

Independent Factors Associated With Major Depressive Disorder in a National Sample of Individuals With Diabetes

LEONARD E. EGEDE, MD, MS¹
DEYI ZHENG, MB, PHD²

OBJECTIVE — To determine whether perceived poor physical health, duration of diabetes, and smoking are associated with major depressive disorder in a national sample of individuals with diabetes.

RESEARCH DESIGN AND METHODS — Data on 1,810 individuals with diabetes from the 1999 National Health Interview Survey (NHIS) were analyzed. The Composite International Diagnostic Interview (CIDI) Short-Form (CIDI-SF) developed by the World Health Organization was used to identify individuals with major depressive disorder. Multiple logistic regression was used to determine whether perceived poor physical health, duration of diabetes, and smoking were associated with major depressive disorder. The model controlled for age, sex, race/ethnicity, education, income, employment, marital status, and health status. Other control variables included BMI, smoking, duration of diabetes, presence or absence of major complications, and type of treatment for diabetes. SUDAAN software was used for statistical analyses to account for the complex sampling design of NHIS.

RESULTS — Independent factors associated with major depressive disorder were age <64 years, female sex, at least high school education, income <124% of federal poverty level, perceived worsening of health status, and smoking.

CONCLUSIONS — In addition to other psychosocial factors such as younger age, female sex, lower income, at least high school education, and smoking, perceptions about the effect of diabetes on overall health seems to play an important role in the etiology of depression.

Diabetes Care 26:104–111, 2003

Diabetes is a chronic, progressive disease that causes significant morbidity and mortality (1). Recent studies have documented twofold odds of depression in individuals with diabetes compared to individuals without diabetes (2,3). Depression in individuals with diabetes has been associated with poor adherence to dietary recommendation (4),

hyperglycemia (5), poor metabolic control (6), complications of diabetes (7), decreased quality of life (8), and increased health care use and expenditure (3). In addition, depression has been associated with decreased adherence to weight loss intervention (9) and increased risk for retinopathy (10) in individuals with diabetes.

Three hypotheses have been proposed to explain the possible relationship between diabetes and depression (11). First, depression may be a response to the psychosocial stress caused by diabetes. Second, depression may be related to the biochemical changes related to diabetes and its treatment. Third, because both conditions are prevalent, they may coexist coincidentally. Two studies conducted in the U.S. (12) and Finland (13) support the hypothesis that depression may be related to the psychosocial burden of diabetes. However, two other studies have documented that depression increases the risk of development of diabetes (14,15). More recently, a review article (16) indicated that although the relationship between diabetes and depression may be bidirectional, the hypothesis that depression resulted from the psychosocial burden of diabetes remained plausible.

The role of psychosocial factors in the etiology of depression has been extensively studied in individuals with diabetes. A long list of factors have been identified to date, female sex (3), younger age (3,17), being unmarried (3,8,18), lower socioeconomic status (10,17–19), perceived poor physical health (3,20,21), lack of social support (22), and perceived lack of control and illness intrusiveness (23,24). Other important factors include duration of diabetes (24), having multiple complications (7,25–27), poor glycemic control (5,8), smoking (28), and type of treatment for diabetes (nonuse of insulin) (17).

These earlier studies have methodological limitations that may affect the ability to generalize their findings to the U.S. population of adults with diabetes. For instance, several studies used nonrepresentative samples from few clinical sites (17–20,22,25,26,28), others used minority populations (6,10) and other subpopulations (8,12), and a few others used managed care populations (4,29). In addition, some studies included only a few participants (23,27), whereas several studies did not differentiate depressive symptomatology obtained from screening

From the ¹Department of Medicine, Medical University of South Carolina, Charleston, South Carolina; and the ²Department of Biometry and Epidemiology, Medical University of South Carolina, Charleston, South Carolina.

Address correspondence and reprint requests to Leonard E. Egede, MD, Medical University of South Carolina, Division of General Internal Medicine and Geriatrics, McClellan-Banks Adult Primary Care Clinic (4th Floor), 326 Calhoun Street, P.O. Box 25010, Charleston, SC 29425. E-mail: egedel@musc.edu.

Received for publication 28 May 2002 and accepted in revised form 21 September 2002.

Abbreviations: CIDI, Composite International Diagnostic Interview; CIDI-SF, Composite International Diagnostic Interview Short Form; NHIS, National Health Interview Survey.

The contents of this publication are solely the responsibility of the author and do not necessarily represent the official views of the Agency for Health Care Research and Quality or the Centers for Disease Control and Prevention.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

questionnaires from clinical diagnoses obtained from diagnostic interview schedules (2). Most importantly, several of these earlier studies did not adequately control for confounding. For example, results from the earlier cited studies have shown an association between depression and up to 15 factors. This means that without simultaneously controlling for these factors, the independent effects of some of these factors cannot be ascertained.

