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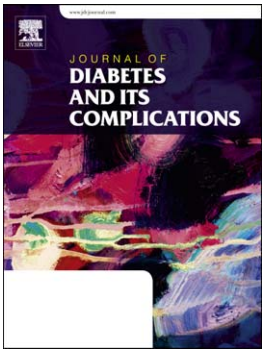

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Title page:

Association of ABC (HbA1c, Blood Pressure, LDL-Cholesterol) Goal Attainment with Depression and Health-Related Quality of Life among Adults with Type 2 Diabetes

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Structured abstract

Aims: To determine the relationship between ABC goal attainment, depression, and health-related quality of life (HRQoL) among a national sample of patients with type 2 diabetes (T2DM).

Methods: A retrospective, cross-sectional analysis was performed examining 808 non-pregnant patients ≥ 20 years old with T2DM from the National Health and Nutrition Examination Survey (NHANES) 2007-2012. ABC goals were defined as HbA1c < 7%, BP < 130/80mmHg, and LDL-C < 100mg/dL. Patient characteristics associated with ABC goal attainment were examined.

Results: Overall, 23.7% of participants achieved simultaneous ABC goals. Severe depression was significantly associated with lower rates of ABC goal attainment compared to those with no depression (5.0% vs. 25.4%, p = 0.048). ABC goal attainment rates were lower among females, Hispanic and non-Hispanic Black minority groups, and patients with a duration of diabetes over five years, while increased visits with health care professionals was significantly associated with meeting all three ABC goals for patients with T2DM.

Conclusions: The relationship between simultaneous ABC goal attainment, depression and HRQoL is complex. Patients with T2DM unable to meet ABC goals may benefit from increased contact with health care professionals.

Keywords: Type 2 diabetes; Hemoglobin A1c; Blood pressure; Cholesterol; Depression; Health-related quality of life

Introduction

In 2012, it was estimated that 29.1 million people in the United States (U.S.) had diabetes mellitus, with 90% to 95% of cases diagnosed as type 2 (Centers for Disease Control and Prevention, National Center for Health Statistics, 2014). The American Diabetes Association (ADA) 2012 guidelines recommend that adults with diabetes maintain hemoglobin A1c (HbA1c) < 7%, blood pressure (BP) < 130/80 mmHg, and low-density lipoprotein cholesterol (LDL-C) < 100mg/dL. Optimal control of HbA1c, BP, and LDL-C, collectively referred to as the ABCs of diabetes, has been shown to reduce the risk of microvascular and macrovascular complications (ADVANCE Collaborative Group et al., 2008; American Diabetes Association, 2012; Howard et al., 2008; Stamler et al., 1993; Stratton et al., 2000; UK Prospective Diabetes Study Group, 1998). However, prior studies have shown that simultaneous control of all three parameters is rarely achieved in most adults with diabetes. A study examining type 2 diabetes (T2DM) patients in California from 2008 to 2010 found that only 21.1% of 15,826 total patients achieved simultaneous control of HbA1c, BP, and LDL-C (Holland et al., 2013). Similarly, a retrospective cohort study of two large health care systems in Colorado, Denver Health and Kaiser Permanente (KP), found low simultaneous goal attainment of all three parameters for both cohort groups (16.2% and 30.3%, respectively) (Schroeder et al., 2012). In comparison, studies that used a nationwide patient sample in the U.S. and abroad found even lower rates (≤ 13%) of simultaneous ABC goal attainment (Bertoni et al., 2008; Cheung et al., 2009; Elis et al., 2008).

The difficulty of attaining diabetes goals may be further complicated by the presence of mental health issues, particularly with regards to depression. In the last two decades, several studies have attempted to unravel the association between diabetes and depression (Anderson et al., 2001; Shah et al., 2008, 2012). In a meta-analysis, researchers have found that the odds of

depression are doubled in patients with diabetes, even after controlling for confounding factors (Anderson et al., 2001). Based on the results of the meta-analysis, the aggregate estimate of the prevalence of depression was 21% for patients with type 1 diabetes, and 27% for patients with T2DM (Anderson et al., 2001). The clinical relevance of this finding is emphasized by results which indicate that patients with depressive symptoms have poorer diet and medication adherence, functional impairment and higher healthcare costs (Ciechanowski et al., 2000). Moreover, depressive symptoms are significantly associated with a variety of diabetes complications including retinopathy, nephropathy, neuropathy, macrovascular complications and sexual dysfunction (de Groot et al., 2001). Contrary to these findings, other studies found no association between depression and goal attainment of HbA1c, BP and LDL-C. However, none of these studies attempted to explain how depression might impact simultaneous ABC goal attainment among individuals with T2DM nationally, particularly with regards to the severity of depressive symptoms (Gary et al., 2000; Heckbert et al., 2010).

