The Effects of Depression on Metabolic Control and Quality of Life in Indigent Patients with Type 2 Diabetes

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Abstract

Background: The objective of this study was to assess differences in metabolic control and health-related quality of life (QOL) among depressed and nondepressed adults in an indigent population with type 2 diabetes.

Research Design and Methods: Subjects completed validated surveys to assess depression and QOL. Depression was assessed with the Center for Epidemiological Studies–Depression Scale and defined as a score of ≥ 16 . Metabolic control (hemoglobin A1C, total cholesterol, low-density lipoprotein [LDL] cholesterol, and high-density lipoprotein [HDL] cholesterol) measures were abstracted from medical records. We compared demographic characteristics, metabolic control, and QOL by depression status. Ordinary least squares regression was used to assess differences in QOL scores and metabolic control levels by depression status adjusting for covariates.

Results: In the study sample ($n = 201$), approximately 20% ($n = 40$) were depressed. In unadjusted analyses, subjects with depression had significantly lower SF-12 physical component summary (PCS) scores (30.4 ± 7.3 vs. 39.6 ± 11.8 , $P < 0.001$) and mental component summary (MCS) scores (32.8 ± 10.5 vs. 48.9 ± 9.2 , $P \leq 0.001$) and significantly higher total cholesterol (209.3 ± 72.1 vs. 186.6 ± 50.9 , $P = 0.024$) compared to those without depression. No significant differences were observed by depression status in hemoglobin A1C, LDL cholesterol, and HDL cholesterol. After adjustment for relevant covariates, depressed individuals continued to have lower SF-12 PCS (36.1 vs. 39.0 , $P \leq 0.001$) and MCS (41.6 vs. 46.8 , $P \leq 0.001$) scores, but the difference in total cholesterol levels was no longer significant.

Conclusions: In an indigent sample with type 2 diabetes, depression is significantly associated with decreased physical and mental components of QOL. This finding further reinforces the importance of addressing depression in all populations with type 2 diabetes.

Introduction

DIABETES AFFECTS APPROXIMATELY 21 million Americans each year with estimated annual direct and indirect costs exceeding \$130 billion dollars.¹ Approximately 30% of all patients with diabetes are believed to have symptoms of comorbid depression; however, all do not necessarily meet the criteria for a diagnosis of depression.² On the other hand, approximately 10% of patients with diabetes have major depression resulting from psychosocial and/or biochemical changes associated with the disease process.² Depression in individuals with diabetes is linked to at least two unfavorable outcomes: poor metabolic control^{3–5} and decreased health-related quality of life (QOL).^{6–8} Thus, depression in patients with diabetes has the potential to complicate diabetes man-

agement practices and negatively affect short- and long-term outcomes.

A review of the current literature related to the effects of depression on diabetes outcomes indicates that at least two specific gaps exist. First, few previous studies have examined the relationships among depression, metabolic control, and QOL in an indigent population. Second, little is known about the effects of depression on diabetes outcomes in patients from low socioeconomic groups where the prevalence of diabetes is much higher.^{9,10} Patients from disadvantaged backgrounds typically do not have access to a usual source of care, and for that reason they are often faced with expensive, serious, but preventable complications associated with diabetes.¹¹ Consequently, it is unclear how diabetes-related patient outcomes (metabolic control and health-related QOL) are affected by

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depression in patients from disadvantaged or low socioeconomic backgrounds and who lack a usual source of care.^{10,11}

The objective of this study was to examine the effects of depression on metabolic control and health-related QOL in an indigent population with type 2 diabetes. We hypothesized that depressed subjects would have significantly lower scores on the physical and mental health components of the SF-12 scale and significantly poorer glycemic control as measured by hemoglobin A1c.

