p*	6-Month[c]	*p*	12-Month[d]	*p*	18-months[e]	*p*
General Diet								
Depressed	3.08 (2.2)	0.031*	3.35 (2.3)	0.004*	4.40 (2.4)	0.889	4.15 (1.7)	0.895
Non-depressed	3.81 (2.3)		4.52 (2.2)		4.46 (2.2)		4.08 (2.2)	
Specific Diet								
Depressed	3.13 (1.3)	< 0.0001*	3.96 (1.6)	0.102	3.93 (1.6)	0.076	3.94 (1.1)	0.033*
Non-depressed	4.22 (1.7)		4.41 (1.5)		4.52 (1.6)		4.57 (1.3)	
Physical Activity								
Depressed	2.31 (1.9)	0.406	3.21 (2.2)	0.877	2.86 (2.1)	0.977	2.73 (2.2)	0.337
Non-depressed	2.56 (2.2)		3.28 (2.5)		2.88 (2.4)		3.24 (2.3)	
Glucose Testing								
Depressed	3.69 (2.4)	0.783	4.45 (2.2)	0.418	4.74 (2.1)	0.207	3.79 (2.2)	0.793
Non-depressed	3.59 (2.8)		4.07 (2.8)		4.02 (2.8)		3.96 (2.8)	
Medication Adherence								
Insulin								
Depressed	4.16 (3.1)	0.069	6.11 (1.9)	0.618	6.06 (2.0)	0.549	5.69 (2.2)	0.567
Non-depressed	5.21 (2.8)		6.33 (1.9)		5.65 (2.5)		6.07 (2.1)	
Oral Medication								
Depressed	5.46 (2.6)	0.005*	5.72 (2.5)	0.023*	6.73 (0.87)	0.9427	5.65 (2.5)	0.184
Non-depressed	6.49 (1.6)		6.68 (1.3)		6.75 (1.1)		6.45 (1.6)	
Foot Care								
Depressed	4.31 (2.5)	0.387	4.43 (2.3)	0.075	5.19 (2.2)	0.212	4.35 (2.3)	0.170
Non-depressed	4.63 (2.5)		5.18 (2.4)		5.70 (1.9)		5.14 (2.4)	
A1c								
Depressed	8.80 (2.7)	0.394	9.06 (2.5)	0.0092*	8.73 (2.5)	0.194	8.75 (2.7)	0.190
Non-Depressed	8.51 (2.2)		8.12 (2.0)		8.17 (2.1)		8.04 (2.2)	

*$p < 0.05$.

[a] Data are means ± SD.

[b] Sample Size: General Diet, Specific Diet, Physical Activity, Glucose Testing, and Foot Care—Depressed = 62, Non-depressed = 188; Insulin—Depressed = 37, Non-depressed = 86; Oral Medication—Depressed = 59, Non-depressed = 177; A1c—Depressed = 62, Non-depressed = 187.

[c] Sample Size: General Diet, Specific Diet, Physical Activity, Glucose Testing, and Foot Care —Depressed = 42, Non-depressed = 123; Insulin—Depressed = 27, Non-depressed = 51; Oral Medication—Depressed = 39, Non-depressed = 114; A1c—Depressed = 47, Non-depressed = 150.

[d] Sample Size: General Diet, Specific Diet, Physical Activity, Glucose Testing, and Foot Care —Depressed = 29, Non-depressed = 101; Insulin—Depressed = 17, Non-depressed = 46; Oral Medication—Depressed = 26, Non-depressed = 95; A1c—Depressed = 33, Non-depressed = 117.

[e] Sample Size: General Diet, Specific Diet, Physical Activity, Glucose Testing, and Foot Care —Depressed = 24, Non-depressed = 69; Insulin—Depressed = 16, Non-depressed = 28; Oral Medication—Depressed = 20, Non-depressed = 64; A1c—Depressed = 22, Non-depressed = 81.

As previously identified, participants with PHQ-9 greater than or equal to 10 were categorized as depressed. Across time, statistically significant differences for patients with and without baseline depression were only evident for the self-care behaviors of diet (i.e., general and specific diet) and oral medication use. Those with self-identified symptoms of depression at baseline were less likely to engage in the self-care behavior associated with general diet at baseline (p = 0.031) and 6-months (p = 0.004), with these differences no longer apparent at 12- and 18-months. Likewise, the non-depressed subgroup reported a greater number of days of adherence with the self-care activity of specific diet (e.g., fruit and vegetable consumption) at baseline (p < 0.0001), with reemergence of significance at the 18-month (p = 0.033) follow-up time point. For the self-care practice of oral medication use, significant differences between participants with and without baseline depression were present at baseline (p = 0.005) and 6-months (p = 0.023), with this significant difference disappearing after 12-months; again, participants without depression reported higher self-care scores for oral medication/pill use. Finally, differences in glycemic control (i.e., A1c) were observed only for the 6-month assessment time point (p = 0.009) with non-depressed participants displaying a significantly lower A1c value (8.12 vs. 9.06).

To further inform the bivariate analyses described above, GEE were used to examine change in diabetes self-management across time to identify significant differences by baseline depressions status. Separate GEE methods were used for each of the self-management measures (e.g., general diet, physical activity, A1c, etc.) to estimate the contrast between depressed and non-depressed subgroups at 6-, 12-, and 18-months. Longitudinal results of diabetes self-management at 6-, 12-, and 18-months using GEE analysis are presented in Table XX. For the adjusted model, significant between-group differences for the baseline depressed and non-depressed subgroups were evident for the behaviors associated with a healthy diet. Specifically, at 6- (p = 0.001) and 18-months (p = 0.04), compared to those without baseline depression, person exhibiting baseline depression engaged in fewer days per week of the behavior associated with general diet (i.e., following a healthful eating plan). For the self-care behavior of specific diet (i.e., fruit and vegetable consumption and decreased high-fat food consumption), between-group differences were observed at 6- (p = 0.05) and 12-months (p=0.008), with attenuation of this difference at 18-months. The remaining self-management factors did not reveal significant (i.e., $p < 0.5$) differences in adherence levels between depressed and non-depressed at any of the follow-up time points.

Although GEE is the preferred statistical method for longitudinal data analysis as it uses all non-missing pairs of data in the estimates, it does have limitations. Thus retention analyses were conducted, as differential program attrition by depressions status was possible. Logistic regression techniques and the Log-Rank test were used to determine whether depressive symptomatology was associated with overall attrition at 6-, 12-, and 18-months. Retention analyses revealed that participants enrolled in the diabetes self-management intervention (i.e., RCT titled "*Diabetes Self-Management in Minorities*") were not more likely to drop-out if at baseline they were identified as depressed (i.e., PHQ-9 greater than or equal to 10).

TABLE XX

ESTIMATES OF THE CONTRAST BETWEEN DEPRESSED AND NONDEPRESSED AT BASELINE WITH OUTCOMES AT EACH FOLLOW-UP TIME POINT ADJUSTED FOR BASELINE VALUE USING GEE

Outcome	Follow-up time	Unadjusted model			Adjusted model*		
		PR[a]/Mean difference	95%CI	*p*	PR/Mean difference	95%CI	*p*
General Diet[b]	Depressed at baseline-Non-depressed—6m	**0.70**	**(0.57, 0.86)**	**0.0006**	**0.67**	**(0.53, 0.85)**	**0.001**
	Depressed at baseline-Non-depressed—12m	**0.81**	**(0.66, 0.99)**	**0.04**	0.88	(0.73, 1.07)	0.21
	Depressed at baseline-Non-depressed—18m	**0.73**	**(0.55, 0.96)**	**0.03**	**0.68**	**(0.48, 0.98)**	**0.04**
Specific Diet[b]	Depressed at baseline-Non-depressed—6m	**0.85**	**(0.75, 0.97)**	**0.02**	0.86	(0.75, 1.00)	0.05
	Depressed at baseline-Non-depressed—12m	**0.77**	**(0.67, 0.89)**	**0.0003**	**0.77**	**(0.66, 0.90)**	**0.0008**
	Depressed at baseline-Non-depressed—18m	0.93	(0.81, 1.05)	0.24	0.91	(0.77, 1.08)	0.26
Physical Activity[b]	Depressed at baseline-Non-depressed—6m	1.11	(0.89, 1.38)	0.37	0.94	(0.72, 1.23)	0.66
	Depressed at baseline-Non-depressed—12m	0.94	(0.65, 1.35)	0.72	0.95	(0.62, 1.44)	0.79
	Depressed at baseline-Non-depressed—18m	0.82	(0.54, 1.27)	0.38	0.83	(0.50, 1.36)	0.45
Glucose Self-Testing[b]	Depressed at baseline-Non-depressed—6m	1.11	(0.94, 1.32)	0.23	1.08	(0.90, 1.30)	0.40
	Depressed at baseline-Non-depressed—12m	0.97	(0.78, 1.21)	0.80	1.01	(0.78, 1.30)	0.95
	Depressed at baseline-Non-depressed—18m	0.96	(0.68, 1.36)	0.82	0.92	(0.60, 1.42)	0.72
Insulin[c]	Depressed at baseline-Non-depressed—6m	1.00	(0.88, 1.14)	0.98	1.04	(0.91,1.19)	0.54
	Depressed at baseline-Non-depressed—12m	**1.18**	**(1.05, 1.33)**	**0.007**	1.17	(0.99, 1.36)	0.05
	Depressed at baseline-Non-depressed—18m	0.92	(0.72, 1.16)	0.47	1.08	(0.87, 1.35)	0.48
Oral Medication/Pills[d]	Depressed at baseline-Non-depressed—6m	0.88	(0.77, 1.00)	0.05	0.94	(0.82, 1.07)	0.34
	Depressed at baseline-Non-depressed—12m	0.99	(0.91, 1.08)	0.87	1.10	(0.99, 1.22)	0.09
	Depressed at baseline-Non-depressed—18m	0.87	(0.67, 1.13)	0.31	0.93	(0.64, 1.36)	0.71
Foot Care[b]	Depressed at baseline-Non-depressed—6m	0.95	(0.81, 1.10)	0.49	0.97	(0.82, 1.15)	0.73
	Depressed at baseline-Non-depressed—12m	0.88	(0.75, 1.04)	0.12	0.95	(0.81, 1.10)	0.48
	Depressed at baseline-Non-depressed—18m	0.85	(0.67, 1.09)	0.20	0.90	(0.67, 1.21)	0.49
A1c[e]	Depressed at baseline-Non-depressed—6m	0.46	(-0.29, 1.21)	0.23	-0.14	(-0.95, 0.67)	0.74
	Depressed at baseline-Non-depressed—12m	0.35	(-0.41, 1.10)	0.37	0.24	(-0.54, 1.02)	0.55
	Depressed at baseline-Non-depressed—18m	0.72	(-0.24, 1.67)	0.14	0.59	(-0.37, 1.56)	0.23