Diabetes and depression have both been associated with poor health-related quality of life (HRQoL) (Egede & Hernandez-Tejada, 2013). HRQoL is a person's subjective perception of their physical and mental well-being. Measurement of HRQoL provides the clinician with a subjective measure of the impact of the disease on the patient's daily functioning compared to physician ordered laboratory measures such as ABC. A study conducted in South Australia observed significantly lower HRQoL scores among adults with diabetes and depression than diabetes alone (Goldney et al., 2004). Furthermore, they found that comorbid diabetes and depression had a greater impact on the physical health summary scores of the SF-36 as compared to the mental health summary scores, indicating that depression may have a more significant impact on physical health in patients with diabetes. The studies mentioned above consistently

indicate that patients with diabetes and depression have poorer HRQoL than patients with diabetes only. However, none of these studies assessed how objective measures of diabetes control (such as ABC) are related to the subjective measurement of HRQoL.

Thus, the purpose of this study was to (1) determine the relationship between ABC goal attainment, depression, and HRQoL, and (2) identify patient characteristics associated with simultaneous ABC goal attainment among a national sample of patients with T2DM.

2. Subjects, materials and methods

2.1 Study design

A retrospective analysis of a national sample of adults with T2DM was performed using data from NHANES 2007-2012. NHANES is conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC) (Centers for Disease Control and Prevention, National Center for Health Statistics, 2015). The NCHS Research Ethics Review Board approved all data collection procedures. Prior to data collection, participants in the survey provided written informed consent (Centers for Disease Control and Prevention, National Center for Health Statistics, 2011a, 2012). Survey participants were selected using a complex, multistage, probability sampling design. Sample weights were assigned to each participant to account for oversampling of certain patient groups and to produce an accurate representation of the national, non-institutionalized U.S. adult population (Johnson et al., 2013).

2.2 Subjects

Selection criteria for study subjects were based on past studies and the NHANES Analytic Guidelines. Subjects included for analysis were non-pregnant and at least 20 years of age. Diabetes diagnosis was self-reported, based on answering "yes" to the question, "Have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?" Participants who were diagnosed with diabetes at less than 30 years old and reported using insulin alone were identified as potentially having T1DM and were excluded from the study (Johnson et al., 2013; Koopman et al., 2005; Ong et al., 2008; H. K. Wong et al., 2014). Only participants who were tested for all three study parameters (HbA1c, BP, and LDL-C), and completed all questions of the Patient Health Questionnaire-9 (PHQ-9) Depression Screener and the CDC HRQOL-4 survey were included in the analysis.

2.3 Definitions

Simultaneous ABC goal attainment was defined as achieving all three of the following clinical goals at the time of data collection: HbA1c < 7%, BP < 130/80 mmHg, and LDL-C < 100 mg/dL (American Diabetes Association, 2012). All three parameters were measured in a standardized manner to ensure uniformity throughout the data collection process. HbA1c was measured using blood samples collected by venipuncture. Patients with hemophilia or who received chemotherapy in the last four weeks were excluded from examinations requiring blood collection (Centers for Disease Control and Prevention, National Center for Health Statistics, 2011d). Systolic and diastolic BP was recorded up to four consecutive times in one visit for each participant after resting in a sitting position for five minutes. For patients with more than one valid BP reading, the first BP reading was excluded and the remaining available readings were

averaged to obtain the mean systolic and diastolic BP, according to protocol (Centers for Disease Control and Prevention, National Center for Health Statistics, 2011c). Blood samples for cholesterol testing were drawn in the morning after fasting for 8.5 to 24 hours. LDL-C was calculated using measured values of total cholesterol, HDL-cholesterol, and triglycerides according to the Friedewald equation (Friedewald et al., 1972). Due to limitations of the equation for triglyceride levels over 400 mg/dL, LDL-C was only calculated for patients with triglycerides less than or equal to 400 mg/dL (National Health and Nutrition Examination Survey, 2011a). Further details of the physical examination and laboratory procedures have been previously published by the CDC (Centers for Disease Control and Prevention, National Center for Health Statistics, 2011b, 2011c).

