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Depressive Symptom Dimensions and Medication Non-adherence in Suboptimally Controlled Type 2 Diabetes

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Abstract

Aims: Research suggests differential effects for somatic and cognitive-affective depressive symptoms in predicting health outcomes. This study evaluated differential relations with medication non-adherence among disadvantaged, and predominantly immigrant adults with sub-optimally controlled Type 2 diabetes (T2D).

Methods: Health plan members taking oral diabetes medication and who had A1c≥7.5% were recruited for a trial of telephonic self-management support. A subset (n=376; age, M=56.6±7.2 years; A1c M=9.1 %±1.6) completed the Patient Health Questionnaire-8 (PHQ-8). Diabetes medication adherence was measured by self-report and claims-based records. Multivariable logistic regression modeled depressive symptoms and odds of non-adherence using pre-intervention data.

Results: A positive PHQ-8 screen (OR=2.72 [95%CI: 1.56-4.73]) and each standard deviation increase in PHQ-8 score (OR=1.40 [95%CI: 1.11-1.75]) were associated with non-adherence, with no independent effects for somatic versus cognitive-affective symptoms. Exploration of individual symptoms identified four significantly associated with non-adherence; after adjustment for likely presence of clinical depression, only fatigue was independently associated with non-adherence (OR=1.71 [95%CI: 1.06-2.77]).

Conclusions: Findings support depression symptom severity as a significant correlate of medication non-adherence among disadvantaged adults with T2D. Support was limited for differential associations for symptom dimensions, but findings suggest fatigue may be associated with non-adherence independent of the likely presence of depression.

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Keywords

type 2 diabetes; medication adherence; depression; somatic symptoms; cognitive-affective symptoms

1. Introduction

Depression is more prevalent among individuals with type 2 diabetes (T2D) compared to those without diabetes[1], and is associated with worse diabetes treatement outcomes, including complications and mortality.[2,3] One potential explanatory pathway for the association between depression and worse diabetes outcomes involves a purported causal effect of depressive symptoms on treatment adherence.[4] Prior research documents consistent correlational associations between increased overall depressive symptom severity and poor diabetes self-management,[5] even at subclinical levels of symptom severity.[6]

However, depression is an extremely heterogeneous construct involving various symptoms and signs, clouding our interpretation of the meaning of elevated scores on depression measures that aggregate these symptoms and our understanding of the mechanisms for the relationship between depressive symptoms and health behaviors and outcomes. To address this issue, studies have examined somatic (e.g., fatigue, sleep disturbance) and cognitive-affective (e.g., sadness, loss of interest) dimensions of depression separately. Findings from national representative samples in various medical populations (e.g., palliative care, spinal cord injuries, and coronary heart disease) indicate that a two-factor model of somatic and cognitive-affective dimensions better fit depressive symptom data than a one-factor solution, [7-11] with these dimensions showing stability over time.[7] A population-based study examining these symptom dimensions showed that differences between adults with and without diabetes were limited to somatic symptoms and not observed for the hallmark cognitive-affective symptoms most central to our conception of depression as a psychiatric disorder.[10]

Differential associations of somatic and cognitive-affective symptom dimensions have also been found in relation to health outcomes in individuals with chronic illness, including diabetes. Relatively robust evidence, from individual studies and a meta-analysis, suggests that somatic rather than cognitive-affective symptoms of depression uniquely predict cardiovasulcar disease outcomes, including the development of heart disease, cardiac events, and mortality.[8,11] In diabetes, individual somatic symptoms as well as cognitive-affective symptoms and symptom groupings have shown to be associated with A1C, though relationships may differ between T1D and T2D.[12,13] In adults with T2D, Bot and colleagues[12] found that endorsement of sleeping difficulties, appetite problems and suicidal ideation (n=365) was cross-sectionally associated with baseline A1C, though no symptoms showed an association with A1C collected at 1 year. Ehrmann and colleagues[13] grouped depression symptoms into somatic, affective and anhedonic dimensions and found scores on the somatic dimension were positively associated with A1C whereas the affective dimension was negatively associated with A1C and the anhedonic dimension was not associated with A1C among individuals with T1D (n=604); no significant associations between symptom