Recently, we used a nationally representative sample to determine the adjusted prevalence of depression, patient factors associated with depression, and the association between depression and health care use and expenditure in individuals with diabetes (3). Although we used a representative sample, that study had two important limitations: one limitation was inadequate control for confounding and the other limitation was that the definition of depression was based on self-report. The main purpose of this study is to clarify the relationship between psychosocial factors and depression using a nationally representative sample of individuals with diabetes while controlling for multiple confounding factors.

We used the 1999 National Health Interview Survey (NHIS) to provide answers to the following important questions:

1. Are perceived poor physical health, duration of diabetes, and smoking associated with major depressive disorder among a national sample of individuals with diabetes?
2. Controlling for known confounders, are these factors independently associated with major depressive disorder among individuals with diabetes?

Based on the results of prior studies (3,24,28), we hypothesized that although perceived poor physical health, duration of diabetes, and smoking may be associated with depression in individuals with diabetes, these factors would not be independently associated with depression after adjusting for known confounders.

RESEARCH DESIGN AND METHODS

Study setting and sample

Data from the 1999 NHIS (30) were analyzed. The NHIS is a national household

survey of nonmilitary and noninstitutionalized persons in the U.S., sponsored by the National Center for Health Statistics of the Centers for Disease Control and Prevention. For the sample adult core, one adult per family was randomly selected to respond to a Computer Assisted Personal Interview questionnaire. The sample was selected by a complex sampling design involving stratification, clustering, and multistage sampling with a nonzero probability of selection for each person. Final weights were constructed to reflect the unequal probability of selection and to adjust for nonresponse and poststratification. Estimates from the NHIS can be generalized to the adult civilian population of the US. Details about the methodology of the 1999 NHIS are available online (30,31).

Diagnosis of depression

The NHIS used the World Health Organization Composite International Diagnostic Interview (CIDI) Short-Form (CIDI-SF) to assess depression. The CIDI-SF is a diagnostic interview designed for use by trained interviewers who are not clinicians. The CIDI-SF was developed from the longer and more complex CIDI (32), and it was revised to screen for disorders defined in the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (33). The CIDI-SF is a valid and reliable diagnostic interview and has classification accuracy of 93% for major depressive disorder (34).

Scoring the CIDI-SF

A complete copy of the CIDI-SF questions and scoring instructions is available from the World Health Organization website (www.who.int/msa/cidi/index.htm). The CIDI-SF uses a stem-branch logic in which a small number of initial diagnostic stem questions are used in each section to skip-out people who are least likely to be considered case subjects before they are asked further symptom questions (35). There are two ways to meet the diagnostic stem requirement for major depressive disorder: either by endorsing all questions about having 2 weeks of dysphoric mood or by endorsing all questions about having 2 weeks of anhedonia. In addition, the symptoms of dysphoric mood and anhedonia should last at least most of the day almost every day. Respondents who deny either the existence of symptoms or

the persistence of symptoms are defined as not having major depressive disorder.

If the respondent endorses dysphoric mood, seven additional questions are asked about losing interest, feeling tired, change in weight, difficulty sleeping, trouble concentrating, feeling down, and thoughts about death, and then a summary major depressive disorder score is calculated based on positive responses to these additional seven questions (range 0–7). Similarly, respondents who endorse anhedonia are asked additional symptom questions, including questions about losing interest, feeling tired, change in weight, difficulty sleeping, trouble concentrating, feeling down, and thoughts about death. A summary major depressive disorder score is also calculated based on positive responses (range 0–7). Based on the recommendations for scoring (35), we classified an individual as having major depressive disorder if they endorsed the stem questions and had positive responses to three or more of the symptom questions. We excluded individuals who endorsed the stem questions but had fewer than three positive responses to the symptoms questions.

Demographic and socioeconomic characteristics

Three racial/ethnic groups were defined: non-Hispanic white, non-Hispanic black, and Hispanic or other. Four age categories were created: 18–34, 35–49, 50–64, and ≥65 years. Education was classified as <high school graduate or ≥high school graduate. Income was defined according to the federal poverty ratio guidelines: poor (<124% of federal poverty level), low income (125–199%), middle income (200–399%), and high income (≥400%). Two dichotomous groups were created for marital status (married versus unmarried) and employment (employed versus unemployed).

