Depressive Symptoms and Metabolic Control in African-Americans With Type 2 Diabetes

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OBJECTIVE — To determine the prevalence of depressive symptoms and the relationship between depressive symptoms and metabolic control.

RESEARCH DESIGN AND METHODS — We conducted a cross-sectional study of 183 African-American adults aged 35–75 years with type 2 diabetes who were recruited from two primary care clinics in East Baltimore, Maryland. Depressive symptoms, using the Center for Epidemiological Studies Depression Scale (CES-D), HbA_{1c}, fasting lipid profile, BMI, and blood pressure, were measured on each participant. Diabetes-related health behaviors were assessed by questionnaire.

RESULTS — The prevalence of depressive symptoms (CES-D ≥22) was 30%. After adjustment for age, sex, income, social support, and duration of diabetes in linear regression models, there were significant graded relationships between greater depressive symptoms and higher serum levels of cholesterol and triglycerides ($P < 0.050$). Similar, albeit less statistically significant, relationships were found with higher levels of HbA_{1c} ($P = 0.104$), diastolic blood pressure ($P = 0.073$), and LDL cholesterol ($P = 0.176$). Unexpectedly, individuals who reported more depressive symptoms also had higher serum levels of HDL cholesterol ($P = 0.047$). The associations were not explained by differences in diabetes-related health behaviors.

CONCLUSIONS — Depressive symptoms are marginally associated with suboptimal levels of HbA_{1c}, diastolic blood pressure, and LDL cholesterol, and significantly associated with suboptimal levels of total cholesterol and triglyceride levels. Prospective studies are required to determine whether improved identification and management of depressive symptoms would enhance metabolic control in this population.

Diabetes Care 23:23–29, 2000

The prevalence and incidence of type 2 diabetes is higher in African-Americans than in whites (1). African-Americans are also at increased risk for complications as a result of diabetes, such as lower-extremity amputations and kidney disease (1). Consequently, it is important to identify risk factors that may contribute to this excess risk and to address problems related to diabetes in the African-American population.

Depression, a modifiable factor that can be managed through counseling and/or medications, could contribute to poor diabetes control. Several studies focusing on the prevalence of depression in adults with diabetes have been completed (2–6). These studies suggest that the prevalence of depression is higher in patients with diabetes than in the general U.S. population, with rates ranging from 8.5 to 60% (mean for structured diagnostic interviews = 14.0%; mean for depression symptom scales = 32.4%) (2–4). In addition, several studies have shown a relationship between depressive symptoms and poorer glycemic control in individuals with type 2 diabetes (7–12).

Unfortunately, existing studies on depression and glycemic control have four limitations. First, most of the participants were selected from specialty-based referral centers. Second, they have not adequately assessed the relationship of depression and glycemic control in a predominantly African-American or other ethnic minority population. Third, although existing studies proposed potential causal explanations, they have not attempted to carefully describe the relationship between depression and glycemic control by accounting for possible mediating factors. Finally, although both diabetes and depression have been identified as risk factors for cardiovascular disease, previous studies have not assessed the relationship between depression and other cardiovascular risk factors in individuals with diabetes.

We, therefore, conducted a cross-sectional study in a group of urban African-Americans with type 2 diabetes with the following three objectives: *1*) to determine the prevalence of depressive symptoms in this sample; *2*) to determine the relationship between depressive symptoms and metabolic control as measured by HbA_{1c}, blood pressure, lipids, and BMI; and *3*) to determine the extent to which poorer metabolic control in individuals with depressive symptoms is mediated by suboptimal diabetes-related health behaviors.

RESEARCH DESIGN AND METHODS

Study setting and sample

Baseline data from Project Sugar, a randomized controlled trial of primary care–based interventions aimed at improving metabolic control in adults with type 2 diabetes, were analyzed cross-sectionally. The study sample

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Received for publication 11 May 1999 and accepted in revised form 5 October 1999.

Abbreviations: CBT, cognitive behavior therapy; CES-D, Center for Epidemiological Studies Depression Scale.