*Due to the difference between depressed and nondepressed at baseline, we subtracted baseline value from each follow-up estimate, and adjusted model controlled for age, race/ethnicity, income, BMI, and intervention assignment.

[a] PR = Proportional.

[b] Sample Size: Unadjusted—Number of observations Used = 404, Number of Subjects = 196; Adjusted—Number of observations Used = 295, Number of Subjects = 142.

[c] Sample Size: Unadjusted—Number of observations Used = 196, Number of Subjects = 196; Adjusted—Number of observations Used = 139, Number of Subjects = 142.

[d] Sample Size: Unadjusted—Number of observations Used = 374, Number of Subjects = 196; Adjusted—Number of observations Used = 277, Number of Subjects = 142.

[e] Sample Size: Unadjusted—Number of observations Used = 348, Number of Subjects = 196; Adjusted—Number of observations Used = 263, Number of Subjects = 142.

The next set of longitudinal analyses examining the relationship between depression and diabetes self-management treated the main predictor of interest (i.e., depressive symptomatology) as a continuous measure with a scale ranging from 0 to 27. Given a uniform within-subject correlation, a compound symmetry correlation structure was specified. Longitudinal results for the standard GEE analyses are presented in Table XXI. Across time, in both the univariate and multivariate models, depression was only significantly associated with the outcome measure of specific diet. The positive association suggests that higher depression scores are longitudinally associated with higher performance levels of the behavior associated with specific diet (e.g., fruit and vegetable consumption). Although standardization was not achieved for the self-care behaviors with a Poisson distribution, this result should be interpreted with caution as the magnitude of the coefficient estimate is negligible and the lower boundary of the 95% confidence interval approximates a value of zero.

TABLE XXI
STANDARD GEE MODEL EXAMINING THE RELATIONSHIP BETWEEN DEPRESSIVE SYMPTOMS AND DIABETES SELF-MANAGEMENT[a]

Outcome variable	Univariable Analyses B (95%CI)	Multivariable Analyses** B (95%CI)
General Diet[b]	0.0008 (-0.0004; 0.0021)	0.0009 (-0.0004; 0.0022)
Specific Diet[b]	0.0007* (0.0001; 0.0013)	0.0007* (0.0001; 0.0013)
Physical Activity[b]	-0.0005 (-0.0022; 0.0012)	-0.0005 (-0.0023; 0.0013)
Glucose Self-testing[b]	0.0003 (-0.0010; 0.0016)	0.0003 (-0.0010; 0.0015)
Medication Adherence		
Insulin[c]	0.0011 (-0.0002; 0.0024)	0.0008 (-0.0006; 0.0021)
Oral Medication/Pills[d]	0.0006 (-0.0001; 0.0014)	0.0008 (0; 0.0015)
Foot Care[b]	-0.0002 (-0.0010; 0.0006)	-0.0003 (-0.0012; 0.0005)
Smoking[b]	0 (-0.0022; 0.0023)	-0.0005 (-0.0023; 0.0014)
A1c[e]	6.22E-7 (-3.87E-6; 5.11E-6)	1.50E-7 (-4.94E-6; 5.24E-6)

*p < .05
**Multivariate models adjusted for age, race/ethnicity, income, BMI, and intervention assignment.
[a] Depression, as measured by the PHQ-9, was the main predictor of interest in the GEE models, and standardization of the β coefficient was only accomplished for A1c as it was the only outcome variable with a normal distribution.
[b] Sample Size: Univariate—Number of observations Used = 654, Number of Subjects = 256; Multivariable—Number of observations Used = 620, Number of Subjects = 241.
[c] Sample Size: Univariate—Number of observations Used = 319, Number of Subjects = 256; Multivariable—Number of observations Used = 298, Number of Subjects = 241.
[d] Sample Size: Univariate—Number of observations Used = 610, Number of Subjects = 256; Multivariable—Number of observations Used = 578, Number of Subjects = 241.
[e] Sample Size: Univariate—Number of observations Used = 597, Number of Subjects = 256; Multivariable—Number of observations Used = 567, Number of Subjects = 241.

Univariate and multivariate modeling of changes across adjacent time points revealed that changes in depressive symptomatology were predictive of changes in diabetes self-care practices across time (see Table XXII). Specifically, in the univariate model, increases in depression score were accompanied by reductions in the performance of the self-care behaviors associated general diet ($p = 0.08$), specific diet ($p = 0.04$), and physical exercise ($p = 0.02$). In the multivariate model, after adjusting for age, race/ethnicity, income, BMI, and intervention assignment, changes in depression level were only associated with changes in specific diet (p =

0.05) and physical exercise (p = 0.02). As before, diet and physical activity performance levels diminished with mental health declines in the form of increased symptoms of depression.

TABLE XXII
STANDARD GEE MODEL EXAMINING THE RELATIONSHIP BETWEEN **C**H**ANG**E I**N** DEPRESSION LEVEL AND DIABETES SELF-MANAGEMENT[a]

Change in Outcome variable	Univariable Analyses B (95%CI)	Multivariable Analyses[b] B (95%CI)
Change in General Diet[c]	-0.063* (-0.134; 0.0.007)	-0.056 (-0.129; 0.017)
Change in Specific Diet[c]	-0.036** (-0.070; -0.0009)	-0.037* (-0.074; 0.0006)
Change in Physical Activity[c]	-0.067** (-0.123; -0.010)	-0.070** (-0.129; -0.010)
Change in Glucose Testing[c]	-0.034 (-0.085; 0.018)	-0.036 (-0.090; 0.018)
Change in Medication Adherence		
Insulin[d]	-0.037 (-0.118; 0.045)	-0.016 (-0.085; 0.054)
Oral Medication/Pills[e]	0.013 (-0.054; 0.080)	0.012 (-0.055; 0.080)
Change in Foot Care[c]	-0.025 (-0.070; 0.018)	-0.030 (-0.077; 0.018)
Change in Smoking[c]	-0.001 (-0.004; 0.001)	-0.003 (-0.008; 0.002)
Change in A1c[f]	-0.000092 (-0.00077; 0.00095)	-1.01E-6 (-0.0009; 0.0009)

*p < 0.10.
**p < 0.05.
[a] Standardization of the β coefficient was only accomplished for A1c as it was the only outcome variable with a normal distribution.
[b] Multivariate models adjusted for age, race/ethnicity, income, BMI, and intervention assignment.
[c] Sample Size: Univariate—Number of observations Used = 649, Number of Subjects = 276; Multivariable—Number of observations Used = 597, Number of Subjects = 243.
[d] Sample Size: Univariate—Number of observations Used = 429, Number of Subjects = 276; Multivariable—Number of observations Used = 388, Number of Subjects = 243.
[e] Sample Size: Univariate—Number of observations Used = 611, Number of Subjects = 276; Multivariable—Number of observations Used = 562, Number of Subjects = 243.
[f] Sample Size: Univariate—Number of observations Used = 594, Number of Subjects = 276; Multivariable—Number of observations Used = 545, Number of Subjects = 243.

D. Aim 3: Longitudinal Predictors of Change in Depressive Symptomatology Scores

The final aim of the current study was to identify the longitudinal predictors of depression in a sample of African American and Latino patients with T2D. The predictors consisted of both mutable and non-mutable factors, as follows: (1) socio-demographic characteristics; (2) family history; (2) healthcare access; (3) disease-related factors (i.e., medication type and length of diabetes diagnosis); (4) self-care performance levels; (5) biomedical variables (i.e., glycemic control and BMI); and (6) psychological constructs (i.e., diabetes-related distress and diabetes self-efficacy). This analysis utilized GEE. A backward selection procedure was used to identify the subset of factors that best predicted depression across time. As before, two models were considered, the standard GEE model and one examining whether change in the non-fixed predictor variables was associated with changes in depressive symptoms across adjacent time points. As before, given the uniform within-subject correlation, a 'compound symmetry' correlation structure was used with both GEE models.