Research Design and Methods

Data source

Data for this study were collected as part of a study funded by the Agency for Health Care Research and Quality to identify patient, provider, and health systems factors that contribute to racial/ethnic differences in health outcomes for low income adults with diabetes and develop a collaborative model of care to reduce healthcare disparities in diabetes. We used billing records from the prior year to identify all patients with type 2 diabetes in the primary care clinics of an academic medical center in the Southeastern United States ($n \sim 3,600$). We took a 10% random sample ($n \sim 360$), and patients were contacted by telephone and invited to participate in the study. The response rate was 60% and did not differ by race/ethnicity. We only had data on race/ethnicity for responders and nonresponders, and there was no significant difference. Two hundred one white and African American patients with a clinical diagnosis of type 2 diabetes who received care from an indigent care clinic were recruited over a 12-month period. Subjects completed validated surveys to assess depression and health-related QOL. Surveys were administered by a research assistant. The study was approved by our local Institutional Review Board. The study was designed to have at least 80% power to detect a 1% point difference in mean hemoglobin A1c and 10-point difference in mean physical component summary (PCS) and mean mental component summary (MCS) scores and mean low-density lipoprotein (LDL) cholesterol levels between depressed and nondepressed groups using a two-sided t test with type 1 error rate of $\alpha = 0.05$. All demographic characteristics collected and reported here were based on self-report.

Variables and instruments

Demographic and clinical variables. These were based on self-report. Age was categorized as <50, 50–64, and 65+ years. Education was categorized as <high school graduate, high school graduate, and >high school graduate. Race was classified as non-Hispanic white and non-Hispanic black. Marital status was dichotomized as married and not married. Insurance status was categorized as private, government (Medicare/Medicaid), and uninsured. Income was categorized as <\$5,000, <\$10,000, <\$15,000, and \$15,000+. Comorbidity was abstracted from the medical records at the same time as when laboratory values were extracted and included: hypertension, heart disease, stroke, congestive heart failure, renal failure, chronic obstructive pulmonary disease, peripheral vascular disease, chronic liver disease, and cancer. Research assistants were trained to review all clinical notes in the past 12 months to identify notation of comorbid conditions. Comorbidity was categorized as 0/1, 2, and 3+. Insulin

use was determined from the medication list in the medical records, and body weight was abstracted from the vital signs section of the electronic medical records. A random 10% sample was reviewed to validate the chart abstraction.

Depression. Depression was assessed with the 20-item Center for Epidemiological Studies–Depression Scale (CES-D).¹² The CES-D is designed to measure the major components of depression (depressed mood, feelings of guilt and worthlessness, feelings of helplessness and hopelessness, and psychomotor retardation) in the general population. The CES-D is a valid and reliable instrument that has been shown to be appropriate for a variety of settings and patient populations. The CES-D has also been deemed reliable for administration in individuals from low income backgrounds¹³ and the homeless.¹⁴ We defined depression as a CES-D score of ≥ 16 .

Metabolic control. Hemoglobin A1C, total cholesterol, and LDL cholesterol were abstracted from the electronic medical records.

Health-related QOL. Health-related QOL was assessed with the Medical Outcomes SF-12 (version 1.0).¹⁵ We computed PCS and MCS scores for the sample.

Statistical analysis

All analyses were performed using version 10 of STATA¹⁶ and version 16.0 of SPSS software (SPSS Inc., Chicago, IL).¹⁷ We performed three main types of analyses. First, we compared the demographic characteristics of the sample by depression status using t test for continuous variables and χ^2 statistics for categorical variables. Second, we computed unadjusted mean scores for hemoglobin A1C, total cholesterol, LDL cholesterol, and health-related QOL by depression status using t tests. Third, we computed adjusted mean scores for hemoglobin A1C, total cholesterol, LDL cholesterol, health-related QOL, and diabetes-related QOL by depression status using ordinary least squares regression controlling for covariates (age, diabetes duration, education, body weight, sex, employment status, insurance status, income, number of comorbid conditions, and insulin use) known to influence diabetes outcomes. All variable distributions were examined for extreme values and skewness and found to be at least approximately normal, allowing the use of parametric statistical tests.

Results

Two hundred one subjects with diagnosed type 2 diabetes were enrolled in the study. As measured by the CES-D Depression Scale approximately 20% ($n = 40$) of the sample was depressed, and 80% was nondepressed ($n = 161$). Those subjects who were depressed were also significantly younger (52.5 vs. 57.6 years, $P = 0.01$) and more likely to be unemployed (95% vs. 68%, $P < 0.001$). Women comprised a significantly larger portion of the depressed subjects than those not depressed (87.5% vs. 68.9%, $P = 0.02$). Duration of diabetes, years of education, marital status, race-ethnicity, insurance status, household income, body weight, and percentage of patients who were insulin users did not differ significantly between depressed and nondepressed subjects. Table 1 shows comparisons of demographic characteristics of the sample by depression status.