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

consisted of 186 African-American adults with type 2 diabetes living in East Baltimore. Eligibility criteria included the following: age 35–75 years, African-American ancestry, residence in East Baltimore, presence of type 2 diabetes, absence of comorbid conditions limiting probable life span to <4 years (e.g., cancer, AIDS), attendance at either of two Johns Hopkins–affiliated primary care clinics, and no indication of end-stage complications of diabetes (e.g., kidney dialysis or transplant, blindness, or lower-extremity amputation). Of the 3,800 medical charts reviewed for preliminary eligibility criteria, 822 individuals were identified as having type 2 diabetes. Of the 822 eligible, 332 were scheduled for the initial screening visit, and 213 actually attended the initial screening visit. Of these, 186 attended both of the required screening visits and were randomized into the study. There were 183 individuals who provided complete information on depressive symptoms and were used in this analysis. This study was approved by the Johns Hopkins Joint Committee on Clinical Investigation and informed consent was obtained for each participant.

Assessment of depressive symptoms

Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (CES-D) (13,14). Adapted from existing scales, the CES-D is a self-report, 20-item questionnaire that aims to identify depressive symptoms in the general population. The CES-D is highly reliable and well validated (15). The instrument uses a zero-to-three response scale with higher scores indicating greater depressive symptomatology. Possible scores range between 0 and 60 (15). It was designed to measure the major components of depression identified in the literature: depressed mood, feelings of guilt and worthlessness, feelings of helplessness and hopelessness, psychomotor retardation, loss of appetite, and sleep disturbances (15). Cutoff scores as low as 16 and as high as ≥22 have been used to identify depressed individuals (15–19). A score of ≥22 is often used in primary-care settings to account for overlapping symptoms between depression and chronic diseases.

Assessment of medical records

To assess whether primary care physicians diagnosed depression as indicated by the CES-D, we conducted a review of the participants' medical charts. Outpatient medical records were reviewed by data collectors while blinded to CES-D score. Participants were classified as having been diagnosed with depression if either of the following two conditions was met before the baseline study visit: *1*) a diagnosis of depression appeared in clinic notes or in the cumulative problem list, or *2*) an antidepressant medication was named in the current medication list (including tricyclics, monoamine oxidase inhibitors, and selective serotonin re-uptake inhibitors). Charts without notes recorded in the 12-month interval before the baseline visit were considered unusable.

Assessment of health behaviors

Diabetes-related health behaviors—including medication compliance, glucose self-monitoring behavior, diet, physical activity, and smoking status—were determined by questionnaire at a structured interview. Medication compliance was measured using a self-reported scale of medication adherence (20). The measure consists of four items that address medication practices and barriers to medication taking. Scores range from 0 to 4, with a score of 4 indicating the highest level of compliance. Scores of 0, 1, and 2 were considered low compliance, 3 moderate compliance, and 4 high compliance. The scale has been shown to be reliable and valid in community-based outreach programs (20). Glucose self-monitoring behavior was defined as the participant's self-report of not having a blood glucose monitor at home, having a monitor at home but not using it, monitoring several times a week versus once a week, or monitoring every day.

Dietary practices were assessed using a brief food frequency questionnaire designed to guide cholesterol reduction in low-income individuals (21). The questionnaire consists of 31 food frequency items and 11 food preparation questions. It identifies positive as well as problematic dietary behaviors and measures potential barriers to dietary change (21). Foods included in the assessment were selected on the basis of their contribution of saturated fat, complex carbohydrates, and fiber in the diet of African-Americans as well as contribution to cholesterol in the diet of all Americans. Responses from individual questions compile into a total dietary risk assessment score that ranges from 0 to 84. Higher scores indicate less optimal dietary practices (21).

Physical activity was measured using a short questionnaire for the measurement of habitual physical activity during leisure time (22). Scores range from 1 to 4, and higher scores indicate increased physical activity. Smoking status was measured by self-report, and participants were categorized as never smokers, former smokers, and current smokers.