Clinical characteristics

Current health status was defined as better, worse, or the same, based on the respondent's perception of the change in their health status compared to 1 year prior. BMI was defined as <18.5, 18.5–24.9, 25.0–29.9, and ≥30 kg/m². Duration of diabetes was defined as <5, 5–9, and ≥10 years since diagnosis. Type of treatment was defined as nonmedication (diet or exercise alone) or medication (in-

Table 1—Comparison of characteristics of individuals with major depression by diabetes status

	Diabetes (n = 176, N = 969, 599)		No diabetes (n = 1,873, N = 11,141,509)		P value
	%	SE	%	SE	
Race/ethnicity					0.0414*
White	68	4.0	78	1.2	
Black	13	2.5	11	0.9	
Hispanic/other	20	3.3	12	0.9	
Age (years)					<0.0001†
18–34	10	3.2	37	1.4	
35–49	32	4.3	38	1.3	
60–64	38	4.3	19	1.1	
≥65	20	3.3	7	0.7	
Women	63	4.4	67	1.3	0.3783
<High school education	28	3.6	19	1.0	0.0087*
Poverty ratio (% of federal poverty level)					0.0037†
<124%	35	4.5	24	1.2	
124–199%	18	3.4	15	1.2	
200–399%	31	4.8	32	1.5	
≥400%	16	3.5	29	1.4	
Employed	42	4.3	72	1.2	<0.0001†
Married	52	4.5	42	1.6	0.0636
Health status					0.0009†
Better	22	3.8	26	1.2	
Worse	41	4.5	22	1.0	
Same	38	4.4	52	1.4	
Obesity status (kg/m ²)					0.0001†
BMI <18.5	47	4.7	26	1.3	
BMI 18.5–24.9	29	4.1	31	1.2	
BMI 25.0–29.9	22	4.2	40	1.4	
BMI ≥30.0	2	1.0	3	0.4	
Smoker	32	4.4	41	1.4	0.046*
Major complications — Yes	51	4.6	19	1.0	<0.0001†
Visited a primary care physician	88	2.9	71	1.2	<0.0001†
Visited a psychiatrist or mental health professional	29	4.2	29	1.2	0.9088
Visited an emergency room	41	4.4	32	1.3	0.0498*

Data are % (percentage of weighted sample) and SE. n = unweighted sample size; N = weighted sample. *P < 0.05; †P < 0.005.

sulin and/or oral agent). Diabetes complication was defined as the presence of any of the following self-reported conditions: cardiovascular disease, stroke or cerebrovascular accident, end-stage renal disease, macular degeneration, and retinopathy or blindness. Smokers were defined as individuals who reported that they were currently smoking.

Health care utilization

Respondents were asked, “During the past 12 months, have you seen or talked to any of the following health care providers about your own health: a mental health professional such as a psychiatrist, psychologist, psychiatric nurse, or a clin-

ical social worker?” A visit to a mental health professional was defined as a “yes” response. Similarly, respondents were asked, “During the past 12 months, have you seen or talked to any of the following health care providers about your own health: a general doctor who treats a variety of illnesses (a doctor in general practice, family practice, or internal medicine)?” A “yes” response indicated a visit to a primary care provider. Finally, respondents were asked, “During the past 12 months, how many times have you gone to a hospital emergency room about your own health?” A “yes” response was defined as at least one emergency room visit within the past 12 months.

Statistical analyses

SAS (SAS Institute, Cary, NC) callable SUDAAN software (36) was used for statistical analyses to generate variance estimates and perform hypothesis testing to account for the complex survey design of the NHIS. Among individuals with major depressive disorder, the χ^2 test was used to identify significant differences in characteristics between individuals with diabetes and those without diabetes. Then, among individuals with diabetes, the χ^2 test was used to compare differences in characteristics between individuals with major depressive disorder and those without depression. In addition, among adults with diabetes, the prevalence of major de-

Table 2—Comparison of characteristics of individuals with diabetes by depression status

	Major depressive disorder (n = 176, N = 989,599)		No depressive disorder (n = 1,634, N = 9,457,448)		P value
	%	SE	%	SE	
Race/ethnicity					0.1418
White	68	4.0	68	1.0	
Black	13	2.5	17	1.0	
Hispanic/other	20	3.3	15	1.0	
Age (years)					<0.0001
18–34	10	3.2	6	0.8	
35–49	32	4.3	16	1.1	
50–64	38	4.3	35	1.4	
≥65	20	3.3	42	1.4	
Women	63	4.4	51	1.4	0.009
<High school education	28	3.6	30	1.3	0.7139
Poverty ratio (% of federal poverty level)					0.003
<124%	35	4.5	19	1.3	
124–199%	18	3.4	16	1.1	
200–399%	31	4.8	35	1.4	
≥400%	16	3.5	30	1.5	
Employed	42	4.3	44	1.3	0.6803
Married	52	4.5	62	1.4	0.0205
Health status					<0.0001
Better	22	3.8	21	1.1	
Worse	41	4.5	16	1.0	
Same	38	4.4	65	1.4	
Obesity status (kg/m ²)					0.3821
BMI <18.5	47	4.7	42	1.4	
BMI 18.5–24.9	29	4.1	35	1.3	
BMI 25.0–29.9	22	4.2	21	1.2	
BMI ≥30.0	2	1.0	1	0.3	
Years since diagnosis					0.0443
<5	37	4.4	27	1.5	
5–9	16	3.8	25	1.4	
≥10	47	4.6	49	1.6	
Insulin or oral agents (versus diet alone)	80	3.7	64	1.0	0.3845
Major complications—yes	51	4.6	39	1.5	0.0165
Smoker	32	4.4	15	1.0	0.0007
Visited a primary care physician	88	2.9	84	1.0	0.3157
Visited a psychiatrist or mental health professional	29	4.2	4	0.6	<0.0001
Visited an emergency room	41	4.4	26	1.3	<0.0001