Depression severity was categorized based on PHQ-9 scores: no depression (0 to 4), mild depression (5 to 9), major depression (10 or greater with the presence of anhedonia and/or depressed mood for more than half the days of the last two weeks), and severe depression (20 to 27) (Heckbert et al., 2010; Kroenke et al., 2001; Spitzer et al., 2010). The Patient Health Questionnaire yields a major depression diagnoses according to DSM-IV criteria and a continuous severity score (Kroenke et al., 2001). The Patient Health Questionnaire diagnosis has high agreement with major depression diagnosis based on structured interviews (78% sensitivity and 98% specificity) (Kroenke et al., 2001). In addition, several other studies have used the PHQ-9 as a diagnosis for depression (Heckbert et al., 2010; Katon et al., 2004).

HRQoL was assessed using the following three questions: (1) "Would you say that in general your health is excellent, very good, good, fair, or poor?"; (2) "Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?"; and (3) "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" Based on CDC recommendations and prior studies, self-reported general health status was dichotomized into poor/fair as "poor" and good/very good/excellent as "not poor" health. For survey questions 2 and 3, reports of ≥ 14 days of "not good" physical or mental health were labeled as "poor" (Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 2000; Okosun et al., 2013; Zhang et al., 2014).

2.4 Measurement of covariates

In addition to HbA1c, BP, LDL-C, depression status, and HRQoL, the following covariates were included in the analyses: age (20-40, 41-64, ≥ 65 years), gender, race/ethnicity, education level, marital status (divorced, separated, widowed, or never married versus married or living with a partner), insurance coverage, poverty-income ratio (PIR), smoking status, waist circumference (cm) and body mass index (BMI, kg/m^2), duration of diabetes (0-4, 5-14, ≥ 15 years), family history of diabetes, type of antidiabetic treatment used (none, insulin with or without oral agents, oral agents only), taking antihypertensive or lipid-lowering medications, if ever seen a diabetes specialist, dietitian or nutritionist, having seen a mental health professional in the past year, HDL-cholesterol (mg/dL), non-HDL cholesterol (mg/dL), triglycerides (mg/dL), total cholesterol (mg/dL), and serum creatinine (mg/dL) (National Health and Nutrition

Examination Survey, 2011b). Frequency of diabetes-related doctor visits in the past year (0-2, ≥ 3), if received foot and dilated eye exams in the past year, and frequency of self-monitoring blood glucose (SMBG, per day) were also included. The following comorbid conditions were analyzed: congestive heart failure (CHF), coronary heart disease (CHD), heart attack, stroke, diabetes-related retinopathy, emphysema, chronic bronchitis, liver condition, and cancer. The total number of comorbidities per subject was calculated by summing the comorbid conditions. Presence of hypertension was defined as being told by a health care professional on two or more different visits that the participant had "high blood pressure" (National Health and Nutrition Examination Survey, 2011c). Serum creatinine readings above 4.0 mg/dL were rounded to 4.0 and used as an indication of potential kidney injury or renal failure. PIR was calculated using individual or family income and the Department of Health and Human Services (HHS) poverty guidelines of the respective year. PIR categories are based on eligibility for the Supplemental Nutrition Assistance Program (SNAP), as recommended by the NHANES Analytic Guidelines (Johnson et al., 2013). BMI categories were based on CDC-recommended weight status ranges (Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 2014). Current smokers were identified as participants who self-reported smoking at least 100 cigarettes in their lifetime and who currently smoked at the time of the survey (National Health and Nutrition Examination Survey, 2011b).

2.5 Statistical Analysis

Methods for construction and application of appropriate sample weights for this study were followed according to the NHANES Analytic Guidelines (Johnson et al., 2013). Chi-squared tests and t-tests were used to assess associations between simultaneous ABC goal attainment and presence of patient characteristics, including depression and HRQoL. Individual (HbA1c, BP, and LDL-C goal attainment) and simultaneous goal attainment rates were compared for those with mild, major, or severe depression using chi-squared tests. The association between individual and simultaneous ABC goal attainment rates and the patient's self-reported poor general health, poor physical or poor mental health was determined using chi-squared tests. Univariate analyses were performed using logistic regression to assess the relationship between demographic and clinical characteristics and simultaneous ABC goal attainment. The multivariate logistic regression model was adjusted for age, education level, insurance coverage, PIR, smoking status, waist circumference, BMI, family history of diabetes, presence of comorbidities (hypertension, high cholesterol, CHF, CHD, heart attack, stroke, diabetes-related retinopathy), total number of comorbidities, and serum creatinine. Statistical analyses were completed using STATA version 13.0 (College Station, TX) with a level of significance set at 0.05.

