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Diabetes, Depressive Symptoms, and Functional Disability in African Americans: The Jackson Heart Study

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Abstract

Aims—To investigate the degree to which comorbid depression contributes to the relationship of diabetes with functional disability in African Americans(AAs), a population at high-risk for complications.

Methods—We examined 2,989 African Americans(AAs) in the Jackson Heart Study who had diabetes and depressive symptoms(CES-D) assessed at baseline. Functional disability was the inability to perform at least one task of daily living. Multivariable logistic regression models explored the association of diabetes and depressive symptoms with functional disability.

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Results—Prevalence of functional disability was highest with both diabetes and depressive symptoms(54%), similar with diabetes alone(31%) or depressive symptoms alone(33%), and lowest with neither(15%). Adjusting for demographics, smoking, BMI, physical activity, cardiovascular comorbidities, and hsCRP, the association of depressive symptoms alone(OR=2.19,95% CI 1.66-2.90) and both diabetes and depressive symptoms(OR=2.80,1.90-4.12) with functional disability was significant, but not for diabetes alone(OR=1.22,0.92-1.62), compared to neither. No significant interaction of diabetes and depressive symptoms was found. In regression analyses including any diabetes and any depressive symptoms together in models, the main effect of depressive symptoms but not diabetes was associated with overall functional disability, and the interaction term was not significant (p-value=0.84).

Conclusions—Functional disability was highest among AAs who have both diabetes and depressive symptoms; the latter was a stronger contributor. Future studies should explore mechanisms underlying functional disability in diabetes, particularly the role of depression.

Keywords

diabetes; depression; functional disability; African Americans; racial disparities

Introduction

Persons with diabetes are more likely to report functional disability in tasks of everyday living compared to those without diabetes which, in turn, is related to increased expenditures, hospitalizations, and mortality (1-4). Consequently, functional disability among persons with diabetes represents a significant public health and economic burden. The reasons for this higher prevalence of disability among persons with diabetes remain unclear but may relate to the presence of comorbidities such as cardiovascular disease (CVD) and obesity (3). Depression is also a common comorbid condition in persons with diabetes that is independently associated with functional disability (5). Previous cross-sectional studies have suggested a synergistic effect of diabetes and major depression on the likelihood of disability compared to either condition alone, in nationally representative U.S. populations (5). However, whether an increased burden of functional disability is also observed in minority populations such as African Americans (AAs) who have a relatively greater prevalence of diabetes is unclear (6, 7). Further, whether comorbid depression contributes to an excess burden of functional disability in the presence of diabetes has not been previously investigated in AAs. AAs have a high prevalence of depression compared to other races, in part related to the presence of poverty, which may itself potentially result in a higher burden of disability in this population (6, 8). Thus, understanding factors related to functional disability in the AA population is imperative for the development of effective and targeted preventive strategies in the future.

Comorbid depression may be related to suboptimal glycemic control among persons with diabetes. Hyperglycemia is, in turn, related to worse functional outcomes (9). In an urban AA population with diabetes, the presence of major depression predicted higher HbA1c levels over time after a diabetes self-management intervention (10). This may relate downstream to a higher rate of other diabetes-related complications, though AAs may also

have higher levels of HbA1c levels due to non-glycemic factors. (11-13). There may also be racial disparities in the treatment of depression in persons with diabetes that contribute to this relationship (14). Interestingly, AAs report having more functional disabilities and have a higher likelihood of developing disability over time, compared to other racial and ethnic groups (15). Thus, AAs with diabetes and depression may represent a particularly vulnerable population at risk for developing functional disability.

In the present study, we sought to examine the following hypotheses: 1) AAs with both diabetes and depressive symptoms have a greater prevalence of functional disability compared to those having either condition alone or neither; and 2) the presence of both diabetes and depressive symptoms has a synergistic interaction on the likelihood of functional disability among this group of AAs.

Methods

The Jackson Heart Study (JHS) is a study of the development and progression of cardiovascular disease in a cohort of 5,301 AA adults, aged 21-94 years from metropolitan Jackson, Mississippi. Enrollment and baseline examinations were performed between 2000 and 2004. The JHS is a large, community-based, observational study whose participants were recruited from three counties (Hinds, Madison, and Rankin) that encompass the Jackson, Mississippi metropolitan area. Sources of JHS participants included former Atherosclerosis Risk in Communities (ARIC) study participants, random selections, volunteers, and as well as first-degree relatives of index participants. Recruiters underwent an extensive training and certification program. In-home interviews were performed upon enrollment, followed by the baseline clinic examination visit, and a 24-hour follow-up home visit. Annual telephone interviews were also completed. Additional details about the study design, recruitment, and methods have been described elsewhere (16). There were a total of 3,496 participants during the baseline visit who had assessment of depressive symptoms. Of these, 34 participants were missing information on diabetes status and an additional 258 participants had incomplete questionnaires for calculation of a CES-D summary score for depressive symptoms. Of the remaining sample, 215 participants were missing information on limitations on walking half a mile, a measure of mobility. Thus, the final study sample for the present cross-sectional study was 2,989 participants. The JHS was approved by the institutional review boards of the participating institutions and written informed consent was obtained from all participants.