Data are % (percentage of weighted sample) and SE. n = unweighted sample size; N = weighted sample.

pressive disorder was determined across individual characteristics.

Finally, multiple logistic regression was used to determine whether perceived poor physical health, duration of diabetes, and smoking were independently associated with depression in individuals with diabetes. Major depression (yes or no) was entered as the dependent variable, whereas perceived poor physical health, duration of diabetes, and smoking were entered as independent variables.

Other independent variables included age, sex, race/ethnicity, education, income, employment, marital status, BMI, duration of diabetes, presence or absence of major complications, and type of treatment for diabetes.

The approach recommended by Homer and Lemeshow (37) was used to select variables for inclusion in the multivariate model. Variables with a P value <0.25 in bivariate tests, along with those known to be clinically important, were

included in the model. Following the fit of the model, we sequentially eliminated variables with nonsignificant Wald statistics and fitted a new model. Then, the restricted model was compared with the full model with the likelihood ratio test. A comparison of the full model and the restricted models showed that all the variables in the full model contributed to the model; therefore, the full model was retained and used for subsequent analyses.

Table 3—Prevalence of major depressive disorder by individual characteristics in adults with diabetes

	%	SE	P value
Race/ethnicity			0.1418
White	9.2	1.0	
Black	7.2	1.4	
Hispanic/other	11.8	2.0	
Age (years)			<0.0001†
18–34	14.2	4.3	
35–49	16.9	2.5	
50–64	10.0	1.4	
≥65	4.5	0.8	
Sex			0.009*
Women	11.2	1.2	
Men	7.2	1.1	
Education			0.7139
<High School	8.9	1.3	
≥High School	9.5	1.0	
Poverty ratio (% of federal poverty level)			0.0003†
<124%	18.3	2.4	
124–199%	11.6	2.4	
200–399%	9.6	1.7	
≥400%	6.0	1.4	
Employment			0.6803
Employed	9.1	1.3	
Not employed	9.7	1.0	
Marital status			0.0205*
Married	7.8	1.0	
Not married	11.6	1.3	
Health status			<0.0001†
Better	9.8	1.8	
Worse	21.9	2.8	
Same	5.7	0.8	
Obesity status (kg/m ²)			0.3821
BMI <18.5	10.4	1.3	
BMI 18.5–24.9	7.8	1.2	
BMI 25.0–29.9	9.4	2.0	
BMI ≥30.0	18.8	8.8	
Smoking status			0.0007†
Smoker	18.0	2.8	
Nonsmoker	7.7	0.8	
Years since diagnosis			0.0443*
<5	12.5	1.8	
5–9	6.4	1.5	
≥10	9.2	1.2	
Medication use			0.3645
Diet alone	11.1	2.1	
Insulin or oral agents	9.0	0.9	
Major complications			0.0165*
Yes	11.8	1.4	
No	7.6	1.0	

Data are % (percentage of weighted sample) and SE. *n* = unweighted sample size; *N* = weighted sample. **P* < 0.05; †*P* < 0.005.

RESULTS— In 1999, 30,801 adults were interviewed; the final response rate was 70%. A total of 1,810 adults aged

≥18 years had self-reported diabetes, not including women in whom diabetes was diagnosed during pregnancy. Of the esti-

mated 195,771,360 adults in the U.S. in 1999, 10,427,047 had diabetes. The prevalence of major depressive disorder was 9.3% among individuals with diabetes compared with 6.1% among individuals without diabetes; ~1 million individuals of the ~10.4 million adults with diabetes had major depressive disorder.