Assessment of parameters of metabolic control

Participants were asked not to eat or drink anything except water the night before (10–12 h) their blood was drawn. Most participants adhered to this request with 91% of participants reporting fasting for >10 h. The main outcome variable, HbA_{1c} was measured using high-performance liquid chromatography. Lipid profile (total, HDL and LDL cholesterol, and triglycerides) was measured using automated enzymatic spectrophotometry. Blood pressure was assessed by taking the mean of six measurements over two visits using a random-zero sphygmomanometer. Height was measured using a stadiometer with shoes off and weight using a balance beam scale with light clothing. All outcomes were considered as continuous variables in the analysis, and triglyceride level was log-transformed because its distribution was highly skewed.

Statistical analysis

Because various cutoff scores have been used as thresholds to indicate depression, the CES-D was analyzed continuously and in quartiles based on the 25th, 50th, and 75th percentile of the distribution. Linear regression models were conducted to assess the crude relationship between depressive symptoms and the parameters of metabolic control, and the relationship adjusted for potential confounders, age, sex, income, social support, and duration of diabetes. To assess the contribution of mediating health behaviors, each behavior was added independently into this base model. Finally, to assess the total contribution of all of the behaviors, diet, physical activity, smoking, medication compliance, and glucose self-monitoring behavior were all added to the base model. All analyses were conducted using STATA® statistical software (College Station, TX) (23).

RESULTS

Characteristics of the study sample

Selected characteristics of the study participants are shown in Table 1. The sample was predominantly female with a mean age of

59 years, and half had less than a high school education. The majority of the participants had extremely modest incomes, and many were dependent on medical assistance or lacked health insurance entirely. Fifty percent were either married or widowed, but only 23% reported living alone.

Of all, 93% of participants reported taking diabetes medication, 72% took blood pressure medication, and 23% took cholesterol medication. The majority reported the highest level of compliance for all three medications. About one-third reported monitoring every day. Only 18% were current smokers.

Of the total sample, 44% used insulin, and half used oral hypoglycemic agents. The mean BMI was well within the range of severe obesity, and ~10% of the participants had a BMI >40 kg/m^2. The mean systolic and diastolic blood pressure were normal (24). Other than total cholesterol, the mean lipid profile measures (HDL cholesterol, LDL cholesterol, and triglycerides) were in the normal range. The mean HbA_{1c} was 8.6%. Of all participants, 48% had HbA_{1c} levels <8.0%, falling in the acceptable range according to ADA recommendations (25).

CES-D scores and diagnosed depression

CES-D scores ranged from 0 to 48, with a mean of 16 and a median of 14. Table 1 shows the prevalence of CES-D–defined depression as defined by two common cutpoints. The prevalence of depressive symptoms in this sample was high. Using a cutoff value of ≥16, 45% of the participants had severe depressive symptoms. Alternatively, at a cutoff of ≥22, the prevalence of severe depressive symptoms was 30%.

To determine the extent to which depressive symptoms provoked clinical attention, we reviewed outpatient medical records. Of the 183 charts requested, 25 (13.4%) contained insufficient data, leaving 161 participants. In this subsample, there were 48 participants with CES-D scores of ≥22, of whom 9 (18.9%) had been diagnosed to have depression by their primary care physicians and 6 (12.5%) were receiving antidepressant medication. The other 39 (81.2%) participants with high CES-D scores had no indication that their primary care physicians recognized depression.

Depressive symptoms and metabolic control

We assessed the crude relationship between parameters of metabolic control and the