Baseline information was obtained during clinic visits or at home using standardized questionnaires including: demographics (age, sex), level of education (< vs. high school), and tobacco use (current smoker versus not). The presence of comorbidities (hypertension, stroke, and cardiovascular disease) was self-reported. Use of blood-pressure and lipid lowering medications was documented.

Calibrated devices were used by certified technicians and nurses to measure participants' weight and height. Body mass index (BMI) was calculated as weight (kilograms)/ height² (meters). In addition, hsCRP was measured by the immunoturbidimetric CRP-Latex assay (Kamiya Biomedical Company, Seattle, WA) using a Hitachi 911 analyzer (Roche

Diagnostics, Indianapolis, IN) as previously described (17); elevated inflammatory markers may be related to the presence of both diabetes and depression (18, 19).

Assessment of diabetes history

Diabetes was defined as HbA1c $\geq 6.5\%$ (48 mmol/mol), fasting blood glucose ≥ 126 mg/dL, use of glucose-lowering medications, or a physician diagnosis. Fasting glucose levels were measured on participants using a Vitros 950 or 250, Ortho-Clinical Diagnostics analyzer (Raritan, NJ) using standard procedures that met the College of American Pathologists accreditation requirement. A high-performance liquid chromatography system (Tosoh Corporation, Tokyo, Japan) that was DCCT-aligned using NGSP guidelines was used to measure glycosylated hemoglobin A1c (HbA1c). At the time of each clinical examination, participants presented all of the medications used within the past 2 weeks, whether prescription, over-the-counter, or herbal preparations. In the instance that a participant did not bring in all medications, staff obtained complete medication lists from a post-examination telephone call to the participants or to the consenting participant's pharmacy and also had data using Medication Survey Form (MSRA). Use of diabetes medications was categorized as none, orals only, insulin only, or the combination of orals plus insulin.

Assessment of depressive symptoms

Elevated depressive symptoms were defined based on answers to the 20-item Center for Epidemiological Studies-Depression (CES-D) questionnaire. A score of ≥ 16 was used as a proxy measure for the clinical diagnosis of depression, similar to other studies (20). If a person was missing information on some questions but still had a CES-D score that was 16 or greater, they were categorized as having depressive symptoms. Cronbach's alpha was 0.82, indicating relatively good internal consistency.

Assessment of functional disability

The presence of functional disability was defined based on responses (yes/no) to questions in the annual telephone follow-up questionnaire. This section of the questionnaire starts with the following: "Now I would like to find out whether you can do some physical activity without help. By 'without help' I mean without the assistance of another person. These questions refer to the last 4 weeks." The specific questions related to functional disability ask if the participant is able to do the following tasks: walk half a mile (8 ordinary blocks) without help; walk up and down stairs without help; perform usual activities such as work around the house or recreation; perform heavy work around the house (shoveling snow, washing windows, walls or floors) without help; or go to work. Overall functional disability was defined dichotomously as a response of "no" to any of these tasks. The methods used to assess functional disability are similar to previous studies (5).

Participants were also asked about the impact of health on usual activities or work including if the participant has a) cut down on usual activities (such as work around the house or recreation) for half a day or more, because of health reasons or b) missed work for at least half a day because of health reasons. For the latter question, only a subset of participants responded (n=1,912) because other participants were not actively working. The functional

disability questionnaire was administered a mean of 1.11 ± 0.29 years following the baseline visit.