Univariate and bivariate analyses

In Table 1, the characteristics of individuals with major depressive disorder by diabetes status are compared. Among individuals with major depressive disorder, those with diabetes were more likely to be of Hispanic ethnicity, to be aged >50 years, to have less than high school education, and to have household income <124% of the federal poverty level and were less likely to be employed. Individuals with diabetes were more likely to report worsening of their health status and to have BMI ≥25.0 kg/m², major complications, primary care physician visits, and emergency room visits, but they were less likely to smoke than individuals without diabetes.

In Table 2, the characteristics of individuals with diabetes by depression status are compared. Among individuals with diabetes, those with major depressive disorder were younger, poorer, and more likely to be women, to be unmarried, to report worsening health status, and to have duration of diabetes of <5 years. In addition, they were more likely to have major complications, to be smokers, and to have an emergency room visit and a psychiatrist/mental health professional visit than individuals without major depressive disorder.

Table 3 shows the prevalence of major depressive disorder by individual characteristics in adults with diabetes. The prevalence of major depressive disorder was higher in younger adults, women, those with income <124% of federal poverty level, unmarried individuals, and those who reported worsening of their health status. In addition, smokers, those with duration of diabetes <5 years, and those with major complications had a higher prevalence of major depressive disorder.

Multivariate analyses

Table 4 shows the factors that were independently associated with major depressive disorder in individuals with diabetes.

Table 4—Independent factors associated with major depressive disorder in individuals with diabetes

	Adjusted odds ratio	95% CI
Race/ethnicity		
White (reference)		
Black	0.7	0.3, 1.3
Hispanic/other	1.7	0.9, 3.2
Age (years)		
18–34	3.3	1.2, 8.8*
35–49	5.0	2.4, 9.9*
50–64	2.8	1.4, 5.5*
≥65 (reference)		
Sex		
Women	1.7	1.1, 2.8*
Men (reference)		
Education		
<High school	0.5	0.3, 0.9*
≥High school (reference)		
Poverty ratio (% of federal poverty level)		
<124%	2.7	1.1, 6.7*
124–199%	2.3	0.9, 5.2
200–399%	1.5	0.7, 3.1
≥400% (reference)		
Employment		
Employed	0.8	0.4, 1.5
Not employed (reference)		
Marital status		
Married	0.8	0.5, 1.3
Not married (reference)		
Health status		
Better	1.6	0.8, 3.1
Worse	5.9	3.2, 10.9*
Same (reference)		
Obesity status (kg/m ²)		
BMI <18.5	0.5	0.1, 4.0
BMI 18.5–24.9	0.5	0.1, 4.0
BMI 25.0–29.9	0.6	0.1, 4.2
BMI ≥30.0 (reference)		
Smoking status		
Smoker	1.9	1.1, 3.4*
Nonsmoker (reference)		
Years since diagnosis		
<5	1.3	0.7, 2.4
5–9	0.9	0.4, 1.7
≥10 (reference)		
Medication use		
Diet alone	0.9	0.5, 1.7
Insulin or oral agents (reference)		
Major complications		
Yes	1.5	0.9, 2.5
No (reference)		

*Statistically significant at $P < 0.05$. Dependent variable: major depressive disorder—yes vs. no. Independent variables: age, sex, race/ethnicity, education, income, employment, marital status, health status, BMI, smoking, duration of diabetes, presence or absence of major complications, and type of treatment for diabetes.

Age <65 years, female sex, ≥ high school education, income <124% of federal poverty level, worsening health status,

and smoking were independently associated with major depressive disorder in adults with diabetes.

CONCLUSIONS— This study has two major strengths: first, the subjects comprised a nationally representative sample of noninstitutionalized adults; second, a valid and reliable diagnostic interview for major depressive disorder was used to determine the prevalence of major depressive disorder and factors independently associated with major depressive disorder in adults with diabetes. Controlling for known confounders, younger age, perceived worsening of health status, poverty, smoking, and having ≥high school education were independently associated with major depressive disorder in individuals with diabetes.

This approach addresses the major limitation of prior studies and introduces new hypotheses about the association between diabetes and depression that can be addressed in prospective studies. The findings of this study are comparable to the results of two large studies on the prevalence of depression in the U.S. (38,39). In both studies, younger age, female sex, and lower income were significantly associated with depression. In addition, perceived poor physical health was associated with depression in a large primary care sample (38) and smoking was causally linked to incident major depressive disorder in another study (40).

In addition, the findings of this study support and strengthen the results of several earlier studies on the relationship between diabetes and depression. The relationship between younger age and depression in individuals with diabetes has been reported previously (3,17). Similarly, perceived poor physical health (3,20,21), female sex (3), lower income (10,18,19), and smoking (28) have been previously associated with depression in individuals with diabetes. However, our findings contradict the results of other prior studies. Our study did not find a relationship between depression and the presence of multiple diabetes complications (7,25–27), unemployment (10,19), marital status (3,8,18), type of treatment for diabetes (17), lower levels of education (17,18), or duration of diabetes (24). Although the prevalence of depression seemed related to lesser duration of diabetes in unadjusted analyses, this relationship did not persist in multivariate analyses. It is very likely that the discrepancies across studies were due to differences in the definition of depression, differences in sample selection, and dif-

ferences in the number of variables that were controlled for in the different studies.