Table 1—*Selected characteristics of 183 adults with type 2 diabetes*

Socio-demographic characteristics	
Female	141 (76)
Age (years)	59 ± 9
Education (years)	10 ± 3
Annual household income	
<$5,000	37 (20)
$5,000–7,500	62 (34)
$7,501–10,000	34 (19)
$10,001–15,000	31 (17)
>$15,000	19 (10)
Martial status	
Married	50 (27)
Widowed	43 (23)
Separated	29 (16)
Divorced	39 (21)
Never married	25 (13)
Health insurance	
Receives medical assistance	78 (43)
Receives medicare only	4 (2)
Has private insurance or belongs to HMO	63 (34)
No insurance	38 (21)
Lives alone	42 (23)
Health behaviors	
Medication compliance	
Diabetes med compliance score	
Low	12 (7)
Moderate	20 (12)
High	140 (81)
Blood pressure med compliance score	
Low	14 (11)
Moderate	14 (11)
High	105 (79)
Cholesterol med compliance score	
Low	3 (7)
Moderate	4 (10)
High	35 (83)
Self-monitoring behavior	
Does not have a blood glucose monitor	49 (26)
Has a monitor but has not used it	24 (13)
Monitors once or several times a week	57 (31)
Monitors every day	55 (30)
Smoking	
Never	84 (46)
Former	67 (36)
Current	34 (18)
Dietary risk assessment score	25 ± 8
Leisure time physical activity index	2.4 ± 0.6
Parameters of metabolic control	
Current medication use	
Insulin	81 (44)
Pills	91 (49)
BMI (kg/m^2)	33 ± 7
Systolic blood pressure (mmHg)	127 ± 18
Diastolic blood pressure (mmHg)	76 ± 12
Total cholesterol (mg/dl)	214 ± 46
HDL cholesterol (mg/dl)	48 ± 13
LDL cholesterol (mg/dl)	142 ± 40
Triglycerides (mg/dl)	129 ± 81
HbA_{1c} (%)	8.6 ± 2.1
Prevalence of CES-D–defined depression	
(CES-D score cutoff)	
≥16	82 (45)
≥22	54 (30)

Data are *n* (%) or means ± SD.

presence of depressive symptoms. Diastolic blood pressure, total cholesterol, HDL and LDL cholesterol, and triglycerides showed significant increasing trends with increasing CES-D quartile. HbA_{1c}, systolic blood pressure, and BMI showed no significant trend with CES-D. Most associations persisted after adjustment for age, sex, income, social support, and duration of diabetes (Fig. 1*A–F*), with the exception of LDL cholesterol. In fact, HbA_{1c} and diastolic blood pressure became marginally statistically significant after adjustment. In addition, total cholesterol and triglycerides in the highest quartile were significantly higher than in the lowest CES-D quartile.

Health behaviors as possible mediators

To determine whether diabetes-related health behaviors mediate the relationship between depressive symptoms and metabolic control, health behaviors were entered independently and in combination into linear regression models adjusting for age, sex, income, social support, and diabetes duration. This analysis was confined to the six parameters of metabolic control, HbA_{1c}, diastolic blood pressure, total cholesterol, HDL and LDL cholesterol, and triglycerides, which showed trends with increasing CES-D. If these health behaviors were mediators, one would expect their introduction into the regression models to attenuate the relationship between CES-D scores and diabetes-related parameters of metabolic control. However, as illustrated in Fig. 1*A–F*, the simultaneous introduction of these health behaviors into the models had little or no effect on the strength of the CES-D association. For every trait, the relationship with CES-D score after additional adjustment for health behaviors was virtually superimposable upon the relationship before adjustment. For example, after adjustment for socio-demographic factors alone, HbA_{1c} rose from 8.2% in the individuals who reported the fewest depressive symptoms to 8.7% in those who reported the most. After simultaneously accounting for the possible influence of diet, physical activity, smoking, glucose self-monitoring behavior, and diabetes medication adherence, this finding was virtually unchanged: those with the fewest symptoms had an HbA_{1c} of 8.3% and those with the most had an HbA_{1c} of 8.8%. Similarly, there were no significant changes when accounting for any one of the individual behaviors (data not shown).

CONCLUSIONS — These data support the following three conclusions regarding African-Americans with type 2 diabetes: First, a high proportion of this sample reports having depressive symptoms, the majority of whom are not clinically recognized to have depression. Second, depressive symptoms are marginally associated with suboptimal levels of HbA_{1c}, diastolic blood pressure, and LDL cholesterol, and significantly associated with suboptimal levels of total cholesterol and triglyceride levels. Third, no specific health behavior was found to mediate the relationship between depressive symptoms and metabolic control.

Four possible limitations of the study deserve comment. First, because the study was cross-sectional, inferences about causality must be made cautiously. Although we hypothesized that depression would reduce metabolic control, we cannot exclude the possibility that poorer control may cause depression.