3. Results

3.1 Baseline characteristics

A total of 808 adults (weighted to represent 15,697,661 people) with T2DM were included in the analysis out of 30,442 participants from NHANES 2007-2012. Based on survey-adjusted, weighted estimations, the mean (± standard error) age of the study sample was 60.5 ± 0.6 years and 48.6% were male. The mean duration of diabetes was 11.2 ± 0.5 years. At the time of data collection, 57.3% of subjects had HbA1c < 7%, 65.6% had BP < 130/80 mmHg, and 56.8% had LDL-C < 100 mg/dL. Overall, 23.7% of participants achieved simultaneous ABC goals. In contrast, 8.1% of the sample achieved none of the three goals. Baseline characteristics according to simultaneous ABC goal attainment are presented in Table 1. Patients at ABC goal were more likely to be male, non-Hispanic White (compared to Hispanic and non-Hispanic Black), married or living with a partner, recently diagnosed with diabetes (< 5 years ago), frequently visited their doctor for diabetes (≥ 3 times in the past year), received a dilated eye exam in the past year, and were treated with lipid-lowering therapy. Based on PHQ-9 scores, 67.0% of the study population had no depression, 20.2% had mild depression, 9.6% had major depression, and 1.41% had severe depression.

3.2 ABC Goal attainment, depression, and HRQoL

Individual HbA1c, BP, and LDL-C goal attainment rates were not significantly different for those with mild, major, or severe depression. Simultaneous ABC goal attainment rates did not differ for those with mild (20.5%, $p = 0.31$) or major depression (20.1%, $p = 0.35$), however rates were significantly lower for those with severe depression (5.0%, $p = 0.048$) when compared to no depression (25.4%). Individual and simultaneous ABC goal attainment rates were not significantly associated with the patient's self-reported general health, physical or mental health. However, patients with mild, major and severe depression were significantly more likely to self-report poor general health. Additionally, patients with mild, major and severe depression were significantly more likely to self-report ≥ 14 days of poor physical health and poor mental health during the past 30 days compared to those with no depression (Figure 1).

3.3 Univariate and multivariate analysis

Results of the logistic regression analyses are reported in Table 2. In the univariate analysis, participants who were married or living with a partner (crude OR = 1.95, $p < 0.05$) or taking lipid-lowering medication (crude OR = 1.70, $p < 0.05$) were significantly more likely to achieve simultaneous ABC goals. In both univariate and multivariate analyses, the following characteristics were significantly associated with simultaneous ABC goal attainment: seeing a doctor for diabetes ≥ 3 times in the past year (adjusted OR = 2.20, $p < 0.01$), and receiving a dilated eye exam in the past year (adjusted OR = 1.90, $p < 0.05$). Males were significantly more likely to attain ABC goals (adjusted OR = 1.94, $p < 0.05$), while Hispanics and non-Hispanic Blacks (adjusted OR = 0.42 and 0.39, respectively; $p < 0.05$) were significantly less likely to attain ABC goals in the multivariate model. Those with a longer duration of diabetes were also

significantly less likely to attain all three goals (5-14 years, adjusted OR = 0.36; ≥ 15 years, adjusted OR = 0.41; $p < 0.05$). Poor HRQoL (physical and mental health) and severe depression were not significantly associated with ABC goal attainment in the univariate and multivariate logistic regression models.

4. Discussion

Stark Casagrande and colleagues (2013) showed that there have been significant improvements in ABC goal attainment rates over the past two decades, with 18.8% of diabetes patients reaching all three ABC goals between 2007-2010. The rate of simultaneous ABC goal attainment among patients with T2DM in this study was higher than previous national estimates at 23.7% (Bertoni et al., 2008; Holland et al., 2013). This improvement has been attributed to a wider selection of therapeutic agents, an increased focus on risk factor control, and public education programs initiated by the National Diabetes Education Program and others to disseminate information about the importance of meeting ABC goals (American Diabetes Association, 2015; Cheung et al., 2009; National Diabetes Education Program (NDEP), 2007; Stark Casagrande et al., 2013).

However, despite these strides, more than three-fourths of diabetes patients in the current study were not at ABC goal. N. D. Wong and colleagues (2014) have shown that simultaneous control of HbA1c, blood pressure, and cholesterol risk factors has been projected to prevent 38% of CHD events over 10 years. Bjornstad and colleagues (2014) found that diabetes patients who did not meet any goals for HbA1c, BP, or LDL-C were more likely to develop microvascular complications, such as diabetic retinopathy and nephropathy, than patients who achieved simultaneous ABC goals. In our study, 8.1% of patients did not meet any goals. Given the high

financial and emotional burden of these diabetes complications, it is important that further efforts be made to help patients and providers achieve these clinical goals (Fenwick et al., 2012).