Statistical Analyses

Descriptive analyses were performed using student's t-test for continuous variables and chi-squared tests for categorical variables. Participants were categorized according to depressive symptoms and diabetes status as follows: no diabetes or depressive symptoms, depressive symptoms alone, diabetes alone, both diabetes and depressive symptoms. The percentage of participants reporting the ability to perform each functional task or the impact of health on functional status and work, as well as overall functional disability, was graphically represented according to depressive symptoms and diabetes status. Multivariable logistic regression models were used to characterize the association of diabetes and depressive symptoms status with functional disability in individual tasks, and overall. Models included all dummy variables for the diabetes-depressive symptoms categories (i.e., diabetes alone; depressive symptoms alone; both diabetes and depressive symptoms) in the same model with "no diabetes-no depressive symptoms" as the reference group. Model 1 was adjusted for age, sex, education, and smoking status. Model 2 was adjusted for variables in model 1 + BMI. Model 3 was adjusted for variables in model 2 + history of cardiovascular disease, history of stroke, history of hypertension, use of blood pressure lowering medications, use of lipid-lowering medications + hsCRP. We tested for multiplicative interaction in the presence of both diabetes and depressive symptoms on the outcome of functional disability, for individual tasks and overall functional disability, by including an interaction term of diabetes and depressive symptoms in the models and used Wald's chi-square test to test for statistical significance. We also calculated Relative Excess Risk due to Interaction (RERI) to assess for the presence of additive interaction (21). A two-sided p-value of <0.05 was considered statistically significant. All analyses were performed using Stata IC version 13.1 (Statacorp, College Station, TX).

Results

Among 2,989 participants, 21% had diabetes and 23% had depressive symptoms; 5% had both. There were significant differences in mean age, sex, education, and smoking status by diabetes and depressive symptoms categories (all $p < 0.001$; Table 1). In addition, BMI and hsCRP was highest in those with both diabetes and depressive symptoms; differences were significant across disease categories. History of hypertension, cardiovascular disease, and stroke and the use of blood pressure lowering medications was highest in those with both diabetes and depressive symptoms, with significant differences across categories. The use of lipid-lowering medications was also significantly different across categories. Among those with diabetes, most participants were not on medications or were on oral medications only.

The overall prevalence of functional disability was highest, and the ability to perform individual functional tasks or go to work was lowest, in those with both diabetes and depressive symptoms and differed significantly across disease categories (Figures 1A-1F, all $p < 0.001$). Participants with depressive symptoms alone or both diabetes and depressive symptoms had the greatest prevalence of missing work for at least half a day (Figure 1G)

and cutting down on usual activities due to health reasons (Figure 1H), with significant differences across disease categories (both $p<0.001$).

Participants with depressive symptoms alone were significantly more likely than those with neither depressive symptoms nor diabetes to have functional disability in mobility tasks (walking up the stairs and walking half mile), doing usual activities, and doing heavy work (Table 2, Model 1; all $p<0.001$). This association was attenuated but remained significant in fully adjusted models (Model 3; all $p=0.001$). In comparison, those with diabetes alone versus those with neither depressive symptoms nor diabetes were more likely to have functional disability in the same tasks (Model 1; all $p<0.01$) but only the inability to walk half mile (Model 3; OR=1.54, 95% CI 1.08-2.19, $p=0.02$) remained significant in fully adjusted models. Participants with both diabetes and depressive symptoms had a significantly higher odds of difficulty in mobility tasks, doing usual activities, and doing heavy work compared to those with neither after accounting for demographics (Model 1; all $p<0.001$); these associations remained significant in fully adjusted models (Model 3, all $p<0.01$).

Participants with depressive symptoms alone reported a significantly increased odds of inability to go to work (Model 3; OR=3.46, 95% CI 2.28-5.27) as did those with diabetes alone (Model 3; OR=1.72, 95% CI 1.03-2.87) in fully adjusted models, compared to participants with neither condition. Participants with both diabetes and depressive symptoms also had a significantly increased odds of inability to go to work (Model 3; OR=5.04, 95% CI 2.79-9.12) versus having neither condition.

The odds of overall functional disability was significantly higher in persons with depressive symptoms alone (Model 1; OR=2.52, 95% CI 1.97-3.23) and diabetes alone (Model 1; OR=1.84, 95% CI 1.43-2.37) accounting for demographics, compared to those with neither condition. In fully adjusted models, the relationship remained significant for those with depressive symptoms alone (Model 3; OR=2.30, 95% CI 1.75-3.03) but was attenuated in those with diabetes alone (Model 3; OR=1.26, 95% CI 0.95-1.67). In persons with both diabetes and depressive symptoms, the odds of overall functional disability was significantly increased (Model 1; OR=4.39, 95% CI 3.07-6.27), and remained significant in fully adjusted models (Model 3; OR=2.75, 95% CI 1.88-4.04), compared to those with neither condition.