Table XXIII presents the univariate and multivariate results for the standard GEE model. In the univariate models, the outcome variable of depression was not longitudinally associated with any of the socio-demographic or biopsychosocial predictor variables included in the analyses. After the backward selection method, the multivariate analysis identified intervention assignment as the only predictor associated with depressive symptomatology across time (standardized regression coefficient $\beta = 0.001$, $p = 0.042$). The positive beta coefficient suggests that assignment into the treatment group was longitudinally associated with higher depression scores when compared to those in the enhanced control group.

In the univariate GEE change models, the factors found to be predictive of change in depressive symptomatology across time included the following: BMI, performance levels for specific diet and physical activity, diabetes-related self-efficacy, and diabetes distress (see Table XXIV). When considering the independent effects of the continuous predictor variables, interpretation of these results suggests that improvements in depression scores were a result of increased BMI, better self-care adherence (i.e., specific diet and physical exercise), and increased diabetes-related self-efficacy scores. Furthermore, longitudinal increases in diabetes-related distress were accompanied by mental health deterioration in the form of increased symptoms of depression.

The multivariate model offers more compelling information. Employing the backward selection procedure, the final multivariate prediction model consisted of the independent variables of intervention assignment (standardized regression coefficient $\beta = 0.047$, $p = 0.041$), diabetes-related self-efficacy (standardized regression coefficient $\beta = -0.048$, $p = 0.08$), and diabetes distress (standardized regression coefficient $\beta = 0.114$, $p < 0.0001$). First, the results suggest that participants randomized into the treatment group are more likely to see increases in depression scores across adjacent time points when compared to the control group (i.e., enhanced TAU). For the continuous independent variables, increased diabetes-related self-efficacy scores and decreased diabetes distress levels best predicted improvements in depressive symptomatology across time.

TABLE XXIII

STANDARD GEE MODEL FOR THE UNIVARIATE AND MULTIVARIATE ANALYSIS OF THE LONGITUDINAL ASSOCIATION OF SOCIO-DEMOGRAPHIC AND BIOPSYCHOSOCIAL VARIABLES AND DEPRESSIVE SYMPTOMATOLOGY

Predictor variable	Univariable Analyses β (95%CI)	Multivariable Analyses[a] β (95%CI)
Demographics		
Age	-2.63E-7 (-1.38E-6; 8.52E-7)	
Female	-0.0004 (-0.001; 0.0006)	
Race/Ethnicity		
African American	0.0001 (-0.0007; 0.0009)	
Latino	1.00	
Marital Status		
Married	0.0002 (-0.0009; 0.001)	
Never Married	0.00009 (-0.001; 0.001)	
Other	1.00	
Education		
< High School	0.0001 (-0.0009; 0.001)	
High School Graduate	-0.001 (-0.003; 0.0003)	
> High School	1.00	
Income		
Less than $20,000	-0.0002 (-0.001; 0.0008)	
More than $20,000	1.00	
Employment		
Currently Employed	-0.001 (-0.003; 0.001)	
Other	-0.002 (-0.004; 0.0001)	
Unemployed	1.00	
Family History/Access		
Household w/ Diabetes		
None	0.0003 (-0.0005; 0.001)	
One	1.00	
More than one	-0.0002 (-0.001; 0.002)	
Health Insurance		
Yes	1.00	
No	0.0005 (-0.0002; 0.001)	
Biomedical Variables		
BMI	-1.26E-6 (-6.36E-6; 3.85E-6)	
Glycemic Control (A1c)	-0.00003 (-0.00007; 7.32E-6)	

*p < 0.10.
**p < 0.05.
[a] Final Sample Size for Multivariable Model—Number of observations Used = 504, Number of Subjects = 193.

TABLE XXIII (continued)

Predictor variable	Univariable Analyses β (95%CI)	Multivariable Analyses[a] β (95%CI)
Disease-related Factors		
Length of Diabetes	-2.62E-6 (-8.23E-6; 2.99E-6)	
Insulin Regimen		
No	0.0001 (-0.0008; 0.001)	
Yes	1.00	
Diabetes Self-Care Behavior		
General Diet	3.62E-6 (-0.0004; 0.00005)	
Specific Diet	0.00004 (-0.00004; 0.0001)	
Physical Activity	0.00003 (-0.00001; 0.00008)	
Glucose Self-testing	2.45E-6 (-0.00002; 0.00003)	
Medication Adherence		
Insulin	0.00006 (-0.00007; 0.0002)	
Oral Medication/ Pills	0.00003 (-0.00005; 0.0001)	
Foot Care	-4.72E-6 (-0.00004; 0.00003)	
Smoking Status	0.0003 (-0.001; 0.002)	
Self-efficacy	-0.0001 (-0.0008; 0.0006)	
Diabetes Distress	-0.00001 (-.0003; 0.0002)	
Treatment Group	0.0006 (-0.0002; 0.001)	0.001* (0.00005; 0.003)

*p < 0.10.
**p < 0.05.
[a] Final Sample Size for Multivariable Model—Number of observations Used = 504, Number of Subjects = 193.

TABLE XXIV
GEE CHANGE MODEL FOR THE UNIVARIATE AND MULTIVARIATE ANALYSIS OF THE LONGITUDINAL ASSOCIATION OF SOCIO-DEMOGRAPHIC AND BIOPSYCHOSOCIAL VARIABLES AND DEPRESSIVE SYMPTOMATOLOGY

Predictor variable	Univariable Analyses β (95%CI)	Multivariable Analyses[a] β (95%CI)
Demographics		
Age	4.90E-6 (-0.00007; 0.00008)	
Female	-0.012 (-0.068; 0.044)	
Race/Ethnicity		
African American	0.004 (-0.044; 0.052)	
Latino	1.00	
Marital Status		
Married	0.020 (-0.047; 0.086)	
Never Married	0.021 (-0.044; 0.087)	
Other	1.00	
Education		
< High School	0.018 (-0.038; 0.074)	
High School Graduate	-0.091 (-0.189; 0.007)	
> High School	1.00	
Income		
Less than $20,000	0.002 (-0.054; 0.058)	
More than $20,000	1.00	
Employment		
Currently Employed	-0.063 (-0.178; 0.053)	
Other	-0.102 (-0.221; 0.018)	
Unemployed	1.00	
Family History/Access		
Household w/ Diabetes		
None	0.011 (-0.037; 0.058)	
One	1.00	
More than one	0.006 (-0.086; 0.098)	
Health Insurance		
Yes	1.00	
No	0.025 (-0.020; 0.069)	
Biomedical Variables		
BMI	-0.007** (-0.012; -0.001)	
Glycemic Control (A1c)	0.001 (-0.007; 0.009)	

* $p < 0.10$.
**$p < 0.05$.
[a] Final Sample Size for Multivariable Model—Number of observations Used = 360, Number of Subjects = 176.

TABLE XXIV (continued)

Predictor variable	Univariable Analyses β (95%CI)	Multivariable Analyses[a] β (95%CI)
Disease-related Factors		
Length of Diabetes	-2.26E-6 (-0.0003; 0.0003)	
Insulin Regimen		
No	0.010 (-0.040; 0.060)	
Yes	1.00	
Diabetes Self-Care Behavior		
General Diet	-0.006 (-0.014; 0.001)	
Specific Diet	-0.009** (-0.016; -0.0009)	
Physical Activity	-0.006** (-0.011; -0.001)	
Glucose Self-testing	-0.002 (-0.006; 0.002)	
Medication Adherence		
Insulin	-0.006 (-0.019; 0.007)	
Oral Medication/ Pills	0.004 (-0.014; 0.021)	
Foot Care	-0.002 (-0.007; 0.002)	
Smoking Status	-0.499 (-1.22; 0.219)	
Self-efficacy	-0.070** (-0.124; -0.016)	-0.048* (-0.102; 0.006)
Diabetes Distress	0.117** (0.079; 0.155)	0.114** (0.076; 0.152)
Treatment Group	0.042 (-0.005; 0.089)	0.046** (0.002; 0.091)

* $p < 0.10$.
**$p < 0.05$.
[a] Final Sample Size for Multivariable Model—Number of observations Used = 360, Number of Subjects = 176.

VI. DISCUSSION

The current study included a clinical sample of African American and Latino patients with T2D recruited from federally qualified health centers in Chicago. In general, this cohort was of low socioeconomic status with 60% reporting less than a high school education and 74% earning less than $20,000 per year. Lower than expected for these racial/ethnic minority subgroups with diabetes, but still well above the rates expected for the general U.S. population, 24.8% were considered to have moderate to severe depression (i.e., probable clinical depression). Performance of the diabetes regimen behaviors showed considerable range from as low as 2.5 days/week for physical activity to as high as 6.2 days/week for oral medication/pill use. The overall objective of this study was to examine the longitudinal association between diabetes self-efficacy, depression, and diabetes self-management. What follows is a discussion of the findings and how they fit into our current knowledge and how they may inform future research in this topic area.