dimensions and A1C were found among individuals with T2D (n=382). A previous cross-sectional study examined symptom groupings from a depression symptom scale among 5,773 individuals with T2D and found that anhedonia was significantly associated with higher A1C whereas depressed mood and anxiety were not.[14] Another study showed that depressed mood was associated with shorter time to cardiovascular hospitalization among adults with T2D, but this was no longer significant after adjustment for covariates; anhedonia was not associated with cardiovascular hospitalization in unadjusted or adjusted analyses. Contrary to expectations, higher anxiety dimension scores from the depression scale were associated with *longer* time to cardiovascular hospitalization, in adjusted analyses only.[15] Finally, recent evidence from a relatively small sample of adults with T2D showed that dimension scores for somatic symptoms, either assessed by self-report or via clinician-rated interview, were associated with electronically-monitored medication non-adherence, whereas cognitive-affective dimension scores were not associated with adherence; neither symptom dimension was associated with A1C.[16] We are unaware of other studies examining depressive symptom dimensions in relation to medication adherence.

This study aimed to assess the relationship between depressive symptoms and odds of low medication adherence among low-income, mostly foreign-born, ethnically diverse adults with T2D, a demographic profile associated with increased risk for poor glycemic control, problems with self-management and increased emotional distress.[1,17,18] Participants were recruited based on their suboptimal glycemic control, despite oral diabetes medication treatment, for an intervention to improve self-management and glycemic control through the provision of telephonic support delivered by health educators. We expected a significant relationship between increased overall depression severity and low adherence and hypothesized that somatic symptoms that overlap with diabetes (i.e., fatigue, trouble sleeping, appetite changes and moving or speaking slowly) would show stronger associations with medication non-adherence than cognitive-affective symptoms. Based on prior research,[6] we also hypothesized that the relationship between depression symptoms and low adherence would be consistent across the full range of symptom severity irrespective of whether major depressive disorder may be present.

2. Subjects, Materials and Methods

2.1 Subjects and Procedures

The larger sample has been described in Walker and colleagues.[19] Members of a union/employer jointly sponsored health plan were recruited for a telephonic self-management randomized controlled trial (RCT) (n=526).[19] Inclusion criteria for this larger RCT included being 30 years or older, being on ≥1 oral diabetes medication, having sub-optimal glycemic control (A1c ≥ 7.5%), ability to read and write English or Spanish, no evidence of cognitive impairment, and being a member of the health care worker union Fund based in New York City. Members of the Fund included full-time health workers or their spouses, with the Fund fully covering prescription medications, doctor visits, laboratory tests and hospitalizations.

The larger RCT aimed to test interventions among individuals facing challenges in attending diabetes self-management education programs in person, and thus did not include face-to-face interactions with participants. A pre-intervention subset (n=376) completed the Patient

Health Questionnaire-8 (PHQ-8),[20] and were included in the current study. The reason only a subset of participants completed the PHQ-8 was because the measure was collected during a second baseline phone call set up to follow the initial call to reduce participant burden, and not all participants could be reached for this second call. Informed consent and Health Insurance Portability and Accountability Act (HIPAA) authorization were obtained orally by telephone. The study was approved by the Albert Einstein College of Medicine Institutional Review Board.

2.2 Measures

Demographics and illness-related variables.—Demographic variables include age, sex, race and ethnicity, marital status, work status, income, self-reported height and weight, and one's country of origin (coded as mainland US- or foreign-born) and language preference (English, Spanish). Illness-related variables were assessed as part of the screening procedures and pharmacy claims data included medication regimen, illness duration, and insulin use in the previous year (never/ever).