The results from this study demonstrate that females, Hispanic and non-Hispanic Black minorities with T2DM have poorer control of HbA1c, BP, and LDL-C compared to males and non-Hispanic Whites. These findings are consistent with prior studies that demonstrated that special attention may be warranted for specific gender and ethnic groups (Bertoni et al., 2008; Holland et al., 2013). It should be noted that in our study, only 16% of Non-Hispanic Blacks and Hispanics achieved simultaneous control of all three parameters compared to 26.5% of non-Hispanic White patients. These rates are better than those reported by Bertoni et al. where 5% of African Americans, 7.9% of Hispanics and 11.6% of Whites achieved simultaneous control. However, these rates overall, and by ethnic group are still quite suboptimal and indicate a need for quality improvement efforts to help patients and clinicians achieve goals. Future studies should determine if these ethnic differences in risk factor control can be attributed to differential access to the healthcare system, less aggressive medication use or demographic differences such as education and income among ethnic groups. With regards to lower rates of ABC control among women, it can likely be attributed to the menopausal status of women in our study (mean age 61.3 years). As women age and go through menopause, they are likely to gain weight and experience hormonal changes. The dual impact of changing hormones and increased weight may make it more difficult for women to attain simultaneous goals than men of a similar age (Johannes & Bairey Merz, 2011).

Patients with duration of diabetes over five years also have a decreased likelihood of achieving ABC goals, which further highlights the difficulty of managing diabetes over time. These findings emphasize the need for enhanced diabetes care for patients likely to be at a higher risk of complications due to poor risk factor control. As shown in this study, subjects who see their doctors for diabetes more frequently and who receive yearly dilated eye exams (a surrogate measure for increased contact with medical professionals), are about 2-fold more likely to be at ABC goal. Encouraging patients to see their providers more often, whether in person, by phone or email, could substantially improve patient health outcomes. Indeed, prior research has shown that more frequent follow-up with patients (such as with a diabetes clinical pharmacist, PharmD) using the above mentioned methods can increase ABC goal attainment and decrease long-term cardiovascular risk (Ip et al., 2013). Future research should attempt to replicate these findings with different healthcare providers (e.g. RN, PA, NP, MD/DO) in various healthcare settings

Despite prior research associating depression with diabetes, the findings of this study did not show a significant relationship between simultaneous ABC goal attainment and depression except for patients with severe depression (Mezuk et al., 2013). After controlling for demographic and clinical characteristics in the multivariable model, this relationship was no longer significant. Although comorbid depression has been shown to impact diabetes self-management and adherence to medications, it does not seem to impact ABC goal attainment (Egede & Ellis, 2008; Lin et al., 2004). Other studies have also reported little to no effect of comorbid depression on physician-ordered tests for ABC goals (Gary et al., 2000; Heckbert et al., 2010). This could be due to the increased contact that depressed patients have with the health care system. Since patients with depression have more frequent visits with primary care physicians, there may be more opportunity to order lab tests and titrate medication regimens to

improve goals (Egede et al., 2014; Heckbert et al., 2010). In addition, the multivariate analysis seems to indicate that the effect of depression on ABC goal attainment is mediated by access to the health care system. For example, patients that have increased access to the health care system are able to reach simultaneous ABC goals even though they may have comorbid conditions such as severe depression, congestive heart failure or stroke. Future studies should further investigate how depression is related to ABC goal attainment in an effort to aid clinicians manage this comorbidity in patients with diabetes.

Patient perception of their health appears to differ, however, amongst participants with and without depression. A strong relationship was seen between HRQoL and all three categories of depression among patients with T2DM, where patients with depression reported worse HRQoL. However, no relationship was seen between the objective measure of ABC goal attainment and the subjective measurement of HRQoL, including physical and mental health. This infers an inconsistency between patient perception of their health and their actual health status, as measured by HbA1c, BP, and LDL-C. Patients may not feel the effects of uncontrolled blood glucose, blood pressure and cholesterol until long-term complications arise, such as diabetes-related retinopathy, neuropathy, myocardial infarction, and stroke. These findings reflect the importance of providing support and encouragement to patients when promoting ABC goal attainment, regardless of their mental health status. Further, our findings suggest that depression might be more important for perceived health related quality of life than for ABC goal attainment. Future studies should determine if the impact of depression on HRQoL is mediated by demographic (e.g. ethnic minority, gender) or medical risk factors (e.g. comorbidities). In addition, future studies should assess the relationship of these risk factors with

more or less stringent definitions of ABC goal attainment (e.g. HbA1c < 8%, BP < 140/80 or < 140/90 mmHg, and LDL-C < 100 mg/dL).