Second, several features of the study raise concerns about potential selection bias. The ratio of women to men with diabetes in this study was three to one, far exceeding the ratio in the general population (26). However, the same three-to-one ratio was noted in the nonrespondents, indicating selection processes related to enrollment in primary care occurred upstream from study recruitment. It is well known that women with diabetes are more likely than men with diabetes to be enrolled in primary care (27). Because the study was set within a randomized trial, it is possible that a healthier subset of the target population may have been included. Finally, because only two clinics were sampled, the sample may not have been representative of the East Baltimore community or of other clinic samples. Nonetheless, these clinics are the largest primary care clinics in East Baltimore, and it is estimated that together they serve 20% of the African-American adult medical patients in the area.

Third, data on CES-D–defined depression were based entirely upon self-report; there was no psychiatric diagnosis of depression. In addition, the CES-D measures depressive symptoms only during a specific time period (within the past week). This hinders our ability to assess a lifetime prevalence of depression. However, the CES-D has been shown to be highly reliable and valid in a variety of epidemiological studies (15). In various studies, sensitivity ranged from 93 to 99%, and specificity from 53 to 86% (15). Health behaviors were also based entirely on self-report. However, many clinical measurements tended to correspond with the self-reported scales (e.g., BMI and physical activity index [data not shown]), which strengthens the credibility of the instruments.

Finally, the study's statistical power was limited, especially with regard to stratified analyses. This reduced our ability to detect modest effects and may explain some of our marginal and negative findings. However, the 183 participants in this study exceed the number of participants in the majority of the other studies conducted on depression and glycemic control (8,11, 28–32). Moreover, this study contains by far the highest number of African-American individuals.

Since 1966, at least 11 published studies have examined the relationship between depression and glycemic control in individuals with type 1 and type 2 diabetes (7–12,28–32). Six of these studies were conducted in populations with largely type 2 diabetes (7–12). Of these, two clearly showed a relationship between depression and glycemic control (7,8). Van Der Does et al. (7) found that higher HbA_{1c} levels were significantly associated with symptom scores of worse mood on the Dutch shortened Profile of Mood States and general well-being on the Affect Balance Scale. Lustman et al. (8) reported that depressed patients, as indicated by the National Institute of Mental Health Diagnostic Interview Schedule Version Three, had higher glycohemoglobin levels compared with those who were never psychiatrically ill. In contrast, Wilson et al. (9) found that psychosocial variables, depression (as measured by the Beck Depression Inventory and the CES-D), anxiety, stress, diabetes knowledge, health beliefs, and social support were not significant correlates of glycemic control. However, they did find that the psychosocial factors combined were significantly associated with self-care behaviors such as medication adherence, glucose testing, diet, and exercise.

The remaining three studies of depression and type 2 diabetes produced equivocal results (10–12). Peyrot and Rubin (10) found that although scores on the CES-D depression scale were higher in individuals with elevated glycosylated hemoglobin, the relationship was not statistically significant (10).