Depressive symptoms.—Symptoms of depression over the previous 2 weeks were assessed using the brief Patient Health Questionnaire-8 (PHQ-8).[20] The validated PHQ-8 consists of 4 somatic (sleep, fatigue, appetite and psychomotor changes) and 4 cognitive affective (loss of interest, depressed mood, negative self-feelings, and difficulty concentrating) symptoms.[7,9,16] The PHQ-8 asks individuals to report depressive symptoms on a 4-point scale (0=not at all, 1=several days, 2=more than half the days, and 3=nearly every day) for the preceding 2-week period. The items are summed for a total score ranging from 0 to 24, with higher scores indicating increased distress. A total score of 10 or higher is considered as a positive screening result for major depressive disorder.[20] Internal reliability in the current sample for total (α=.84), somatic (α=.73) and cognitive-affective (α=.75) scores was good. The two symptom dimensions showed a strong correlation (r=.68, p<.001).

Medication Adherence.—Pharmacy claim records were obtained through the Fund and included oral glucose lowering agent (OGLA) prescription fill date, its class, number of pills prescribed per day, and total number of pills dispensed. This information, collected over a 12-month period prior to baseline participation, was used to calculate a total medication possession ratio (MPR) (number of days' supply of pills dispensed in 1 year/365 days), which is a commonly used medication adherence measure.[21,22] A higher MPR or claims-based score indicates higher medication adherence. Claims-based adherence was defined as low if MPR was in the lowest tertile.[23]

Self-reported medication adherence was measured using the 4-item Morisky Green Levine Medication Adherence Scale (MGLS).[24] The MGLS assesses both unintentional (i.e., forgetting and carelessness) and intentional (i.e., stopping the drug when feeling better / worse) adherence to medications. Response choices are dichotomous (yes/no), which were added together and reverse-coded so that higher scores indicate higher medication adherence (0 = low adherence, 4 = high adherence). Low self-reported (SR) adherence was defined as a MGLS score <2.[23] The MGLS has been shown to be reliable and valid among various patient populations.[24,25]

Glycemic Control.—Glycemic control was assessed by A1c collected using mail-in kits ("Lab-in-an-envelope").[26] For this, participants drew blood from their fingertips using a spring-loaded lancet and filled in 1 to 3 circles on a filter paper (each 1.2 cm in diameter) that was then mailed in a pre-paid envelope to the Home Healthcare Laboratory of America for analysis. The test done with a Roche analyzer had been approved by the National Glycohemoglobin Standardization Program (NGSP),[27] and obtaining A1c values using filter paper have shown to produce similar values compared to assessing A1c using conventional whole-blood samples.[28]

2.3 Statistical Analyses

Descriptive statistics were examined for measures of medication adherence, depressive symptoms, and patient and illness-factors, as well as their bivariate relationships. Pearson's r and Student's t-tests were used to assess bivariate relationships between continuous variables, and χ^2 tests were used for categorical variables. Glycemic control was included as a continuous variable, as well as categorized as sub-optimal (7.5% <= A1C < 8.5%) and poor (A1c≥8.5%).

Medication adherence was analyzed based on combined information from pharmacy claim records and self-reports on the MGLS, based on a general lack of evidence for superiority of one method of assessment over another and the apparent increase in accuracy associated with composite measures that combine multiple methods of assessment.[29] Results from the full sample of the parent study showed that both measures were significantly associated with glycemic control.[19,23] In the current subsample, low SR adherence was significantly associated with poor glycemic control ($\chi^2(1,375)=4.2$, $p=.048$) and low claims-based adherence showed a trending relationship with A1c ($t(374)=-1.9$, $p=.06$). For the current analyses, we categorized those with low adherence on either or both measures as having low adherence ($n=207$) and compared this group to those who did not have low adherence on either measure ($n=169$).