A strength of this study was the use of a national sample of patients with T2DM. Furthermore, all laboratory measurements were standardized providing internal validity to the study. This study also had some limitations. The study was cross-sectional, and therefore causality could not be determined. The presence of depression was assessed via self-report using the PHQ-9 rather than a clinician's diagnosis. However PHQ-9 has been validated as a reliable tool to measure depressive symptoms (Kroenke et al., 2001). This study was unable to include self-reported antidepressant medication use in the analyses, as this information was not provided by NHANES 2007-2012. Data obtained by visual inspection of participants' medication bottles to determine antidepressant use was excluded due to the potential for misclassification as antidepressants have multiple indications. However, findings from a prior study that controlled for depression treatment did not find any effect on ABC goal attainment, lending strength to our findings (Heckbert et al., 2010). Instead, this study examined the use of mental health therapy by including information on whether participants self-reported seeing a mental health professional in the past year.

In summary, the findings of this study further reveal the complexity of ABC goal attainment and how it relates to depression and HRQoL amongst patients with T2DM.Severe depression is associated with lower rates of simultaneous goal attainment, yet mild or major depression had no effect on goal attainment. However, patient perception of their physical and mental health was impacted for those with mild, major and severe depression. Rates of simultaneous ABC goal attainment are lower among females, Hispanic and non-Hispanic Black minority groups, and patients with a duration of diabetes over 5 years. Meanwhile, increased

contact with health care professionals appears to increase the likelihood of meeting optimal HbA1c, BP, and LDL-C goals for patients with T2DM.

5. Disclosures

The authors report no conflicts of interest. This study was approved by the Touro University California Institutional Review Board (IRB Application # P-2614; December 12, 2013).

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Table 1
Patient characteristics of the sample population from NHANES 2007-2012, stratified by ABC goal attainment (n = 808).

	Not at ABC Goal	At ABC Goal
Overall	76.3	23.7
Age (years)		
20-40 †	7.3	5.4
41-64	53.4	42.1
≥ 65	39.3	52.5
Male	45.7	57.9*
Race/Ethnicity		
Non-Hispanic White †	60.7	70.5
Hispanic	15.7	9.7*
Non-Hispanic Black	17.3	10.6*
Other/Mixed	6.3	9.2
Education Level		
≤ High school †	55.0	51.2
Some college or AA degree	26.4	31.2
College graduate or above	18.6	17.6
Marital Status		
Divorced, separated, widowed, or never married †	41.1	26.3
Married or living with partner	58.9	73.7**
Insurance Coverage		
No coverage †	14.8	8.2
Private insurance	59.3	63.8
Public/Other insurance	25.9	28.0
PIR		
≤ 1.30 (low) †	26.5	20.8
> 1.30-3.50	44.4	47.7
> 3.50 (high)	29.1	31.5
Current Smoker	12.2	16.9
Waist Circumference (cm)	110.7 ± 1.2	109.2 ± 1.4
BMI (kg/m^2)		
< 18.5	0.6	0.3
18.5-24.9 †	11.7	13.6
25.0-29.9	23.0	26.1
≥ 30.0	64.7	60.0
Duration of Diabetes (years)		
0-4 †	29.9	42.4
5-14	41.1	35.6*
≥ 15	29.0	22.0*
Family History of Diabetes	66.6	72.0
# of Times Saw Doctor for Diabetes in Past Year		
0-2 †	46.7	31.9
≥ 3	53.3	68.1**