Before presenting a detailed discussion of the results acquired for each study aim, what follows is an exploration of how the results map onto the guiding framework previously presented (see Figure 1, page 15). The current study was theoretically guided via integration of concepts from the SCT and Peyrot's biopsychosocial model (see Figure 1). First, the framework proposes that depression affects glycemic control via a direct pathway through its effects on physiology and indirectly by diminishing self-care practices. Integrating the SCT, the construct of self-efficacy is identified as a mediator in the association between depression and self-care practices. Second, a bidirectional relationship between depression and diabetes self-management is proposed as PGC and low engagement in self-care practices are hypothesized to increase depressive symptoms. Additional factors in the theoretical framework identified as influencing symptoms of depression include socio-demographic characteristics, diabetes-related self-efficacy, and diabetes distress.

Study results support the associations identified in the theoretical framework used to guide the current study. Specifically, depressive symptoms were longitudinally associated with the non-disease-specific health behaviors of diet and physical exercise. Second, and although only true for the African American subpopulation, self-efficacy was an important construct in the relational pathway between depression and diabetes self-care. Finally, multivariate GEE models revealed diabetes-related self-efficacy and diabetes distress as longitudinal predictors of depression. The utility of the theoretical framework justifies its continued use when attempting to conceptualize the relationship between depression, diabetes-related self-efficacy, and diabetes self-management. A more detailed discussion follows.

A. Mediational Effect of Diabetes-related Self-Efficacy

First, a cross-sectional exploration was conducted on the potential mediating role of self-efficacy in the relationship between depressive symptomatology and engagement levels in diabetes self-care. The first stage of the mediational analysis revealed that higher depression scores were associated with lower engagement level in the self-care activities of general diet, specific diet, physical activity, and foot care. Those with higher depression scores were also more likely to self-identify as smokers. This cross-sectional finding using baseline data is consistent with prior research that has linked comorbid depression and diabetes to lower self-care performance levels. Multiple studies with and without inclusion of racial/ethnic minority subsamples with type 1 and/or 2 diabetes have produced robust evidence documenting an inverse relationship between depressive symptomatology and the performance of self-care activities, with higher depression scores associated with lower diabetes regimen adherence levels (Chao, Nau, Aikens, & Taylor, 2005; Ciechanowski et al., 2000; Egede & Ellis, 2008; Gonzales et al., 2007; Lerman et al., 2004; Lerman et al., 2009; Osborn & Egede, 2012; Park, Hong, Lee, Ha, & Sung, 2004). For example, in a cross-sectional study that included 201 patients with T2D, those with clinically significant levels of depression reported lower levels of self-care adherence when compared to their non-depressed counterparts (Egede & Ellis, 2008).

The second stage of the mediational analysis examined the association between self-efficacy and depressive symptomatology. For the sample as a whole, after inclusion of relevant covariates, diabetes-related self-efficacy was not significantly associated with depression. This finding, which negated further mediational testing on the sample as a whole, is inconsistent with available research that links depression to compromised diabetes-related self-efficacy scores in clinical patients with diabetes (Chao, Nau, Aikens, & Taylor, 2005; Johnson, 1996). For instance, after reviewing the evidence on the predictive ability of self-efficacy on performance of self-care behaviors, Johnson (1996) argues for the use of a self-efficacy theoretical framework when delivering diabetes education. More recent studies support these findings (Al-Khawaldeh, Al-Hassan, & Froelicher, 2012). Given the lack of association between diabetes-related self-efficacy and depressive symptomatology for the total sample in this study, self-efficacy does not appear be a mediator in the relationship between depressive symptoms and diabetes self-care practices when jointly considering the African American and Latino subpopulations. Although preliminary, these findings suggest that researchers may consider alternate factors (e.g., social support, decreased levels of attention and memory, etc.). On the other hand, measurement error and/or low instrument validity may have masked the direct effect of diabetes-related self-efficacy on diabetes self-care. Prior research provides evidence that may help elucidate the absence of a mediational effect via self-efficacy, and these are explored below.

It is possible that relevant constructs in the causal pathway between depression and diabetes self-care were not included as part of the original RCT. For instance, the constructs of social support and outcome efficacy were not included in the current study. These interpersonal constructs may play important roles in the relational mechanism linking depression and diabetes self-care. Egede and Osborn (2010) found social motivation to mediate the relationship between depressive symptoms and diabetes self-care performance levels; note that the construct of social motivation captured four domains of perceived functional social support (i.e., emotional/informational, tangible, positive social interaction, and affection). Although the authors do not offer an explanation as to why social support mediates the association between depression and diabetes self-care, one can hypothesize that individuals with comorbid depression and T2D are less likely to solicit and receive the interpersonal support needed to effectively engage in the often-complex diabetes self-care regimen. Interpersonal support can derive from multiple levels and sources including family, friends, healthcare providers, and the community. The role that social support plays in promoting healthy behavior adherence may be particularly significant in the African American and Latino cultures where familialism and family cohesion are predominant (Marin, 1993; Sabogal, Marin, Otero-Sabogal, VanOss Marin, & Perez- Stable, 1987).

Other potential mediators not captured as part of the original RCT are related to constructs within the Health Belief Model (HBM) (e.g., perceived benefits, barriers, and severity). Chao, Nau, Aikens, and Taylor (2005) explored the mediational role of patient's diabetes-specific health beliefs in the relationship between depression and medication adherence.

The authors found that the effect of depression on medication adherence was indirect via perceived barriers and diabetes-specific self-efficacy. The barriers captured, involved perceived medication-related side effects and emotional/cognitive barriers associated with medication use. Patients with comorbid depression were more likely to report side effect-related barriers, emotional and cognitive barriers, and lower self-efficacy scores. These self-perceptions in turn lead to lower self-care performance levels.

It could also be argued that self-efficacy, the key mediational factor, was not properly conceptualized and/or captured in the current study. Multiple tools with convincing psychometric testing are available when measuring the construct of diabetes-related self-efficacy (e.g., Perceived Diabetes Self-Management Scale (PDSMS); The Diabetes Management Self-Efficacy Scale (DMSES); The Self-efficacy Questionnaire (SEQ); Kavookjian's self-efficacy confidence scale; and the self-efficacy subscale of the Multidimensional Diabetes Questionnaire). However, there does not seem to be agreement as to the most effective measurement tool. Additionally, there is lack of agreement as to the proper scoring mechanism and whether measures of self-efficacy should involve the use of subscales for each of the treatment recommendations (e.g., medication-specific self-efficacy, diet-specific self-efficacy, exercise-specific self-efficacy, etc.). Some researchers have argued that self-efficacy is a behavior-specific construct that needs to be measured separately for each of the self-care behaviors that are part of the recommended diabetes regimen (Mishali, Omer, & Heymann, 2011). Thus, it is possible that the DES-SF is not the appropriate tool when attempting to measure the construct of diabetes-related self-efficacy, particularly in the context of predicting adherence to the diabetes regimen.

In spite of the above discussion and the inherent issues when attempting to measure the construct of diabetes-related self-efficacy, self-efficacy as measured using the DES-SF was found to mediate the relationship between depression and foot care in the African American subgroup. Mediational testing was possible as self-efficacy and depression were significantly associated in this subpopulation. After adjusting for the covariates, when diabetes self-efficacy was regressed on depressive symptoms, a significant association was observed for the African American subpopulation only. It is possible that ethnic and/or cultural factors lead to differential manifestations of psychosocial constructs and to their subsequent divergent effects on feelings of confidence and mastery. Below, two potential hypotheses for the racial/ethnic differences encountered are explored.

First, both quantitative and qualitative studies have documented the notion/concept of fatalism in the Latino community in relation to chronic illness management (Baquet & Hunter, 1995; Falicov, 1996; Quatromoni, Milbauer, Posner, Carballeira, Brunt, Chipkin, 1994). Fatalism is defined as, “a doctrine that events are fixed in advance so that human beings are powerless to change them” (Merriam-Webster, 2012). During the development of a valid and reliable instrument to capture the health beliefs and attitudes of low-income Mexican Americans with diabetes, factor analysis revealed the need to capture the construct of fatalism (Schwab, Meyer, & Merrell, 1994). The authors argue that its inclusion increased the cultural sensitivity of the instrument as many individuals in this subpopulation endorsed items associated with feelings of powerlessness and hopelessness (e.g., No matter what I do, I cannot control my diabetes). Qualitative research has also repeatedly documented fatalistic attitudes toward the development and progression of diabetes among Latinos, as the performance of self-care behaviors (e.g., physical exercise, healthy eating) is not thought to attenuate or prevent diabetes-related complications (Quatromoni et al., 1994). An intrinsic belief that illness management is outside of the individual locus of control may serve to attenuate the negative effects triggered by symptoms of depression. In effect, it is possible that fatalistic beliefs in that diabetes and its complications are inevitable, may result in an overall reduction in confidence in the performance of diabetes self-management behaviors over and above that produced by depression and its associated symptoms. This is a reasonable hypothesis as high scores of diabetes-related fatalism have been associated with more self-care adherence problems (Egede & Ellis, 2010).