Separate univariate and multivariable logistic regression models were constructed to test four methods of modeling depression as a predictor of low adherence: 1) total PHQ-8 score (z-transformed to assess the increase in odds for each SD increase in depressive symptom severity), 2) positive screening result on the PHQ-8 (y/n), 3) cognitive-affective and somatic symptom dimension scores (entered in separate models and together) and 4) individual depressive symptoms (entered as dichotomous variables [endorsed, y/n]). Dichotomous coding of symptoms reduced the influence of depression severity on the assessment of individual symptoms and reduced shared variance between individual symptoms and the PHQ-8 screening result (from 24-52% to 14-31%). In multivariable models, we adjusted for covariates age, gender, A1C, insulin use, and diabetes duration, to assess the independent associations of depressive symptoms.

To test whether the relationship between depression symptoms and low adherence was consistent across the full range of symptom severity irrespective of whether major depressive disorder (MDD) may be present, as reported by Gonzalez and colleagues,[6] the multivariable model with total PHQ-8 score was further adjusted for PHQ-8 screening result, which has been reported to have a false negative rate of 0% and 3.0% for MDD or any

depressive disorder, respectively.[20] We also adjusted estimates for individual symptoms for PHQ-8 screening result in a separate step to evaluate the effect of controlling for risk of MDD on the relations between individual symptoms and low adherence. Models with total PHQ-8 score and individual PHQ-8 symptoms were also repeated after excluding all participants who screened positive for MDD. Regression models did not show significant multicollinearity (all VIF <2.5, tolerance >.40). Analyses were conducted using SPSS software version 22.0.[30]

3. Results

3.1 Sample characteristics

Baseline characteristics of the study sample are reported in Table 1 and show participants were racially diverse, mostly foreign-born, mostly middle-aged adults with poor glycemic control, with 22.9% prescribed insulin in addition to their oral diabetes medication(s). Participants included in the present analyses (who completed the PHQ-8 at baseline) had significantly better glycemic control (M=9.1±1.6) and poorer SR adherence (M=2.7±1.1) than those of the larger dataset who did not complete the PHQ-8 at baseline (M_{A1C}=9.6±2.0, $t(524)=11.7$, $p=.001$; M_{SR}=3.0±1.1, $t(524)=4.4$, $p=.04$). The groups did not significantly differ on other study variables. The average self-reported medication adherence was 2.72 (SD=1.11) indicating “medium” adherence and average claims-based MPR was 0.55 (*SD*=0.25), which corresponds to the approximate middle of the possible range of scores for MPR (0-1.0), but is lower than the average MPR of 0.75 reported by a meta-analysis of 13 studies with T2D samples.[31] The average PHQ-8 score was 5.8 (SD=5.5), indicating “mild” levels of depressive symptoms, and approximately 23% screened positive for MDD. Overall, patients scored significantly higher on somatic (*M*=3.2, *SD*=3.0; mean rank=135.1) than cognitive-affective symptoms (*M*=2.6, *SD*=2.9; mean rank= 133.5; Wilcoxon $Z=-4.5$, $p<.001$).

A total of 84% of participants were born outside of the mainland US, with the most common area of origin being the Caribbean Islands (58.8%). Approximately 16% of participants preferred Spanish to English.

3.2 Bivariate Relationships: Medication Adherence, Depressive Symptoms and Covariates

Claims-based and SR medication adherence showed a significant positive relationship ($r=.26$, $p<.001$), with approximately 6.8% shared variance. As illustrated in Table 1, having low medication adherence was significantly associated with having an A1C value at or above 8.5%, younger age, shorter diabetes duration, a higher total PHQ-8 score, and positive PHQ-8 screen. Low medication adherence was not associated with insulin use. Higher total PHQ-8 scores were associated with younger age ($r(374)=-.18$, $p<.001$), being female ($t(374)=3.86$, $p<.001$), and insulin prescription ($t(374)=-2.27$, $p=.02$).