Ever Seen a Diabetes Specialist, Dietitian, or Nutritionist	70.6	66.7
Doctor Checked for Foot Sores in Past Year	66.0	76.5
Dilated Eye Exam in Past Year	64.3	77.5**
Frequency of SMBG		
< 1 time per day †	49.5	50.4
≥ 1 time(s) per day	50.6	49.6
Type of Antidiabetic Treatment		
None/No insulin or oral agents †	13.9	10.1
Insulin with or without oral agents	26.7	15.5
Oral agents only	56.4	74.4
Taking Antihypertensive Medication(s)	63.1	62.5
Taking Lipid-Lowering Medication(s)	50.7	61.5*
Seen Mental Health Professional in Past Year	5.5	5.1
Comorbidities		
Hypertension	60.2	58.0
High cholesterol	61.9	63.7
CHF	10.4	8.2
CHD	11.3	11.0
Heart attack	11.3	11.3
Stroke	8.7	7.6
Diabetes-related retinopathy	14.5	13.2
Emphysema	2.1	5.8
Chronic bronchitis	13.3	8.4
Liver condition, any	7.2	4.9
Cancer/malignancy, any	18.5	17.0
Total # of Comorbidities		
0 †	12.9	9.1
1	23.6	29.1
≥ 2	63.5	61.8
HbA1c (%)	7.5 ± 0.1	6.3 ± 0.0**
Systolic Blood Pressure (mmHg)	132.9 ± 1.0	119.3 ± 1.1**
LDL-Cholesterol (mg/dL)	107.4 ± 1.5	73.8 ± 1.4**
HDL-Cholesterol (mg/dL)	48.0 ± 0.7	49.6 ± 1.2
Non-HDL Cholesterol (mg/dL)	137.7 ± 2.0	101.1 ± 1.6**
Triglycerides (mg/dL)	151.6 ± 6.5	136.2 ± 7.1
Total Cholesterol (mg/dL)	185.8 ± 2.0	150.7 ± 1.4**
Serum Creatinine (mg/dL)	1.0 ± 0.0	1.0 ± 0.0
PHQ-9 Depression Category		
No depression †	74.6	25.4
Mild depression	79.5	20.5
Major depression	79.9	20.1
Severe depression	95.0	5.0*
HRQoL: Poor General Health	42.9	40.1
HRQoL: Poor Physical Health	18.5	21.6
HRQoL: Poor Mental Health	14.6	14.4

AA = Associate of Arts degree; PIR = poverty-to-income ratio; BMI = body mass index; SMBG = self-monitoring blood glucose; CHF = congestive heart failure; CHD = coronary heart disease; HbA1c = hemoglobin A1c; LDL = low-density lipoprotein; HDL = high-density lipoprotein; PHQ-9 = Patient Health Questionnaire-9; HRQoL = health-related quality of life. Values are reported as % or mean ± standard error.

† Referent used for chi-squared tests

* $p < 0.05$ vs. Not at ABC Goal

** $p < 0.01$ vs. Not at ABC Goal

Table 2
Univariate and multivariate logistic regression of subjects meeting ABC goals, NHANES 2007-2012 (n = 573).

Variable Name	Crude OR	95% CI	Adjusted OR	95% CI	P-value
Gender					
Female	*Referent*				
Male	1.51	(0.94, 2.42)	1.94	(1.03, 3.66)	0.04
Race/Ethnicity					
Non-Hispanic White	*Referent*				
Hispanic	0.44	(0.24, 0.83)	0.42	(0.22, 0.81)	0.01
Non-Hispanic Black	0.58	(0.33, 1.02)	0.39	(0.19, 0.81)	0.01
Other/Mixed	0.95	(0.27, 3.38)	0.92	(0.28, 3.02)	0.89
Marital Status					
Divorced, separated, widowed, or never married	*Referent*				
Married or living with partner	1.95	(1.14, 3.32)	1.50	(0.78, 2.89)	0.22
Duration of Diabetes (years)					
0-4	*Referent*				
5-14	0.43	(0.24, 0.78)	0.36	(0.17, 0.74)	0.01
≥ 15	0.43	(0.21, 0.89)	0.41	(0.18, 0.97)	0.04
# of Times Saw Doctor for Diabetes in Past Year					
0-2	*Referent*				
≥ 3	1.99	(1.21, 3.26)	2.20	(1.27, 3.82)	0.01
Ever Seen a Diabetes Specialist, Dietitian, or Nutritionist					
Never	*Referent*				
Yes	0.84	(0.43, 1.67)	0.73	(0.40, 1.33)	0.29
Doctor Checked for Foot Sores in Past Year					
No	*Referent*				
Yes	1.60	(0.79, 3.25)	1.50	(0.67, 3.35)	0.32
Received Dilated Eye Exam in Past Year					
No	*Referent*				