Although not empirically supported, it is also possible that depression is more intricately tied to self-efficacy in the African American subgroup, if Latinos with literacy and language barriers already experience deteriorations in self-confidence beyond the additive effect brought about by symptoms of depression. Approximately 85% of the Latino subsample in the current study reported less than a high school education, and health literacy scores for this group indicated marginal functional health literacy. However, health literacy scores may have been overestimated. Latinos unable to take the 7-minute timed test due to low levels of literacy (e.g., inability to read and/or write) were treated as missing data observations, increasing the potential for inflated health literacy scores in this subgroup. Documentation of the relationship between health literacy and self-efficacy is available. The literature on hormone therapy has documented a positive association between health literacy and self-efficacy, with mean self-efficacy scores of 22.95 and 22.49 for those with marginal and inadequate health literacy, and a mean score of 34.42 for those with adequate scores (Torres & Marks, 2009). Possible scores for the self-efficacy scale ranged from 0 to 44, and it captured a women's confidence in making decisions as they pertain to a hormone therapy regimen. Similar results have been obtained when examining colorectal cancer screening behaviors. Among a sample of ninety-six older adults, those with low health literacy scores reported less information-seeking behavior, and were less likely to feel confident in their ability to participate in a colorectal screening (von Wagner, Semmler, &

Wardle, 2009). Less is known about the association between health literacy and self-efficacy in patients with diabetes. But evidence from diverse fields supports the hypothesis that health literacy has the potential to affect confidence in the performance of diabetes self-management behaviors. For instance, regardless of depression status, Latino patients with low literacy levels may have diminished medication-specific self-efficacy if they are unable to read the medication label, even if available in their own language. Finally, unlike their African American counterparts, Latino immigrants are more likely to experience language barriers due to limited English proficiency (LEP). Challenges associated with LEP include reduced effectiveness in the use of health information, multiple barriers when attempting to navigate the health service system, and the mandatory need of interpretation services when attempting to communicate with non-Spanish speaking health providers. It is therefore hypothesized that barriers associated with low literacy and LEP all have the potential to reduce confidence in the ability to self-manage a chronic illness, over and beyond the potential contributions of depressive symptoms.

B. Longitudinal Effects of Baseline Depression on Diabetes Self-management

The second aim was to examine the longitudinal relationship between depression and diabetes self-management (i.e., performance levels of diabetes self-care behaviors and glycemic control) among African Americans and Latinos with T2D. The construct of depression was first treated as a dichotomous variable categorizing people into depressed and non-depressed subgroups. This was followed by treatment of depressive symptomatology as a continuous variable with scores ranging on a defined scale (i.e., 0–27). Because these longitudinal models differentially treated the construct of depression, they offer distinct but compatible evidence to further understand the phenomenon of interest. The results suggest that presence of depressive symptomatology does not longitudinally impede improvements across all of the diabetes self-management behaviors. Instead, depression seems to be more intricately tied to the non-disease-specific health behaviors of diet and physical exercise. Below, the findings are discretely discussed as they apply to the two GEE models (i.e., treatment of depression as a dichotomous vs. continuous variable). This is followed by a discussion on how these findings inform the complex longitudinal relationship between depression and diabetes self-management. In the section detailing possible limitations of the current study, a brief discussion is presented on the effects of overall study attrition on sample availability across time and the need for cautious interpretation of the GEE results.

1. **Categorical treatment of depression**

Presence of baseline depression was only found to prospectively predict healthy eating behavior in African American and Latino patients with T2D. Analytical techniques of GEE revealed lower performance levels for the behaviors of healthy eating (i.e., general and specific diet) for patients who endorsed symptoms of depression at baseline, with the level of significance not being attenuated with time. However, the detrimental effects of depression were not evident across all of the self-management measures. Instead, and with the exception of healthy eating behaviors, clinical patients who endorse symptoms of depression at baseline showed significant improvements in multiple diabetes self-management outcomes (i.e., physical activity, glucose self-testing, medication adherence, foot care, and glycemic control) with an associated improvement comparable to their non-depressed counterparts. These latter findings are contradictory to existing literature on this topic. For example, Gonzalez et al. (2008) found that at 9-months follow-up, individuals with higher baseline depression scores were more likely to report lower self-care levels for the behaviors of diet, physical activity, foot care, and medication use. Similarly, after tracking a nationally representative sample of adults with T2D over a 12-month period, Dirmaier et al. (2010) found baseline presence of depression to prospectively predict medication nonadherence and lower performance levels for diabetes-related health behaviors. Although the body of knowledge available is still limited, it may be concluded from these longitudinal studies that baseline depression is detrimental and may diminish levels of engagement in self-management across time, but as will be discussed below, intervention studies may offer an alternative.

Participants in the current study were followed longitudinally, but in the context of a 12-month diabetes self-management intervention. All study participants were enrolled as part of the original parent study (i.e., *Diabetes Self-Management in Minorities*; PI: Laurie Ruggiero) that involved an RCT where all participants received a diabetes education booklet and direct staff contact when completing the required computer-delivered surveys. With the exception of healthy eating behaviors, enrollment in a diabetes self-management intervention, regardless of intervention assignment, may have had a more positive impact for participant with baseline depression. Literature suggests that depression may moderate the effects of diabetes self-management training and/or psychotherapy on self-care adherence and glycemic control. A randomized control trial conducted with a sample of 87 patients with poorly controlled diabetes showed CBT to significantly lower A1c levels at 12-months in the subgroup with high depression scores (i.e., CES-D $\geq$ 16) (Snoek et al., 2008). The subgroup with lower levels of depression did not experience the same significant improvement in glucose regulation. Likewise, Jerant et al. (2008) found depression to moderate the effects of a chronic illness self-management intervention, as the subgroup experiencing a higher number of depressive symptoms showed greater gains in self-efficacy when compared to those with low levels of depression. Although more research is needed in this area, depression seems to be acting as a moderator that enhances the positive effects of chronic illness self-management training programs. Thus, people with comorbid depression and diabetes may reap the most benefits from psychotherapeutic and diabetes self-management interventions.

The indication that depression may moderate the effects of diabetes education and/or psychotherapy on diabetes self-management is not incompatible with available evidence on exercise adherence in populations with a psychiatric illness such as depression. For instance, Jette et al. (1998) found a positive association between the mood state of depression/dejection and adherence to the home-based "Strong for Life" resistance exercise program in a sample of community-dwelling older adults between the ages of 60 and 94 years. Patten et al. (2003) found no significant differences in session attendance or mean number of minutes of exercise engagement between depressed and non-depressed smokers participating in a group-based exercise program. Examination of weekly exercise frequency further revealed that depressed smokers, when compared to their non-depressed smoking counterparts, reported significantly higher exercise levels. The authors hypothesize that the potential increase in positive emotional well-being associated with participation in physical exercise may contribute to the higher exercise performance levels in the depressed subpopulation. Peer and researcher staff based social support and positive reinforcement, if perceived to be of therapeutic benefit by the depressed subpopulation, may offer another mechanism for their high exercise adherence rates. Prohaska, Walcott-McQuigg, Peters, and Li (2000) offer yet another theory proposing that older adults with depression may intentionally opt to participate in exercise programs as a self-prescribed treatment method for their associated symptoms of depression. More research is needed to elucidate this phenomenon.

In summary, and with the caveat that adherence to healthy eating may be the exception, instead of serving as a deterrent and/or barrier against positive health behavior change, depression may act as a moderator that enhances the benefits associated with secondary and tertiary diabetes intervention programs (e.g., diabetes education, CBT to improve glycemic control, etc.). Hypotheses to explain this phenomenon may be similar to those offered by experts implementing exercise intervention programs among populations with a mental health illness. As stated above, individuals with baseline depression may benefit by experiencing heightened emotional well-being, increased perceptions of social support, and elevated attunement to positive reinforcement. Or, patients experiencing symptoms of depression may have opted to enroll in the parent study as a self-improvement treatment approach. As will be described below, the longitudinal analysis treating depression as a continuous variable may offer some additional insight. Finally, as noted above, between-group differences by depression status were observed at 6- and 18-months for general diet, and at 6- and 12-months for specific diet. Additional research is needed to understand the impact of baseline depression on adherence to healthy eating behaviors across time and why this association differs for the remaining self-management measures.

2. **Depression as a continuous variable**

When treated as a continuous variable, longitudinal changes observed in the independent variable of depressive symptomatology were associated with changes in diabetes self-care performance levels. Specifically, increases in symptoms of depression as measured by the PHQ-9 were accompanied by decreases in the performance levels associated with specific diet and physical exercise. Few studies have examined the longitudinal relationship between changes in depressive symptoms and changes in diabetes self-management. These studies suggest that changes in depressive symptomatology are associated with changes in the more proximal health behavior outcome measures (e.g., diet and physical exercise) but not the more distal outcome of glycemic control. Only one longitudinal study has examined the relationship between changes in depression and changes in diabetes self-care in the absence of a psychotherapeutic and/or diabetes self-management intervention. Over a 5-year period, Katon et al. (2009) found that patients with persistent or worsening depression had lower performance levels for the self-care activities of diet and physical exercise when compared to patients without depressive symptoms. This is consistent with the results of the current study, as worsening depression scores were associated with diminished performance of general diet and exercise behaviors. These results suggest that changes in depression may be more intricately tied to non-disease-specific health behaviors (i.e., diet and physical activity) and less to disease-specific active management behaviors (e.g., blood sugar self-testing). Research is needed to investigate whether depression differentially affects adherence to non-disease-specific health behaviors versus active management behaviors. It may be possible that symptoms of depression are more likely to impact behaviors requiring extensive lifestyle modifications (i.e., diet and exercise) and larger time investments.