3.3 Depressive Symptoms and Low Medication Adherence

When controlling for covariates, a positive PHQ-8 screen for MDD was associated with a 2.72-fold increase in the odds of low adherence (OR = 2.72 [1.56–4.73]), and each standard

deviation increase in the PHQ-8 symptom severity score was associated with 40% increased odds of low medication adherence (OR=1.40 [1.11–1.75]). The overall total symptom severity score did not remain significantly associated with low adherence when the analysis was limited to those who screened negative on the PHQ-8 (OR=1.02 [95%CI: 0.65-1.60]) or when screening result was adjusted statistically (OR=0.98 [95%CI: 0.66-1.45]).

The cognitive-affective and somatic dimensions showed similar associations with low adherence when entered in the model individually with covariates (cognitive-affective: OR=1.12 [1.04-1.21]; somatic: OR= 1.09 [1.02–1.18]), and neither dimension showed an independent relationship when both were entered in the same model (cognitive-affective: OR=1.10 [95%CI: 0.99-1.22]; somatic: OR=1.03 [95%CI: 0.93-1.13]).

Table 2 shows symptom endorsement frequency and results of logistic regression models with dichotomized depressive symptoms. Endorsement of ‘move or speaking slowly, or opposite’ (OR=2.01 [95% CI, 1.16–3.47]), ‘tired or little energy’ (OR=2.15 [95%CI: 1.37-3.38]), and ‘trouble concentrating’ (OR=1.72 [95%CI: 1.07-2.78]) independently predicted low medication adherence when adjusting for covariates. Only endorsement of ‘tired or little energy’ remained an independent predictor when removing those with a positive PHQ-8 screen (OR=1.77 [95%CI: 1.09-2.87]) or when adjusting for a positive PHQ-8 screen (OR=1.71 [95%CI: 1.06-2.77]) as a covariate.

4. Discussion

The goal of this study was to examine the associations between depressive symptoms and low medication adherence among disadvantaged, racially diverse, and predominantly immigrant adults with sub-optimally controlled T2D. Findings replicate previous research showing a consistent association between overall depressive symptom severity and medication non-adherence.[5] Whether based on depression screening result or overall depression symptom severity, we observed significant and substantial relationships between depression and medication non-adherence. Previous findings suggesting a stronger association for somatic symptoms of depression as compared to cognitive-affective symptoms were not replicated in this sample.[16] Our results showed no differential relationship to medication non-adherence for PHQ-8 symptoms when grouped as somatic vs. cognitive-affective dimensions, and neither of these dimensions demonstrated significant independent relationships with medication adherence. Given that the unique effect of somatic vs. cognitive-affective symptoms was only observed on adherence data collected by electronic monitoring and was not observed for adherence measured by self-report in the earlier study,[16] further research that takes measurement methods into account is warranted.

In contrast to expectations based on previous research,[6] we did not find that the relationship between depression symptoms and low adherence was consistent across the full range of symptom severity irrespective of whether major depressive disorder may be present. Rather, relationships between overall depressive symptom severity and non-adherence were attenuated to non-significance when adjusting for clinically significant depression via either limiting the analysis to those with very low likelihood of having clinical depression (e.g. 0-3% false negatives[20]), or through statistical adjustment for a positive depression screening

result. The current study differed from that of Gonzalez and colleagues[6] in significant ways. First, the earlier study used a larger convenience sample of adults recruited from primary care, not based on sub-optimal glycemic control or interest in obtaining support for their diabetes self-management. Results from the current sample may be more generalizable to individuals with suboptimal glycemic control who have identified a problem with their self-management and are motivated to address it. It may be possible that clinical depression is more of a driver of low adherence among this group of patients, who in general were experiencing problems with their glycemic control and treatment adherence, than in the general population of primary care patients with T2D. Second, the earlier sample also included largely White working class adults with T2D, while this sample predominantly included disadvantaged Black and foreign-born adults. Previous research has shown differences in depression symptom profiles among Blacks and immigrant Hispanics compared to non-Hispanic White adults in the US,[32,33] which could limit the comparability of our results. Finally, the earlier study relied on a single item self-report for medication adherence over the prior seven days, whereas the current study used a composite of self-reported medication non-adherence, measured as a general tendency to ever have adherence problems, and pharmacy refill data. Future research should examine whether contextual or psychosocial factors (e.g., race/ethnicity, immigration status, adherence measurement method, degree of glycemic control) potentially moderate the relationship between depressive symptoms and non-adherence among adults with T2D.