The most recent studies were randomized controlled trials conducted by Lust-

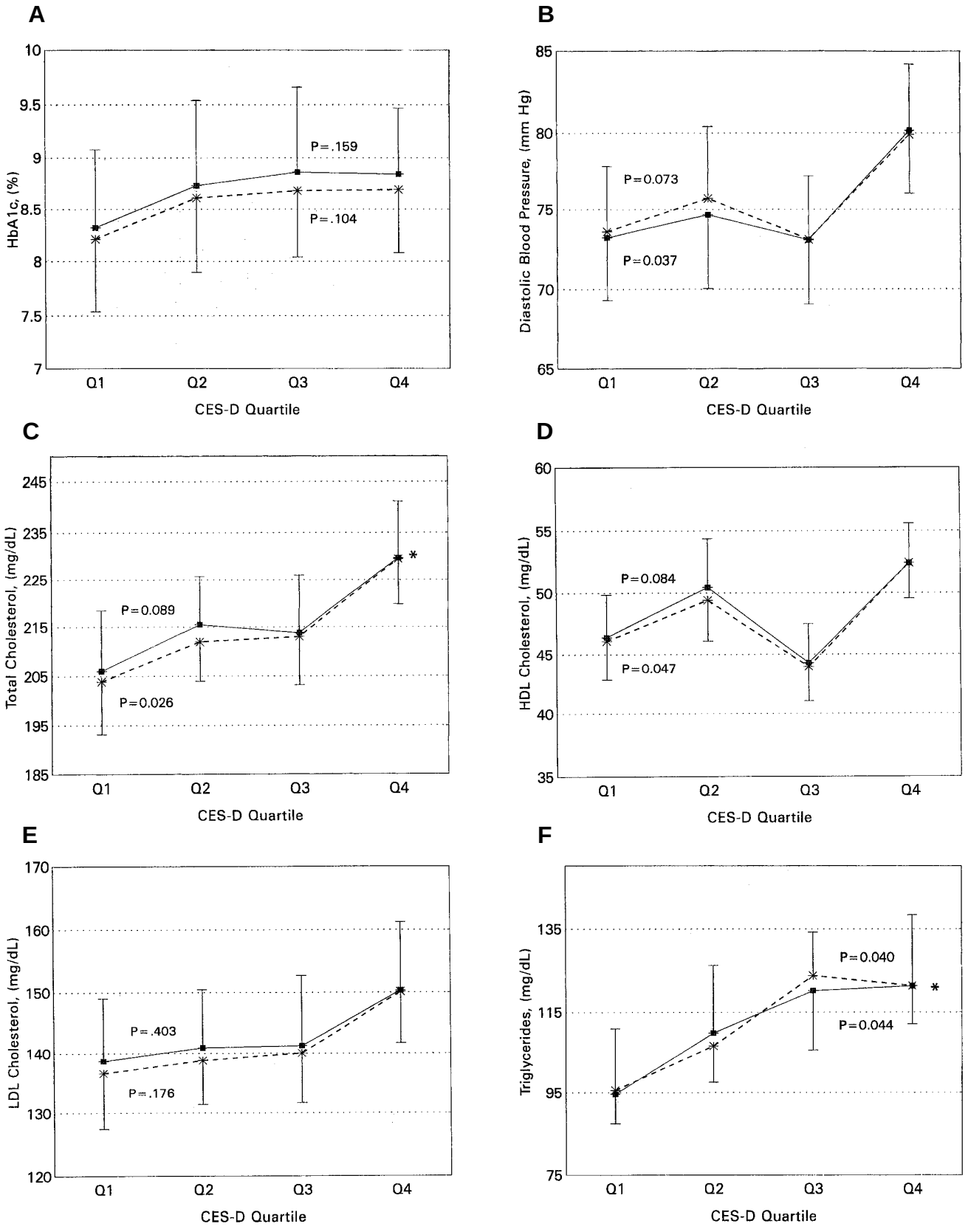

Figure 1—*Adjusted mean levels of selected parameters of metabolic control, HbA_{1c} (A), diastolic blood pressure (B), total cholesterol (C), HDL cholesterol (D), LDL cholesterol (E), and triglycerides (F), by CES-D quartile in 183 adults with type 2 diabetes. Squares and sold lines indicate levels adjusted for age, sex, income, social support, duration of diabetes, diet, exercise, smoking, self-monitoring behavior, and diabetes medication compliance. Stars and dotted lines indicate means adjusted for age, sex, income, social support, and duration of diabetes. Bars indicate upper or lower standard of error. P values for trend are shown on each graph, and a significant difference ($P < 0.050$) in the 4th quartile compared with the 1st quartile is indicated by an asterisk next to the line.*

man et al. The first was a randomized placebo-controlled trial of the effects of nortriptyline on glycemic control (11). Nortriptyline-treated patients showed a trend toward worsened glycemic control, mainly in those patients who were not depressed. However, glucose regulation improved for those who showed improvements in depression. One possible explanation for these findings is that the drug had a direct hyperglycemic effect and improvement in depression has an independent beneficial effect on glycemic control. The other was a trial that randomized diabetic patients with diagnosed depression to either a cognitive behavior therapy (CBT) plus a diabetes education program, or to a diabetes education program only (control group) (12). After the 10-week treatment interval, patients in the CBT group achieved significantly higher remission rates of depression than control patients ($P < 0.001$). Although there was no difference in the post-treatment glycosylated hemoglobin levels between the two groups, levels were significantly better in the CBT group compared with the control group at the 6-month follow-up (9.5 vs. 10.9%, $P = 0.03$).