More evidence is available on the prospective effects of depression on glycemic control in the presence of psychotherapeutic and pharmacotherapeutic interventions. The finding that changes in glycemic control are not predicted by changes in depression is not completely contradictory to current knowledge in this field of research. The majority of interventions directly applying intensive psychotherapy and pharmacotherapy have been successful in decreasing self-reported symptoms of depression, but this has not been accompanied by parallel improvement in glycemic control (van der Feltz-Cornelis al., 2010). For example, after delivering CBT for 16-weeks to patients with comorbid depression and diabetes, Georgiades et al. (2007) found significant reductions in depressive symptomatology at 12-months, but these were not accompanied by improvements in glycemic control as measured via A1c. A meta-analysis conducted by van der Feltz-Cornelis et al. (2010) corroborates these findings. After inclusion of fourteen randomized control trials that focused on the effects of anti-depressant interventions, the authors found a combined moderate clinical decrease in depression with a virtual absence in improved glycemic control. Only one pharmacotherapy intervention that used Sertraline established parallel improvement in depressive symptoms and glycemic control. Given the above mentioned results, it is not surprising that changes in depression were not associated with changes in glycemic control for the current study. Neither the parent study (i.e., *Diabetes Self-management in Minorities*) nor the current cross-sectional study implemented an anti-depressant intervention. In the absence of an anti-depressant intervention where only small changes in depression may be anticipated, one would not expect significant positive changes in glycemic control.

In summary, presence of baseline depression does not impede or deter future improvements across all diabetes self-management measures. Instead, the results suggest that symptoms of depression are more intricately tied to the non-disease-specific health behaviors associated with healthy eating and engagement in physical activity. These results were triangulated as depression was treated as a dichotomous and continuous variable.

C. **Longitudinal Antecedents for Depression**

The third and final aim sought to longitudinally determine the socio-demographic, behavioral, and biopsychosocial predictors of depression. When examining changes in depressive symptomatology across time, the final multivariate model identified intervention assignment, diabetes-related self-efficacy, and diabetes distress as significant predictors. In particular, increases in self-efficacy and decreases in diabetes distress were accompanied by mental health improvements in the form of diminished depressive symptomatology. To some extent, this study corroborates earlier work on this topic. Both cross-sectional and longitudinal studies provide evidence as to the predictive ability of psychological factors when it comes to depressive symptoms in patients with diabetes (Bot et al., 2010; Katon et al., 2009; Pibernik-Okanovic et al., 2008). For instance, in addition to disease-specific factors (i.e., neuropathy), the psychological factors of diabetes-related distress and prior family histories of psychiatric illness were significant predictors of depression in a clinical sample of adults with T2D (Stankovic, Jasovic-Gasic, & Zamaklar, 2011).

The patients randomized into the treatment group showed slight increases in depressive symptomatology across time. Notice, the purpose of the current study was not to examine psychosocial outcomes by intervention assignment, thus the result should be interpreted with caution given study attrition and need for more in-depth statistical testing (e.g., response profiles). Nonetheless, there are several hypotheses that may aid in the understanding of this finding. First, it is possible that individuals receiving diabetes self-management counseling may develop feelings of intense burden as they are exposed to the complexity involved in the management of their chronic illness. This concept has been previously explored among adults newly diagnosed with T2D. An alternate explanation is that the variable of intervention assignment did not accurately capture intervention dosage received by the participants. Treatment of the covariate of intervention assignment was similar to an intent-to-treat analysis, making it possible that participants randomized into the treatment group did not in fact receive the intervention. As will be discussed later, this may serve as a study limitation.

Several findings in the univariate models are also consistent with available evidence on this topic. Specifically, longitudinal increases in the performance of the self-care behaviors of specific diet and physical exercise were predictive of improvements in depressive symptoms. Previous work has uncovered this inverse relationship. Using path analysis, Sacco et al. (2005) found that low self-care performance levels were associated with higher depression scores as measured using the PHQ-9. Further, the inverse relationship between self-care performance levels and depressive symptoms was mediated by diabetes-related self-efficacy. Using a larger sample size, Sacco et al. (2007) replicated their earlier findings with the additional discovery that diabetes-related medical symptoms also played a role in the pathway linking self-care adherence and depression. Thus, it is plausible that individuals with higher self-care performance levels experience increases in self-efficacy, which in turn lead to improvements in depression. Or, these improvements in depression may be a result of diminished diabetes-related symptoms experienced by patients with high self-care performance levels.

As alluded to above, the results for the current study are not completely congruent with current evidence. Unlike previous research, the current study did not find socio-demographic characteristics, behavioral factors, or disease-specific factors to predict change in depressive symptoms across time. First, one possible explanation as to the lack of significance for the socio-demographic variables, particularly those capturing socioeconomic status, is the homogeneity of the sample. About three fourths of the sample reported annual incomes below $20,000 and approximately 70% were either awarded a high school diploma or reported less than a high school education. Absence of variability in the measures capturing socioeconomic status could explain their lack of significance when attempting to predict depression across time. Next, and as will be discussed in the study limitations, inclusion of variables capturing diabetes-related complications was not possible given their absence in the dataset used for the current study. Despite their absence, A1c and self-reported insulin use, both of which may serve as distal proxies for diabetes-related complication, were not found to prospectively predict depression scores.

D. **Study Limitations**

Several study limitations should be considered when interpreting the findings of the current study. First, although longitudinal data was available, a cross-sectional approach was taken when testing the mediational role of self-efficacy in the relationship between depression and diabetes self-management. Future studies should attempt this while applying GEE methods. Second, subgroup analyses when examining the mediational role of self-efficacy significantly reduced the sample size making it possible that reductions in power affected the ability to detect significant relationships between variables. Third, determination of depression status was not based on a clinical diagnosis made by a mental health provider but as a self-report measure was administered (i.e., PHQ-9), which served only as a screening tool and not a diagnostic examination. The assessment tools used to capture diabetes self-care and those used to collect the biopsychosocial covariates (e.g., diabetes distress, length of disease diagnosis) were also based on self-report questionnaires and are therefore subject to biases (e.g., recall bias, respondent fatigue, etc.). Given the use of a computer-delivered survey tool when collecting study variables, overestimation of the strength of the association between predictor (e.g., depression) and outcome measures (e.g., diabetes self-care) is possible given the potential for shared methods variance (Doty & Glick, 1999). Fourth, the use of secondary data also served as a limitation to the current study as it restricted the availability of potentially significant factors when examining the relationships between self-efficacy, depression, and diabetes self-management. For instance, measures of social support, acculturation, and disease-specific morbidity may have been of benefit to the current study. Fifth, dichotomization of the variable capturing depression may have led to the non-significant findings when longitudinally tracking diabetes self-management. Categorization of individuals into low, medium, and high depression subgroups as identified at baseline, may have strengthened the ability to detect differences in self-management across time. Sixth, it was not possible to control for receipt of antidepressant therapy in the study population. Seventh, generalization of the findings may be limited by homogeneity in the socio-demographic factors (e.g., socioeconomic status) of the current sample. Although the analyses in the current study controlled for intervention assignment, this was based on intent-to-treat and not on the actual dosage of the intervention received.

Two additional limitations will need to be addressed in future analyses. First, as evidenced by incongruent findings between the standard and change models, the instability of the GEE analyses examining the longitudinal effects of depression on diabetes self-management may be explained by overall study attrition. Specifically, at baseline the available sample of 276 participants included 62 participants with PHQ-9 scores meeting the cutoff for probably clinical depression. By 18-months, of the 144 study participants that remained, 24 were categorized as depressed (i.e., PHQ greater than or equal to 10). Although rates of attrition did not differ by depressions status, the small number of participants categorized as depressed at 18-months may have reduced the statistical power associated with the longitudinal analyses. Future analyses using the current dataset may consider longitudinal models with specified follow-up assessment end-points of 6- and/or 12-months were study attrition is lower. The second limitation is related to the techniques used to collect A1c values. Given differing methods when collecting blood samples for the purpose of acquiring A1c values (i.e., lab values vs. finger stick method), adjusted figures may need to be calculated.

E. **Public Health Implications and Future Directions for Research**

The current study addressed differing but interrelated research queries. First, longitudinal changes in the psychosocial factors of diabetes-related self-efficacy and diabetes distress were predictive of changes in depressive symptomatology. Specifically, improvements in depressive symptoms were preceded by increases in self-efficacy and decreases in diabetes-related distress. This finding suggests that mental health providers treating patients with comorbid diabetes may need to intervene on the psychological sequela associated with their chronic illness. Treatment of depressive symptoms is also warranted as depression can longitudinally impact adherence to healthy eating and physical exercise behaviors. In addition to psychotherapy and/or pharmacotherapy, mental health providers may consider use of Glasgow's patient-centered counseling approach (Glasgow, Emont, & Miller, 2006). The five A's patient-centered counseling consists of the following procedures: (1) *assess* current patient self-care behavioral practices and healthcare beliefs; (2) *advise* as to areas for improvement based on patient characteristics; (3) *agree* with patient as to feasible goals for improved self-management; (4) *assist* in developing a plan of action and identification of potential barriers to adherence; and (5) *arrange* follow-up contacts to review patient progress. This approach intended to facilitate lifestyle behavior change and promote diabetes self-management has the potential to increase self-efficacy and decrease diabetes-related distress. Note, this may need to be done in collaboration with the healthcare providers in the primary care setting (e.g., primary care physician, diabetes educator, community health worker, etc.). Glasgow's patient-centered approach was a component implemented in the intervention arm of the parent study providing the ability for future research to explore its impact on diabetes distress and diabetes-related self-efficacy.