This study provides novel findings on unique symptom-level associations between depressive symptoms and medication non-adherence. In the current study, significant and substantial associations were observed between endorsement of individual somatic and cognitive-affective symptoms. Specifically, psychomotor changes, fatigue, and impaired concentration showed independent associations with low treatment adherence in covariate-adjusted analyses. Only endorsement of one somatic symptom, fatigue, had a statistically significant relationship to low medication adherence when accounting for the likely presence of depression, suggesting that the associations of individual symptoms with low adherence in this sample were primarily explained by overall depression severity or likelihood of the presence of MDD. Symptom-level findings were inconsistent with symptoms previously linked to glycemic control,[12-14] but show similarities with a previous cross-sectional study linking individual depressive symptoms to differences in functioning and behavioral variables among individuals with depression. Fried and Nesse[33] found that concentration problems and sad mood were the two depressive symptoms most strongly associated with reduced functioning related to work, managing the home, social and private activities, and social relationships among 3,703 depressed outpatients. It is possible that the presence of particular depressive symptoms such as concentration problems are more strongly associated with behavioral variables that can impact health. Our findings of symptom-level differences support the conclusion by others[34-36] that a focus on total depressive symptom sum scores may obscure meaningful symptom-level associations with demographic and behavioral variables.

Fatigue may have a relationship with risk for non-adherence that is independent of the role of depression. Fatigue is a common symptom in diabetes that has been shown to be associated with poor glycemic control,[37] and endorsement of fatigue showed the lowest

association with a positive screen for depression in the current sample (shared variance=14%). Previous research has identified fatigue as a likely barrier to self-management, including medication adherence, in non-depressed chronic illness samples (e.g.,[38,39]). Fatigue has also been shown to be associated with psychosocial factors, with fatigue more commonly reported among ethnic minorities[40] and individuals with low SES,[41] as compared to their White and higher SES counterparts. The finding that fatigue was the most commonly endorsed symptom in the current study highlights the importance of better understanding this symptom in relation to depression, treatment adherence and sub-optimally controlled T2D, particularly among disadvantaged individuals.

The results of this study should be considered in the context of its design. The sample is unique given its insurance coverage, lower income, high number of foreign-born participants, and entry criterion of sub-optimal glycemic control despite prescription of diabetes medication, all in which limit its generalizability. Furthermore, we were unable to control the level of disease burden, which was not measured and may have contributed to observed relationships between patient and/or illness factors and depression symptom dimensions. Additionally, concordance between our two measures of adherence was low, which is common,[42,43] but contributes to heterogeneity. Finally, baseline data were cross-sectional, and thus causal and directional inferences cannot be made. Future studies with a longitudinal design, including ecological momentary assessment methods, would allow for better assessment of the direction of influence underlying the observed associations between depressive symptoms and medication adherence.

This study supports that the presence of elevated depressive symptoms, as well as fatigue independent of depression, may be risk factors for low medication adherence. Given the cross-sectional nature of the results, as well as the lack of consistency among studies, it is difficult to make specific clinical recommendations until the relationship between depressive symptoms and medication adherence is further clarified. For example, intervention studies that have had a significant impact on improved depressive symptoms in diabetes have tended not to find cooccurring improvement in medication adherence and other self-management behaviors (e.g.,[44]). Similarly, physical activity has been shown to alleviate fatigue among chronic illness patients (e.g.,[45,46]) and meta-analysis also supports cognitive-behavioral therapy as a moderately efficacious treatment for reducing chronic fatigue,[47] though it remains unclear whether reductions in fatigue would improve medication adherence among individuals with diabetes.