TABLE 1. SAMPLE CHARACTERISTICS BY DEPRESSION STATUS

Variable	All (n = 201)	Depressed (n = 40)	Not depressed (n = 161)	P value
Age (%)				
<50 years	21.9	35.0	18.6	
50–64 years	53.7	55.0	53.4	
65+ years	24.4	10.0	28.0	
Age [mean (SD)]	56.6 (10.8)	52.5 (10.9)	57.6 (10.6)	0.01*
Educational level (%)				0.50
<High school	40.4	48.7	38.4	
High school	27.3	23.1	28.3	
>High school	32.3	28.2	33.3	
Years of education [mean (SD)]	11.6 (3.2)	11.3 (2.9)	11.6 (3.3)	0.59
Sex [female (%)]	72.6	87.5	68.9	0.02*
Race/ethnicity (%)				0.08
White	37.8	50.0	34.8	
Black	62.2	50.0	65.2	
Marital status [married (%)]	38.5	25.0	41.9	0.05
Insurance status (%)				<0.01*
Private	19.9	0.0	24.8	
Government (Medicare/Medicaid)	57.2	72.5	53.4	
Uninsured	22.9	27.5	21.7	
Income (%)				0.08
<\$5,000	26.6	34.2	24.7	
<\$10,000	25.0	18.4	26.7	
<\$15,000	23.4	34.2	20.7	
\$15,000+	25.0	13.2	28.0	
Employed [yes (%)]	26.5	5.0	31.9	<0.01*
Comorbidity (%)				0.18
0/1	47.8	35.0	50.9	
2	29.9	35.0	28.6	
3+	22.4	30.0	20.5	
Insulin user [yes (%)]	42.3	55.0	39.1	0.07
Diabetes' duration [mean (SD)]	12.5 (9.1)	12.3 (10.1)	12.5 (8.9)	0.88
Body weight (lbs) [mean (SD)]	218.4 (54.4)	217.1 (59.7)	218.8 (53.1)	0.86

*Statistically significant at $P < 0.05$.

Table 2 shows the unadjusted mean scores for measures of metabolic control and health-related QOL by depression status. In this sample, depressed patients were significantly different from nondepressed patients in (1) total cholesterol levels (mean = 209 ± 72.1 for depressed vs. 186.6 ± 50.9 for nondepressed, $P = 0.02$), (2) health-related QOL PCS (mean = 30.4 ± 7.3 for depressed vs. 39.6 ± 11.8 for nondepressed, $P < 0.001$), and (3) health-related QOL MCS (mean = 32.8 ± 10.5 for depressed vs. 48.9 ± 9.2 for nondepressed, $P < 0.001$). There were no significant differences between de-

pressed and nondepressed patients in (1) hemoglobin A1C levels (mean = 8.4 ± 2.0 depressed vs. 8.0 ± 1.9 nondepressed, $P = 0.26$), (2) LDL cholesterol levels (mean = 112.0 ± 39.3 depressed vs. 109.0 ± 35.0 nondepressed, $P = 0.68$), and (3) high-density lipoprotein (HDL) cholesterol levels (mean = 42.2 ± 13.7 depressed vs. 44.3 ± 13.5 nondepressed, $P = 0.39$).

Table 3 shows the adjusted mean scores for measures of metabolic control and health-related QOL by depression status. In this sample, depressed patients were significantly different from nondepressed patients in health-related QOL

TABLE 2. UNADJUSTED MEANS FOR METABOLIC CONTROL AND QOL BY DEPRESSION STATUS

Variable	Mean (SD)			P value
	All	Depressed (n = 40)	Not depressed (n = 161)	
Metabolic control				
Hemoglobin A1C	8.1 (1.9)	8.4 (2.0)	8.0 (1.9)	0.26
Total cholesterol	191.0 (56.2)	209.3 (72.1)	186.6 (50.9)	0.02*
LDL cholesterol	110.1 (35.6)	112.3 (39.3)	109.6 (34.7)	0.68
HDL cholesterol	43.9 (13.5)	42.2 (13.7)	44.3 (13.5)	0.39
Health-related QOL				
PCS (SF-12)	37.8 (11.6)	30.4 (7.25)	39.6 (11.8)	<0.001*
MCS (SF-12)	45.8 (11.4)	32.8 (10.5)	48.9 (9.2)	<0.001*

*Value statistically significant ($P < 0.05$).