Implementation of a collaborative care model where a mental health specialist works alongside a patient's primary care physician, has documented success in the treatment of depression (Katon et al., 2004). For instance, when compared to those receiving TAU, Katon et al. (2004) found that patients receiving mental health treatment collaboratively from a depression clinical nurse specialist and a primary care physician showed greater adherence to antidepressant medication and greater improvements in symptoms of depression across time. The success of a collaborative care model has also been documented among Latinos with comorbid diabetes and depression. A randomized control trial–*Multifaceted Diabetes and Depression Program (MDDP)*–implemented in a sample of Latino adults with major depressive disorder found improvements in depressive symptoms, functional outcomes (i.e., Sheehan Disability Scale), and quality of life (Ell et al., 2010; Hay, Katon, Ell, Lee, & Guterman, 2011). The treatment consisted of a socioculturally adaptive model where the primary care physician, psychiatrist, and a bilingual master's level therapist all worked collaboratively to effectively treat the mental health illness (Ell et al., 2009). Sociocultural adaptations were implemented at multiple levels (i.e., provider, systems, and patient level adaptations). For example, patients were given the choice as to the preferred treatment method (i.e., psychotherapy vs. pharmacotherapy) and they were asked to participate in workshops intended to challenge misconceptions and stigma associated with treatment. They also had the choice to include family members as part of the treatment regimen. Finally, in an earlier study conducted by Gilmer et al. (2008), similar improvements in depressive symptoms were reported when using a collaborative care model in low-income Latino patients. As implemented in the MDDP, collaboration across healthcare providers was an important component. A depression care manager worked with the patient, diabetes case manager, and primary care physician. Again, patients were given the opportunity to decide the best treatment approach (i.e., psychotherapy vs. pharmacotherapy.)

Given the detrimental effects of depression in adults with diabetes, along with utilization of a collaborative care model, research needs to examine the utility of ethnicity-specific treatment for depression in African Americans and Latinos with diabetes. Although guideline-based care (e.g., pharmacotherapy, CBT, etc.) is effective in the treatment of depression among low-income minority populations, researchers and practitioners should be cautious not to use a cookie-cutter approach. Researchers have explored ethnicity-specific treatment options for depression. Takeuchi et al. (1995) found that minorities receiving ethnicity-specific mental health treatment options had higher return rates when compared to those receiving mainstream treatment. Studies have also suggested a positive effect on length and outcome of treatment when there is a provider-patient match on ethnicity and language. More research needs to be conducted to further explore whether ethnicity-specific treatment options are efficacious. It still remains to be determined whether culturally specific treatment options offer better success rates for minority groups. Alternative mental health treatment options should also be explored. This includes the use of alternative practices such as tai chi, yoga, mindfulness, and Reiki.

Returning to the discussion on the role of diabetes self-efficacy, based on the study results and the discussion up to this point, the reader starts to get a clearer sense of the complex role that self-efficacy plays when examining symptoms of depression in patients with T2D.

Changes in diabetes-related self-efficacy are predictive of changes in depression, and perhaps to a lesser extent, self-efficacy may also play a role in the pathway between depression and diabetes self-management. This is particularly true for the African American subgroup examined in the current study. Furthermore, a cyclical pattern may be at play here. Diminished levels of diabetes self-efficacy may lead to increases in symptoms of depression, and these subsequent increases in symptoms of depression may in turn further diminish diabetes-related self-efficacy. The cyclical increase in symptoms of depression and decrease of self-efficacy may then lead to lowered self-care adherence. Thus, self-efficacy seems to have cyclical, upstream, and downstream effects when it comes to depression in underserved populations with T2D. As previously identified, healthcare professionals may need to implement strategies to increase patient confidence in the performance of self-management behaviors if improvements in depressive symptoms and self-care adherence are to be expected. Future studies should also examine and compare the role of self-efficacy in African Americans versus Latinos. Presence of depressive symptomatology was inversely associated with self-efficacy only in the African American subgroup. It is therefore important for researchers not to look at minority groups aggregately (i.e., African Americans and Latinos), as divergence in demographic and cultural factors may result in differences when examining the association between depression, self-efficacy, and diabetes self-management.

Despite the identified complex role of self-efficacy in patients with comorbid depression and diabetes, more research is needed to identify the mechanism through which depression affects diabetes self-care. Self-efficacy will still need to be considered, but researchers may need to identify the appropriate tool with adequate psychometric properties to measure this construct. Additional variables will also need to be considered when examining this pathway. These include constructs such as social support, emotional and cognitive barriers, poor motivation, and decreases in attention and/or memory. Identification of the mechanisms through which depression and low level of diabetes self-management interact has the potential to inform the development of more targeted prevention and treatment programs for minority adults with clinically significant level of depression.

Finally, regardless of the etiology and causal pathway, once patients with T2D develop comorbid depression, evidence documents a decline in diabetes self-management. Given the underdiagnosis and low treatment rates for depression in minority populations (Robins, Locke, & Regier, 1991; Unutzer, Katon, Callahan, et al., 2003), it becomes clinically relevant to recognize that presence of depression will not necessarily serve as a barrier for initiation and maintenance across all diabetes self-management outcomes. Healthcare providers should be aware that underserved adults with depression are capable of joining diabetes self-management programs, and with the exception of non-disease-specific health behaviors (i.e., healthy eating and physical activity), longitudinally they show compatible diabetes self-management levels when compared to their non-depressed counterparts. Given the substantial benefits associated with proper diabetes self-management, healthcare providers should offer behavioral prescriptions and encouragement for patients with and without depression to initiate a self-management regimen.

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VITA

NAME: Rosalba Hernandez

EDUCATION:

Doctor of Philosophy (PhD) 2012, University of Illinois at Chicago, Community Health Sciences, School of Public Health, Chicago, Illinois
Dissertation Title: *Longitudinal relationship between depression and diabetes self-care in minorities with type 2 diabetes*

Master of Science (MS) 2010, University of Illinois at Chicago, Community Health Science, School of Public Health, Chicago, Illinois
Thesis Title: *Minorities with comorbidity of depression and type 2 diabetes: Adherence to self-care activities*

Bachelor of Science (BS) 2005, University of Illinois at Chicago.
Major in Biological Sciences (Summa Cum Laude and Departmental Honors)

EXPERIENCE:

Co-Investigator
Sept 2010–Present

University of Illinois at Chicago, Institute for Health Research and Policy, Chicago, Illinois
Project Title: *Stress Reduction with Tai Chi for Elderly Hispanics with Diabetes*
• Co-wrote grant proposal submitted to current funder (i.e., National Institute on Aging) and worked on all aspects of IRB submission for program implementation and participant recruitment.
• Developed focus group guide to examine the cultural acceptability of Tai Chi among older Latino adults.
• Recruited focus group participants, served as a co-facilitator during focus group sessions, and prepared field notes summarizing group discussions.
• Transcribed focus group audio files, developed code book with thematic identification of topics, coded interview transcripts, and analyzed data using Atlas/ti qualitative software.

Co-Investigator
Feb 2011–Present

Taller de José, Chicago, Illinois
Project Title: *The Accompaniment Model: Conceptualization and Identification of Biopsychosocial Outcomes*
• Authored and prepared grant proposal submitted to current funder (i.e., Illinois Area Health Education Centers) to conceptualize the accompaniment services offered by Taller de José, a non-for-profit organization serving low-income Mexican-American immigrants in Chicago
• Collaborated with researcher from Dominican University in the implementation of qualitative research methods to identify client perspectives on services received and potential outcome measures for program evaluation.