Yes	1.95	(1.19, 3.22)	1.90	(1.09, 3.30)	0.03
Frequency of SMBG					
< 1 time per day	*Referent*				
≥ 1 time(s) per day	0.93	(0.54, 1.60)	1.03	(0.50, 2.12)	0.94
Type of Antidiabetic Treatment					
None/No insulin or oral agents	*Referent*				
Insulin with or without oral agents	0.62	(0.24, 1.61)	0.39	(0.14, 1.05)	0.06
Oral agents only	1.80	(0.75, 4.33)	1.39	(0.51, 3.81)	0.52
Taking Antihypertensive Medication					
No	*Referent*				
Yes	1.08	(0.61, 1.93)	0.78	(0.30, 2.04)	0.60
Taking Lipid-Lowering Medication					
No	*Referent*				
Yes	1.70	(1.09, 2.66)	2.09	(0.92, 4.77)	0.08
HDL cholesterol (mg/dL)	1.01	(0.99, 1.03)	1.01	(0.99, 1.04)	0.24
Triglycerides (mg/dL)	1.00	(0.99, 1.00)	1.00	(0.99, 1.00)	0.45
HRQoL: Physical Health					
< 14 days poor physical health	*Referent*				
≥ 14 days poor physical health	1.33	(0.62, 2.84)	1.49	(0.75, 2.95)	0.25
HRQoL: Mental Health					
< 14 days poor mental health	*Referent*				
≥ 14 days poor mental health	0.98	(0.44, 2.18)	1.11	(0.59, 2.09)	0.74
Severe Depression (yes/no)					
No	*Referent*				
Yes	0.21	(0.02, 1.86)	0.56	(0.05, 5.88)	0.62
Seen Mental Health Professional in Past Year					
No	*Referent*				
Yes	1.20	(0.46, 3.15)	1.61	(0.48, 5.37)	0.43

Model adjusted for age, educational level, insurance coverage, poverty-to-income ratio, smoking status, waist circumference, body mass index, family history of diabetes, hypertension, high cholesterol, congestive heart failure, coronary heart disease, heart attack, stroke, diabetes-related retinopathy, total # of comorbidities, and serum creatinine.

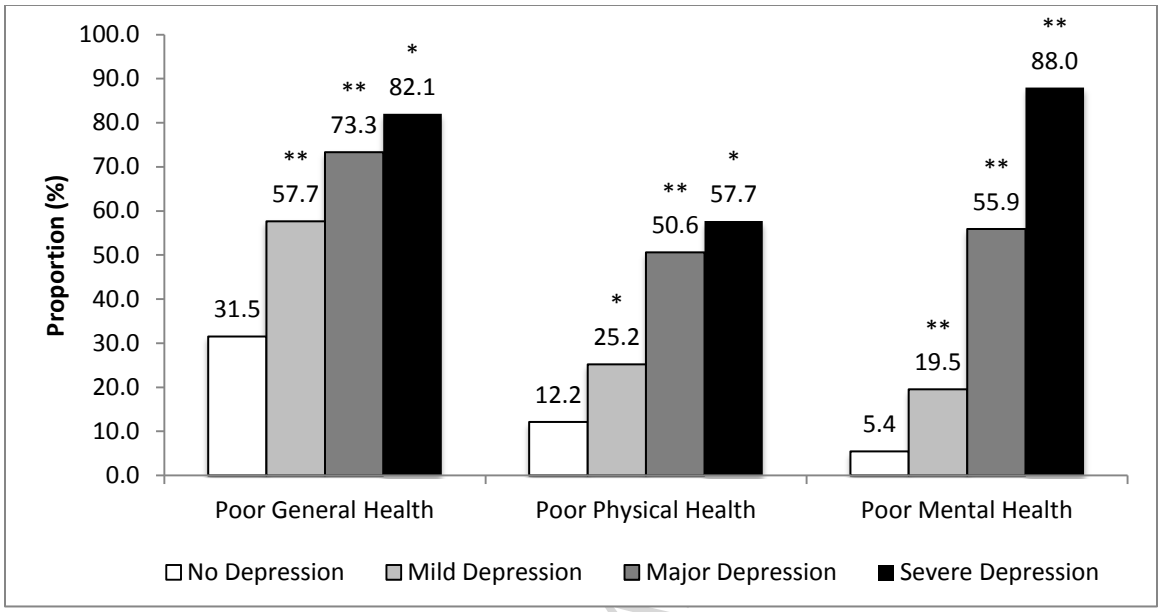

Fig. 1: HRQoL stratified by depression severity among subjects with T2DM (depression category based on PHQ-9 score: No (referent), 0-4; Mild, 5-9; Major, ≥ 10 plus anhedonia and/or depressed mood; Severe, ≥ 20).
* $p < 0.01$ vs. No Depression
** $p < 0.001$ vs. No Depression