Finally, this study provides additional data on health services utilization in depressed individuals with diabetes. In a recent study (3), we showed that compared with nondepressed individuals with diabetes, depressed individuals with diabetes had increased health care use and expenditure. Akin to our earlier finding, this study found that depressed individuals with diabetes were more likely to have primary care and emergency room visits compared with their depressed counterparts without diabetes. In addition, depressed individuals with diabetes were more likely to report visits to a psychiatrist or mental health professional. It is noteworthy that the proportion of patients who visited a psychiatrist was not significantly different. This suggests that the pattern of visits to psychiatrists or mental health professionals did not differ by diabetes status.

Of additional importance is the fact that <30% of depressed individuals, regardless of diabetes status, reported visiting a psychiatrist. It may be that primary care providers treated most patients with depression or that the stigma of seeing a mental health professional played a role in decreasing visits to a psychiatrist. Further studies are needed to clarify this issue.

There are limitations to interpreting the results of this study. First, because this analysis is based on cross-sectional data, causality cannot be determined. Prospective studies are needed to establish the causal link between depression and diabetes. However, the findings of this study may be useful to generate hypotheses for future prospective trials. Second, this study did not differentiate type 1 from type 2 diabetes because of sample size limitations. Although it has been suggested that the prevalence of depression may differ by type of diabetes due to differences in the etiology of diabetes (41), the literature suggests otherwise (2,18). Future studies enrolling adequate samples of individuals with type 1 and type 2 diabetes are required to address this question.

A third limitation is the absence of data on glycemic control. Although there are data suggesting that depression worsens glycemic control, the converse hypothesis that poor glycemic control may

lead to depression is uncertain. In a study that assessed glycemic control using three levels of glycosylated hemoglobin (<9.5, 9.5–12.0, and >12.0%), depression was not found to be independently associated with HbA_{1c} levels (18). Finally, because this study did not have data on social support (22), perceived control of diabetes management (23), or perceived illness intrusiveness (24), the association between these factors and depression could not be ascertained.

Despite these limitations, the results of this study have two major implications. First, our findings support and strengthen the hypothesis that depression may be a response to the psychosocial burden of living with diabetes. After controlling for potential confounders, psychosocial factors such as perceived health status, income, and education remained independently associated with depression in individuals with diabetes. Additional support for this hypothesis was the finding that perceived worsening of health status was independently associated with depression, whereas longer duration of disease, having major complications, or using insulin or medications were not associated with depression. These findings suggest that, in addition to other psychosocial factors, perceptions about the effect of diabetes on overall health rather than disease chronicity, illness severity, or type of treatment is likely to play an important role in the etiology of depression in individuals with diabetes.

The notion that psychosocial factors rather than disease duration or severity plays important roles in the etiology of depression in individuals with diabetes is supported by prior work. In separate studies, perceived control of diabetes (23), intrusiveness of diabetes (24), perceived daily burden of living with diabetes (20), and perceived threat of diabetes (42) were found to be significantly associated with depression in individuals with diabetes. Therefore, future studies examining the causal relationship between diabetes and depression need to pay attention to the important role that psychosocial factors are likely to play.

The second major implication is the deleterious effect of smoking on the psychological well-being of individuals with diabetes. We found that smoking was independently associated with major depressive disorder in individuals with diabetes. Prior studies have shown that

smoking increases the risk of major depressive disorder (28) and that smokers with major depressive disorder are less successful at their attempts to quit (40). In addition to the deleterious effects of smoking on the mental health of individuals with diabetes, smoking is also hazardous to physical health. There is evidence that smoking is an independent risk factor for cardiovascular disease (43) and is strongly associated with higher 24-h blood pressures (44), poor glycemic control (45), increased prevalence of microvascular complications (45), diabetic nephropathy (46), and excess morbidity (47). Therefore, there is a need to discourage smoking initiation in individuals with diabetes and encourage smoking cessation in current smokers. More importantly, effective smoking cessation programs need to be aggressively implemented for individuals with diabetes who are current smokers.

In conclusion, this study has identified independent factors that are associated with major depressive disorder in individuals with diabetes. In addition, perceptions about the effect of diabetes on overall health in addition to other psychosocial factors seem to play an important role in the etiology of depression in individuals with diabetes.