Overall, our results highlight the complex relationship between depressive symptoms and low medication adherence. Continued research involving symptom-level associations may help clarify mixed findings in terms of depression and self-management behaviors among individuals with diabetes. In this sample, a positive PHQ-8 screen and total depressive symptoms were related to medication non-adherence, with the endorsement of three symptoms showing independent relationships. Only endorsement of the somatic symptom, fatigue, was independently associated with treatment non-adherence when excluding those with probable depression or when adjusting for probable depression and other potential confounders. Results suggest that health providers should pay attention to the presence and severity of depression, as well as the presence of fatigue, in relation to medication non-

adherence among their patients. Future research should examine temporal or causal relationships between depressive symptoms and low adherence to distinguish whether specific symptoms largely contribute to or result from low adherence, or both. Continued work examining the role of specific emotional and physical symptoms in relation to diabetes self-management and health outcomes would contribute to the growing literature on patient-reported outcomes in diabetes, and may contribute to improved diabetes care.

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Table 1.

Participant Characteristics

	Total	Not Low Adherence	Low Adherence	p
	N=376	N=169	N=207	
Age (range = 41-73), M (SD)	56.6 (7.15)	56.9 (7.1)	54.6 (7.0)	**.002**
Female Sex, % (n)	68.6 (258)	27.8 (47)	34.3 (71)	.182
BMP[†] (n=375), M (SD)	31.6 (6.2)	31.1 (6.1)	32.1 (6.3)	.124
Foreign-born, %(n)	84.0 (316)	85.8 (145)	82.6 (171)	.479
Hispanic Ethnicity, % (n)	23.1 (87)	23.7 (40)	22.3 (47)	.807
Race, % (n)				**.034**
Black	65.7 (247)	60.9 (103)	69.6 (144)	
White	14.6 (55)	16.0 (27)	13.5 (28)	
Asian	5.1 (19)	7.7 (13)	3.9 (8)	
More than one	5.6 (21)	3.0 (5)	6.8 (14)	
Other/Unknown	9.0 (34)	12.4 (21)	6.3 (13)	
Education Level (n=373), % (n)				.758
Less than high school diploma	27.6 (104)	28.4 (48)	27.1 (56)	
High school diploma	31.4 (118)	32.0 (54)	31.0 (64)	
Some college or tech school	20.7 (78)	25.4 (43)	24.2 (50)	
College degree or more	15.4 (58)	13.0 (22)	12.6 (26)	
Not Know	0.8 (3)	1.2 (2)	0.5 (1)	
Annual Income (n=327), % (n)				.090
Less than $29,000	40.7 (153)	40.8 (69)	40.6 (84)	
$30,000-$49,000	28.2 (106)	32.5 (55)	24.6 (51)	
$50,000-$99,999	18.1 (68)	13.0 (22)	22.2 (46)	
Refused/Not Know	13.0 (49)	13.6 (23)	12.6 (26)	
Years since diagnosis, (n=367), M (SD)	9.43 (6.7)	10.3 (6.8)	8.7 (6.4)	**.024**
A1C > 8.5%, % (n)	53.2 (200)	47.3 (80)	58.0 (120)	**.048**
A1C (%), M (SD)	9.1 (1.6)	8.9 (1.5)	9.2 (1.7)	.061
Mmol/mol	76.0 (17.5)	73.8 (16.4)	77.0 (18.6)	.061
Prescribed insulin, % (n)	22.9 (86)	22.5 (38)	23.2 (48)	.902
Medication Adherence, M (SD)				
Self-Report	2.7 (1.1)	3.5 (0.5)	2.1 (1.0)	**<.001**
Pharmacy Claims	0.55 (0.3)	0.7 (0.2)	0.4 (0.2)	**<.001**
PHQ-8 ≥ 10	22.9 (86)	14.2 (24)	30.0 (62)	**<.001**
Total PHQ-8, m (SD)	5.78 (5.49)	4.82 (4.9)	6.58 (5.8)	**.002**
Somatic Symptoms, m (SD)	3.2 (3.0)	2.73 (2.8)	3.56 (3.2)	**.008**
Trouble falling / staying asleep, m (SD)	.93 (1.1)	0.80 (1.1)	1.03 (1.2)	.050
Tired or little energy, m (SD)	1.2 (1.1)	1.07 (1.1)	1.29 (1.1)	**.049**
Poor appetite, m (SD)	.71 (1.0)	0.62 (1.0)	0.79 (1.0)	.110
Move or speak slowly, m (SD)	.36 (0.8)	0.24 (0.7)	0.45 (0.9)	**.011**
Cognitive-Affective Symptoms, m (SD)	2.6 (2.9)	2.1 (2.6)	3.0 (3.2)	**.002**