TABLE 3. ADJUSTED MEANS FOR METABOLIC CONTROL AND QOL BY DEPRESSION STATUS

	Mean (SE)		P value
	Depressed (n = 40)	Not depressed (n = 161)	
Metabolic control			
Hemoglobin A1C	8.07 (0.16)	8.15 (0.13)	0.54
Total cholesterol	194.9 (5.4)	190.7 (4.3)	0.33
LDL cholesterol	110.1 (3.4)	111.3 (2.7)	0.66
HDL cholesterol	42.1 (1.3)	43.8 (1.0)	0.10
Health-related QOL			
PCS (SF-12)	36.1 (0.99)	39.0 (0.79)	<0.001*
MCS (SF-12)	41.6 (0.93)	46.8 (0.74)	<0.001*

Results are adjusted for age, diabetes' duration, education, body weight, sex, employment status, insurance status, income, number of comorbid conditions, and insulin use.

*Value statistically significant ($P < 0.05$).

PCS (mean = 36.1 for depressed vs. 39.0 for nondepressed, $P < 0.001$) and MCS (mean = 41.6 for depressed vs. 46.8 for nondepressed, $P < 0.001$). There were no significant differences between depressed and nondepressed patients in (1) hemoglobin A1C levels (mean = 8.1 depressed vs. 8.2 nondepressed, $P = 0.54$), (2) total cholesterol (mean = 194.9 depressed vs. 190.7 nondepressed, $P = 0.33$), (3) LDL cholesterol levels (mean = 110.1 depressed vs. 111.3 nondepressed, $P = 0.66$), and (4) HDL cholesterol levels (mean = 42.1 depressed vs. 43.8 nondepressed, $P = 0.10$).

Discussion

The results of this study indicate that in this indigent population with type 2 diabetes, health-related QOL differed in patients with depression compared to nondepressed patients after adjustment for relevant covariates. Patients who were depressed reported lower health-related QOL than nondepressed patients. In contrast, measures of metabolic control did not differ significantly between depressed and nondepressed patients after adjustment for relevant covariates.

There are three important findings that emerged from this study. First, depressed patients with diabetes reported decreased QOL when compared to nondepressed patients. QOL generally includes physical and mental functional functioning and the associated feelings of well-being.¹⁸ The differences between the adjusted means of the PCS (2.9) and MCS (5.2) scores of the depressed and the nondepressed patients were not only statistically but also clinically meaningfully different. Edelman et al.¹⁹ reported that mean differences of 2.0–2.5 points on QOL life scales among patients with diabetes are clinically meaningful differences on SF-12 subscales and other health-related QOL scales. These values were based on Cohen's standardized effect size for determining minimally clinically important differences in health-related QOL measures.^{20,21}

These findings agree with at least two previous studies. Eren et al.²² found that the presence of depression resulted in a significant reduction in QOL in individuals with diabetes. Additionally, a 2004 population-based survey of patients with diabetes also revealed lower health-related QOL in patients

with diabetes and those at risk for diabetes (three to five diabetes-related risk factors).²³ It is also believed that comorbid depression has an additive effect on chronic diseases and negatively affects QOL.²⁴ Therefore it is tenable that depressed patients with diabetes are more likely to rate their QOL lower than nondepressed patients.

Complications due to improper management of diabetes are the most likely determinants of negative patient-reported QOL. To test this hypothesis, Goldney et al.²⁴ evaluated the association between depression and QOL in individuals with (1) depression only, (2) diabetes only, and (3) depression and diabetes and found significant differences in both the physical and mental measures of QOL. The lowest QOL scores was reported by patients with diabetes and coexisting depression, thereby highlighting the effects of depression on patient-reported assessments of QOL. The findings of our study and those of Goldney et al.²⁴ underscore the need to consider patient perceptions of disease management and control as depression has a negative influence on QOL and overall outcomes.