None of the studies conducted on depression and glycemic control in individuals with type 2 diabetes focused on African-Americans or included a substantial number of other ethnic minorities. In addition, little or no attention was given to the relationship between depression and metabolic variables other than HbA_{1c}.

In our study, the prevalence of CES-D–defined depression was high, with rates ranging from 30 to 45%. The fact that the sample was drawn from a primary care setting, was predominantly female, and was generally of low socioeconomic status may explain the high rates (33–35). Moreover, the use of a depressive symptom scale such as the CES-D may have inflated the rates. Because the sensitivity of depressive symptom scales is high, prevalence rates are higher than when a psychiatric diagnosis of depression is made. Although the prevalence was higher than the U.S. general population, it was within the range of prevalence rates reported from other studies using depressive symptom scales in individuals with diabetes (3,4).

Characteristics of depression could be specific to African-American culture. A study that examined characteristics of depressive symptoms in elderly urban and rural African-Americans found that restricted social support, medical illness, and low levels of education were the most important predictors of positive CES-D scores (36). Another consideration could be the impact of racism in the U.S., which has been recognized as being hazardous to mental health (37). Furthermore, individuals from lower socioeconomic backgrounds (in which a disproportionate number of African-Americans fall) may suffer higher rates of mental disorders (35). Stressors of racist attitudes and discriminatory behavior toward African-Americans combined with stressors of low socioeconomic status can make low-income African-Americans particularly vulnerable to mental disorders (37).

The relationship between depressive symptoms and metabolic control was not explained by diabetes-related health behaviors that we had hypothesized to be mediators. One reason for this could be that the behaviors in this study were not adequately measured. For example, we had little variation in our measure of medication adherence. Another possibility could be that there are behaviors related to depression and glycemic control that were not measured in this study. Other factors (e.g., other chronic or psychiatric conditions or a family history of depression) that were not included in our study could contribute to the relationship. A third alternative could be that the relationship between depression and glycemic control might be via a causal pathway that is independent of behaviors. For example, a direct biologic relationship may explain the association. Eaton et al. (38) suggested several possible mechanisms. One possibility is that a common neuroendocrine basis underlies or precedes both depression and diabetes. Another possibility could be that a psychological reaction similar to depression could arise from the morbidity of diabetes and its complications (38).

In our study, the finding that HDL cholesterol increased with CES-D quartile was unexpected. A study conducted by McCann et al. (39) reported that lipoprotein (LDL and HDL) levels significantly increased from baseline in response to acute psychological stress (<2 h). It is possible that depression affects lipid metabolism as a whole through physiologic mechanisms rather than through the effects of self-care behaviors on LDL and HDL cholesterol independently.

In summary, the main implication of this study is that depression may be an important contributor to suboptimal metabolic control in African-Americans with type 2 diabetes. If confirmed in prospective studies, this supports the notion that identification and treatment of depression in African-Americans may reduce their excess risk of complications.

Future research in this area should include prospective studies, treatment trials, and direct comparisons with white or other racial group populations to determine if some of the increased risk of complications from diabetes and increased mortality in African-Americans could be attributed to depression. Until then, the precise relationship between depressive symptoms and metabolic control remains uncertain.

Acknowledgments — This work was supported by grants from the National Institutes of Health (RO1-DK48117-04 and RO1-DK48117-03S1) and the Johns Hopkins University Outpatient Department General Clinical Research Center (R00052).

The authors would like to acknowledge the Project Sugar staff, particularly Marian Batts-Turner and Yvonne Cummings, and the Johns Hopkins Outpatient General Clinic Research Center staff for their support with data collection. We would also like to acknowledge the Project Sugar participants, whose cooperation and involvement made this research possible.

The results were presented in part at the 58th Scientific Sessions of the American Diabetes Association, Chicago, Illinois, June 1998.

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