	Total	Not Low Adherence	Low Adherence	p
	N=376	N=169	N=207	
Little pleasure in doing things, m (SD)	.84 (1.1)	0.71 (1.0)	0.94 (1.1)	**.035**
Feeling down, depressed, m (SD)	.79 (1.0)	0.64 (0.9)	0.91 (1.1)	**.009**
Feeling bad about yourself, m (SD)	.50 (0.9)	0.37 (0.8)	0.61 (1.0)	**.009**
Trouble concentrating, m (SD)	.48 (.87)	0.38 (0.8)	0.56 (0.9)	**.041**

Table 2.

Dichotomized depressive symptoms as predictors of low adherence.

	Endorsement Frequency		Predicting Low Adherence			
	Not Low Adherence % (n)	Low Adherence % (n)	Unadjusted OR (95%CI)	Covariate-Adjusted†† OR (95%CI)	Depression Screen-Adjusted††† OR (95%CI)	Likely Depression Excluded§ OR (95%CI)
Somatic Symptoms						
Trouble falling/staying asleep, y	43.2 (73)	52.7 (109)	1.46 (0.97–1.20)	1.51 (0.98–2.32)	1.16 (0.73-1.84)	1.27 (0.77-2.09)
Tired or little energy, y	**57.4 (97)**	**73.9 (153) ****	**2.10 **(1.36–3.25)**	**2.15 **(1.37–3.38)**	**1.71 *(1.06-2.77)**	**1.77 *(1.09-2.87)**
Poor appetite, y	36.7 (62)	44.4 (92)	1.38 (0.91–2.09)	1.29 (0.83–2.00)	0.91 (0.56-1.48)	0.69 (0.40-1.18)
Move or speak slowly, y	**13.8 (25)**	**24.6 (51) ***	**1.88 *(1.11–3.20)**	**2.01 *(1.16–3.47)**	1.35 (0.73-2.51)	1.23 (0.55-2.74)
Cognitive-Affective Symptoms						
Little pleasure in doing things, y	**40.8 (69)**	**51.2 (106) ***	**1.52 *(1.01–2.29)**	1.48 (0.97–2.27)	1.07 (0.67-1.72)	1.04 (0.63-1.73)
Feeling down, depressed, y	42.0 (71)	49.8 (103)	1.37 (0.91–2.06)	1.34 (0.87–2.06)	0.87 (0.53-1.43)	0.89 (0.53-1.50)
Feeling bad about yourself, y	22.5 (38)	31.4 (65)	1.58 (0.99–2.51)	1.55 (0.95–2.53)	0.94 (0.52-1.69)	1.14 (0.56-2.31)
Trouble concentrating, y	**23.1 (39)**	**32.4 (67) †**	**1.60 *(1.01–2.53)**	**1.72 *(1.07–2.78)**	1.19 (0.69-2.05)	1.00 (0.53-1.92)

† p=.05

* p<.05,

** p<.01

†† Adjusted for age, gender, A1C, insulin use, and illness duration

††† Adjusted for positive screen, age, gender, A1C, insulin use, and illness duration

§ Excluding those with positive screen for depression (n=290); adjusted for age, gender, A1C, insulin use, and illness duration