Acknowledgments—L.E.E. is supported, in part, by Grant 1K08HS11418 from the Agency for Health Care Research and Quality (Rockville, MD) and Grant U50/CCU417281 from the Centers for Disease Control and Prevention (Atlanta, GA). D.Z. is supported, in part, by Grant U50/CCU417281 from the Centers for Disease Control and Prevention (Atlanta, GA).

References

1. *Diabetes statistics*, NIH publ. no. 99–3892 [article online], 1999. Available from: <http://www.niddk.nih.gov/health/diabetes/pubs/dmstats/dmstats.htm>. Accessed 9 May 2002
2. Anderson RJ, Freedland KE, Clouse RE, Lustman PJ: The prevalence of comorbid depression in adults with diabetes: a meta-analysis. *Diabetes Care* 24:1069–1078, 2001
3. Egede LE, Zheng D, Simpson K: Comorbid depression is associated with increased health care use and expenditures in individuals with diabetes. *Diabetes Care* 25:464–470, 2002
4. Ciechanowski PS, Katon WJ, Russo JE: Depression and diabetes: impact of depressive symptoms on adherence, func-

- tion, and costs. *Arch Intern Med* 160: 3278–3285, 2000
5. Lustman PJ, Anderson RJ, Freedland KE, de Groot M, Carney RM, Clouse RE: Depression and poor glycemic control: a meta-analytic review of the literature. *Diabetes Care* 23:934–942, 2000
 6. Gary TL, Crum RM, Cooper-Patrick L, Ford D, Brancati FL: Depressive symptoms and metabolic control in African-Americans with type 2 diabetes. *Diabetes Care* 23:23–29, 2000
 7. de Groot M, Anderson R, Freedland KE, Clouse RE, Lustman PJ: Association of depression and diabetes complications: a meta-analysis. *Psychosom Med* 63:619–630, 2001
 8. Hanninen JA, Takala JK, Keinänen-Kiukaanniemi SM: Depression in subjects with type 2 diabetes: predictive factors and relation to quality of life. *Diabetes Care* 22:997–998, 1999
 9. Marcus MD, Wing RR, Guare J, Blair EH, Jawad A: Lifetime prevalence of major depressive disorder and its effect on treatment outcome in obese type II diabetic patients. *Diabetes Care* 15:253–255, 1992
 10. Roy A, Roy M: Depressive symptoms in African-American type 1 diabetics. *Depress Anxiety* 13:28–31, 2001
 11. Lustman PJ, Griffith LS, Gavard JA, Clouse RE: Depression in adults with diabetes. *Diabetes Care* 15:1631–1639, 1992
 12. Palinkas LA, Barrett-Connor E, Wingard DL: Type 2 diabetes and depressive symptoms in older adults: a population-based study. *Diabet Med* 8:532–539, 1991
 13. Rajala U, Keinänen-Kiukaanniemi S, Kivela SL: Non-insulin-dependent diabetes mellitus and depression in a middle-aged Finnish population. *Soc Psychiatry Psychiatr Epidemiol* 32:363–367, 1997
 14. Eaton WW, Armenian H, Gallo J, Pratt L, Ford DE: Depression and risk for onset of type II diabetes: a prospective population-based study. *Diabetes Care* 19:1097–1102, 1996
 15. Kawakami N, Takatsuka N, Shimizu H, Ishibashi H: Depressive symptoms and occurrence of type 2 diabetes among Japanese men. *Diabetes Care* 22:1071–1076, 1999
 16. Talbot F, Nouwen A: A review of the relationship between depression and diabetes in adults: is there a link? *Diabetes Care* 23:1556–1562, 2000
 17. Peyrot M, Rubin RR: Persistence of depressive symptoms in diabetic adults. *Diabetes Care* 22:448–452, 1999
 18. Peyrot M, Rubin RR: Levels and risks of depression and anxiety symptomatology among diabetic adults. *Diabetes Care* 20: 585–590, 1997
 19. Friis R, Nanjundappa G: Diabetes, depression and employment status. *Soc Sci Med* 23:471–475, 1986
 20. Karlson B, Agardh CD: Burden of illness, metabolic control, and complications in relation to depressive symptoms in IDDM patients. *Diabet Med* 14:1066–1072, 1997
 21. de Groot M, Jacobson AM, Samson JA, Welch G: Glycemic control and major depressive disorder in patients with type 1 and type 2 diabetes mellitus. *J Psychosom Res* 46:425–435, 1999
 22. Miyaoka Y, Miyaoka H, Motomiya T, Kitamura S, Asai M: Impact of sociodemographic and diabetes-related characteristics on depressive state among non-insulin-dependent diabetic patients. *Psychiatry Clin Neurosci* 51:203–206, 1997
 23. Macrodimitris SD, Endler NS: Coping, control, and adjustment in type 2 diabetes. *Health Psychol* 20:208–216, 2001