Second, measures of metabolic control did not differ between depressed and nondepressed patients after adjustment of relevant covariates. These findings agree with Van Tilburg et al.,²⁵ who also reported a lack of meaningful association between depressive symptomology and glycemic control in patients with type 2 diabetes, although associations were present in patients with type 1 diabetes. However, we note that a number of studies report positive associations between depression and poor glycemic control.^{26–30} Gary et al.²⁶ found that depressive symptoms were associated with suboptimal levels of hemoglobin A1C and LDL cholesterol levels. Ciechanowski et al.²⁷ also found significant associations between depressive symptoms and hemoglobin A1C levels in patients with type 1 diabetes, although not in patients with type 2 diabetes. Richardson et al.²⁸ assessed the longitudinal effects of depression on glycemic control and found that over 4 years of follow-up there was a significant longitudinal relationship between depression and glycemic control and that depression was associated with persistently higher hemoglobin A1c levels over the time period. Similarly, Wagner et al.²⁹ found higher hemoglobin A1C and more diabetes complications in African Americans with higher depressive symptoms after controlling for confounders. Finally, Hailpern et al.³⁰ found significant associations between depression and hemoglobin A1C in an inner city male population with diabetes having severe depression, but the same associations were not observed in female patients with severe depression. Confirming the interrelationship between depressive symptomology and metabolic control is of considerable interest for clinicians managing patients with diabetes because proper glycemic control is critical to self-management of diabetes and generally associated with better QOL in patients with diabetes.^{24,31}

Third, total cholesterol levels were higher (although not statistically significant) in depressed patients. These findings are supported by previous observations by Gary et al.,²⁶ who also found higher total cholesterol levels in African American patients with type 2 diabetes and depressive symptoms. It is unclear why depressed patients have higher total cholesterol levels. Poor diet, limited physical activity, and poor medication adherence may be one explanation for the observed differences between depressed and nondepressed patients.

Despite what we believe are very interesting findings, we are left with more questions regarding what specific roles patient-specific characteristics play in determining the diabetes outcomes measured in this study. Few studies have given full consideration to the influences low incomes and lack of a usual source of care have on diabetes management. Poor and underserved populations suffer from limited access to adequate healthcare services, resulting in disparities in outcomes.³² Low income patients have a higher prevalence of diabetes^{9,10} and greater likelihood of more adverse long-term complications.³³ Rabi et al.³⁴ proposed that clinical, biologic, and behavioral characteristics differ by income levels, resulting in more negative diabetes outcomes. However, there is evidence that when provided proper disease management, indigent patients can have outcomes similar to patients at higher income levels.³⁵ For example, indigent patients seen by a pharmacist certified in diabetes education for diabetes education were compared to patients seen in a primary care clinic who were seen by a nonpharmacist educator where 88% of the patients had insurance.³⁵ After 3 years, total cholesterol, LDL cholesterol, hemoglobin A1C, and triglyceride levels declined equally in both groups. Additionally, the indigent patients seen by the pharmacist faculty clinician reached the American Diabetes Association target for A1C (<7%), which suggests that even though patients differ by income, equivalent outcomes can be achieved with patient-focused diabetes care.

We recognize a number of limitations of our study. First, as noted above, our patient sample represented only indigent patients. Approximately 25% of our sample had incomes less than \$5,000 and an average educational levels of 11 years. We acknowledge that education levels are frequently tied to poor health literacy and associated poor diabetes knowledge, poor self-management practice, and poor outcomes.³⁶ Second, because we did not stratify by severity of depression, we were unable to identify or characterize the specific mechanism by which severity of depression affects the variables of interest. Third, cross-sectional studies by nature are limited in their ability to adequately discuss direction of causality.¹⁰ In summary, in this study, we obtained critical information related to the effects of depression on adequate metabolic control and health-related QOL. Our results demonstrate that depressed and nondepressed indigent patients with diabetes may exhibit differing patterns of QOL.

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Author Disclosure Statement

No competing financial interests exist.

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