Research Assistant Nov 2010–Present	University of Illinois at Chicago, Institute for Health Research and Policy, Chicago, Illinois Project Title: *Evaluation of a statewide health screening and education program* • Apply survey research methodology to support the development of survey instruments to collect information relating to health care access, health behaviors, and health status across New Mexico. • Develop and create interactive touchscreen computer-assisted survey instruments, including Spanish versions, to minimize barriers to participant, such as literacy and language. • Support the overall evaluation of a statewide health screening and education initiative and prepare executive reports to summarize data and document project impact in the underserved rural regions. • Prepare and submit all IRB-related documentation.
Research Assistant Mar 2007–Nov 2010	University of Illinois at Chicago, Institute for Health Research and Policy, Chicago, Illinois Project Title: *Improving Diabetes Self-Management in Minorities* • Participated in all aspects of the parent project to learn about the development, implementation, and evaluation of a large-scale clinical trial. • Developed computer-assisted survey instruments. • Developed depression screening and physician notification protocol implemented across multiple FQHCs throughout Chicago. • Conducted reliability check on abstraction of biomedical data from patient charts and fidelity of implementation of treatment protocol. • Co-wrote and served as lead author on multiple abstracts for national and international conferences.
Qualitative Methods in Public Health Teaching Assistant Fall 2009, 2010, and 2011	University of Illinois at Chicago, School of Public Health, Chicago, Illinois • Facilitated first class session and offered an overview of syllabus and student expectations • Graded and advised students on course work. • Assisted students with use of Atlas/ti, a qualitative analysis software. • Collaborated with course instructor to modify and improve class content and syllabus.
Research Team Leader Summer 2008, 2009, 2010, and 2011	University of Illinois at Chicago, Graduate College, Summer Research Opportunity Program (SROP,) Chicago, Illinois • Lectured on research methodologies to an audience of undergraduate students majoring in social and biological sciences. • Graded and advised students on coursework. • Conducted a poster formatting workshop. • Facilitated final symposium presentations at the conclusion of the program.

Research Assistant June 2006–Mar 2007	University of Illinois at Chicago, Institute for Health Research and Policy, Chicago, Illinois Project Title: *Diabetes Prevention: Reaching Diverse Populations Where They Live* • Co-managed weekly diabetes education sessions. • Data management and data entry. • Translated program documents as needed. • Attended investigator meetings and prepared meeting minutes.
Medical Assistant Aug 2005–May 2006	Academic and Clinical Associates in Dermatology, Oak Park, Illinois • Assisted doctor during patient surgeries: Prepared syringe with local anesthetic, readied electric desiccator, and prepared formaldehyde container for biopsy. • Facilitated patient-doctor interaction by translating for Spanish-speaking patients. • Assisted physician in preparation and bottling of medications. • Billed insurance providers for medical services received.
Laboratory Assistant Aug 2002–Aug 2003	University of Illinois at Chicago, Department of Biological Sciences, Chicago, Illinois • Prepared plant specimens and isolated carbon content for analysis with mass spectrometer. • Entered data from carbon content analysis. • Conducted literature reviews and gathered needed empirical evidence for manuscript preparation.

SKILLS:
Research:

- Experimental research design.
- Quantitative statistical analysis (linear regression, multivariate statistics).
- Qualitative research (participant observation, semi-structured interviews, focus groups) and data analysis and focus group facilitator.
- Excellent grasp of community and behavioral health prevention theories.
- Specialized knowledge in cross-cultural and health disparities research.

Computers: MS Word, Excel, Powerpoint, SPSS, SAS, Atlas/ti

Language: Spanish: Speech-Excellent, Writing- Excellent, Reading- Excellent

AWARDS:

- UIC School of Public Health Scholarship for Disadvantaged Students (SDS) (2012)
- Scrimshaw Latino Health Scholarship (2011)
- Diversifying Faculty in Illinois, Illinois Board of Higher Education (FY 2011–2012, FY 2010–2011, and FY 2008–2009)
- Grantmakers In Aging Fellow (2010)
- Grants Technical Assistance Workshop Fellow, National Institute on Aging (2009)
- Abraham Lincoln Graduate Fellowship (FY 2009–2010 and FY 2006–2007)
- Martin Luther King Jr. Scholarship, University of Illinois at Chicago (FY 2007–2008)
- Delta Omega Society, National Honorary Public Health Fraternity (2010)

MAJOR COMMITTEE AND BOARD MEMBERSHIPS:
University of Illinois at Chicago, Vice Chancellor for Research Search Committee (2012)

ABSTRACT REVIEWER:
American Public Health Association annual meetings (Aging and Public Health Section)

PUBLICATIONS:
Hernandez, R., Prohaska, T. R., and Sarkisian, C. A. The relationship between depression and walking behavior in older Latinos: The "¡Caminemos!" study. (Under review)

Hernandez, R., Ruggiero, L., Chavez, N., and Choi, Y. K. Biopsychosocial Predictors of Diabetes Self-Care among African American and Latino Patients with Type 2 Diabetes. (In progress)

Ruggiero, L., Quinn, L., Gerber, B., Choi, Y. K., Hernandez, R., and Castillo, A. Examination of an innovative intervention designed to enhance diabetes self-care in low income priority populations attending primary care clinics. (In progress)

Moadsiri, A., Ruggiero, L., and Hernandez, R. Sustainability of community-based diet-related chronic disease prevention programs. (In progress)

PRESENTATIONS
Hernandez, R., Sosa, L. V., Brazda, K., and Monnot, L. (2011 December). The accompaniment model: conceptualization and identification of biopsychosocial outcomes. Oral presentation. Immigrant Health Research Conference, Chicago, IL.

Hernandez, R., Ruggiero, L., Chavez, N., Choi, Y. K., and Zhao, W. (2011 November). Biopsychosocial predictors of diabetes self-care among African American and Latino patients with type 2 diabetes. Oral presentation. The American Public Health Association, Washington, DC.

Castillo, A., Aponte-Soto, L., and Hernandez, R. (2011 November). Assessing stress and stress reduction with Tai Chi among elderly Hispanics with diabetes. Poster presentation. The American Public Health Association, Washington, DC.

Ruggiero, L., Quinn, L., Gerber, B., Choi, Y. K., Hernandez, R., and Castillo, A. (2011 October). Examination of an innovative intervention designed to enhance diabetes self-care in low income priority populations attending primary care clinics. Poster presentation. NIH National Institute of Nursing Research, Washington, DC.

Hernandez, R., Ruggiero, L., Chavez, N., and Choi, Y. K. (2011 February). Minorities with comorbidity of depression and type 2 diabetes: Adhrence to self-care activities. Oral presentation. 3rd Annual minority in the Midwest Conference, Chicago, IL.

Ruggiero, L., Choi, Y. K., Zhao, W., Hernandez, R., Castillo, A., on behalf of the entire UIC Diabetes Self-Care Study Team. (2011). Diabetes self care in low income priority populations attending primary care clinics in the United States. The 16th Scientific Meeting of PsychoSocial Aspects of Diabetes (PSAD), Cambridge, UK.

Hernandez, R., Prohaska, R., and Sarkisian, C. (2010 November). The relationship between depression and walking behaviour in older Latinos: The “Caminemos!” study. Poster presentation. The American Public Health Association, Denver, CO.

Hernandez, R., Prohaska, R., and Sarkisian, C. (2010 October). The relationship between depression and walking behavior in older Latinos: The “Caminemos!” study. Oral presentation. Grantmakers in Aging Annual Conference, Chicago, IL.

Ruggiero, L., Choi, Y. K., and Hernandez, R. (2009 April). Depression and diabetes: Rates and predictors in primary care patients. The 14th Scientific Meeting of PsychoSocial Aspects of Diabetes (PSAD), Dubrovnik, Croatia.

Hernandez, R., Ruggiero, L., and Cintron, D. (2006 July). Community-based intervention feasibility for the prevention of type 2 diabetes. Committee on Institutional Cooperation (CIC)/Summer Research Opportunity Program (SROP) Conference, Urbana Champagne, IL.

Longitudinal Relationship between Depression and Diabetes Self-care in Minorities with Type 2 Diabetes

Rosalba Hernandez, Ph.D.
Department of Public Health
University of Illinois at Chicago
Chicago, Illinois (2012)

Dissertation Chairperson: Thomas R. Prohaska, Ph.D.

This study evaluates the longitudinal relationship between depressive symptoms, diabetes-related self-efficacy, and diabetes self-management. The primary aims were: (1) to examine whether diabetes-related self-efficacy mediates the relationship between depression and diabetes self-care in African American and Latino adults with type 2 diabetes; (2) after controlling for intervention assignment, to examine the longitudinal association between depressive symptoms and diabetes self-management (i.e., diabetes self-care performance levels and glycemic control) and to determine if individuals with higher baseline levels of depression are less likely to increase diabetes management (i.e., self-care behaviors and glycemic control) during 6-, 12-, and 18-month follow-up; and (3) to examine biopsychosocial factors that predict change in depressive symptomatology across time, after controlling for intervention assignment. Baseline in-person survey data were collected from African American and Latinos aged greater than or equal to 18 years with type 2 diabetes participating in a diabetes self-management intervention at four primary care clinics (n = 276). The sample (n = 276) had a mean age of 53.2 years; 69% were female; 54% African American and 46% Hispanic; and 74% reported incomes below $20,000. Analyses of baseline data revealed that depression was negatively correlated with the self-care behaviors of general diet, specific diet, physical activity, foot care, and smoking, with higher depression scores associated with lower self-care performance. In the African American subgroup, diabetes-related self-efficacy was an important construct in the relational pathway between depression and diabetes self-care. Longitudinal analyses using generalized estimating equations revealed an inverse association

between depressive symptoms and non-disease-specific health behaviors of diet and physical exercise. The longitudinal predictors of depression consisted of two intrapersonal constructs of diabetes-related self-efficacy and diabetes distress. These findings suggest that among Latino and African American adults with type 2 diabetes, depression may adversely affect adherence to non-disease-specific health behaviors across time, but the mutable risk factors of elevated diabetes distress levels and diminished self-efficacy may be targets for public health interventions related to mental well-being.