 24. Talbot F, Nouwen A, Gingras J, Belanger A, Audet J: Relations of diabetes intrusiveness and personal control to symptoms of depression among adults with diabetes. *Health Psychol* 18:537–542, 1999
 25. Robinson N, Fuller JH, Edmeades SP: Depression and diabetes. *Diabet Med* 5:268–274, 1988
 26. Leedom L, Meehan WP, Procci W, Zeidler A: Symptoms of depression in patients with type II diabetes mellitus. *Psychosomatics* 32:280–286, 1991
 27. Bailey BJ: Mediators of depression in adults with diabetes. *Clin Nurs Res* 5:28–42, 1996
 28. Haire-Joshu D, Heady S, Thomas L, Schechtman K, Fisher EB Jr: Depressive symptomatology and smoking among persons with diabetes. *Res Nurs Health* 17: 273–282, 1994
 29. Fisher L, Chesla CA, Mullan JT, Skaff MM, Kanter RA: Contributors to depression in Latino and European-American patients with type 2 diabetes. *Diabetes Care* 24:1751–1757, 2001
 30. *National Health Interview Survey* [machine-readable data file], 1999. Available from ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Datasets/NHIS/1999. Accessed 1 August 2002
 31. *Data file documentation, National Health Interview Survey* [machine-readable data file and documentation], 1999. Available from ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/1999/SAMADULT.pdf. Accessed 1 August 2002
 32. World Health Organization: *Composite International Diagnostic Interview*. Version 1.0. Geneva, World Health Org., 1990
 33. American Psychiatric Association: *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC, American Psychiatric Association, 1994
 34. Kessler RC, Andrews G, Mroczek D, Ut-sun TB, Wittchen HU: The World Health Organization's Composite International Diagnostic Interview Short-Form (CIDI-SF). *Int J Methods Psychiatr Res* 7:171–185, 1997
 35. Nelson CB, Kessler RC, Mroczek D: Scoring the World Health Organization's Composite International Diagnostic Interview Short-Form (CIDI-SF; v1.0 NOV98), August 2001. Available online at http://www.who.int/msa/cidi/cidi_sh_scoring.pdf. Accessed 15 November 2002
 36. Research Triangle Institute: *Software for Statistical Analysis of Correlated Data (SUDAAN)*. Release 8.0. Research Triangle Park, NC, Research Triangle Institute, 2001
 37. Homer DW, Lemeshow S: *Applied Logistic Regression*. New York, John Wiley & Sons, 2000
 38. Zung WW, Broadhead WE, Roth ME: Prevalence of depressive symptoms in primary care. *J Fam Pract* 37:337–344, 1993
 39. Kessler RC, McGonagle KA, Zhao S, Nelson CB, Hughes M, Eshleman S, Wittchen HU, Kendler KS: Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: results from the National Comorbidity Survey. *Arch Gen Psychiatry* 51:8–19, 1994
 40. Breslau N, Peterson EL, Schultz LR, Chilcoat HD, Andreski P: Major depression and stages of smoking: a longitudinal investigation. *Arch Gen Psychiatry* 55: 161–166, 1998
 41. Van Tilburg MA, McCaskill CC, Lane JD, et al: Depressed mood is a factor in glycemic control in type 1 diabetes. *Psychosom Med* 63:551–555, 2001
 42. Connell CM, Davis WK, Gallant MP, Sharpe PA: Impact of social support, social cognitive variables, and perceived threat on depression among adults with diabetes. *Health Psychol* 13:263–273, 1994
 43. Turner RC, Millns H, Neil HA, et al: Risk factors for coronary artery disease in non-insulin dependent diabetes mellitus: United Kingdom Prospective Diabetes Study (UKPDS 23). *BMJ* 316:823–828, 1998
 44. Poulsen PL, Ebbelohj E, Hansen KW, Mogens CE: Effects of smoking on 24-h ambulatory blood pressure and autonomic function in normoalbuminuric insulin-dependent diabetes mellitus patients. *Am J Hypertens* 11:1093–1099, 1998
 45. Chaturvedi N, Stephenson JM, Fuller JH: The relationship between smoking and microvascular complications in the EURODIAB IDDM Complications Study. *Diabetes Care* 18:785–792, 1995
 46. Mehler PS, Jeffers BW, Biggerstaff SL, Schrier RW: Smoking as a risk factor for nephropathy in non-insulin-dependent diabetics. *J Gen Intern Med* 13:842–845, 1998
 47. Gay EC, Cai Y, Gale SM, et al: Smokers with IDDM experience excess morbidity: the Colorado IDDM Registry. *Diabetes Care* 15:947–952, 1992