When asked about the impact of health conditions on the ability to work, persons with depressive symptoms alone had a significantly increased odds of reporting missing work for at least half a day for health reasons in adjusted models (Model 3; OR=1.92, 95% CI 1.25-2.95) or cutting down on usual activities for health reasons (Model 3; OR=2.64, 95% CI 1.81-3.87) compared to persons with neither diabetes nor depressive symptoms. Significant findings were not observed for participants with diabetes alone. Participants with both diabetes and depressive symptoms had an increased odds of cutting down on work (Model 3; OR=2.42, 95% CI 1.36-4.30) compared to those with neither condition.

In interaction analyses, no evidence was found for a multiplicative interaction of having both diabetes and depressive symptoms on any of the individual functional tasks, or overall disability (all p -values for interaction >0.05). In fully adjusted models that included the

presence of any diabetes (n=680) and the presence of any depressive symptoms (n=631) together in models, the main effect of depressive symptoms was significantly associated with functional disability (Model 3, OR=2.30, 1.75-3.03) but not the main effect of diabetes (Model 3, OR=1.26, 0.95-1.67) and the interaction term between the two conditions was not significant (p-value for interaction=0.84). Similar trends were found across individual functional tasks, and for the impact of health status on work. In general, the effect of diabetes was attenuated after adjusting for other factors, while the relationship of depressive symptoms with functional disability remained significant. We also found no evidence for the presence of an additive interaction between diabetes and depression symptoms on the likelihood of functional disability in any of the models (all 95% confidence intervals for RERI cross 0).

Discussion

The prevalence of functional disability among this group of AAs was generally highest for those with both diabetes and depressive symptoms, compared to either condition alone or neither condition, with approximately half of participants in this category reporting disability in at least one functional task. However, the prevalence of self-reported impact of health status on work and usual activities was twice as high in those with depressive symptoms alone compared to diabetes alone. Persons with depressive symptoms alone or those with both diabetes and depressive symptoms had a significantly greater odds of overall functional disability after accounting for BMI, physical activity, cardiovascular comorbidities, and inflammatory factors compared to those with neither condition. Importantly, in the presence of depressive symptoms, the effect of diabetes was largely attenuated after accounting for other potential confounding factors, and there was no significant interaction of having both diabetes and depressive symptoms on the odds of functional disability.

Previous studies have reported on the relationship of depression and diabetes status to functional disability (5, 22-27) but no other studies have focused specifically on AA populations. Interestingly, participants who had comorbid depressive symptoms accounted for about 25% of persons with diabetes among AAs living in Jackson, Mississippi in our study compared to a previous study where those with comorbid depression only accounted for about 10% of persons with diabetes in a nationally representative population (5). Of note, in that study, major depression was defined using an older questionnaire called the Composite International Diagnostic Interview Short Form (CIDI-SF) whereas we used the newer CES-D instrument that is well-validated and now more often used for assessing depressive symptoms in population-based studies. The CIDI-SF is an interviewer-administered depression scale that may be more closely aligned to the clinical diagnosis of major depression, resulting in a lower prevalence, but does not assess the global presence of depressive symptoms (28, 29).

In the previous study of U.S. adults (5), there was a progressive increase in self-reported difficulty in functional tasks across diabetes and depression categories. The prevalence of functional disability was lowest in those who had neither condition, followed by those with depression alone, then diabetes alone, and finally highest in those with both depression and

diabetes. In comparison, we found that among AA participants in JHS, those with depressive symptoms alone or diabetes alone had a similar prevalence of function disability, and those with both conditions had the highest prevalence of functional disability. However, among those with both diabetes and depressive symptoms, the proportion of participants with functional disability in our study was one-half, compared to three-quarters in the U.S. population (5). Interestingly, the U.S. population studied by Egede (2004) was overall relatively younger in age compared to the Jackson Heart Study. However, the definition of the outcome differed slightly; in the previous study of U.S. adults, any difficulty in a functional task (only a little difficult, somewhat difficult, very difficult, or cannot do at all) was classified as a functional disability, while our study definition was based on the need for assistance in functional tasks. Also, there were more functional tasks ascertained in the previous study of U.S. adults compared to our study, which may have further contributed to the higher overall prevalence of disability. Further, AAs had a significantly lower odds of disability than whites in the national study, which may also help to explain the differences noted. Of note, the previous study suggested a synergistic effect of diabetes and depression on functional outcomes; however, no formal interaction analyses were reported. We extend previous findings by reporting that having diabetes did not generally increase the odds of disability in the presence of depressive symptoms among our group of African Americans, after accounting for multiple comorbid conditions. In other words, depressive symptoms appears to be more robustly linked to physical functioning than diabetes among this group of African Americans. Depression may be an important modifiable factor for functional disability in AAs with diabetes and further studies are needed to explore mechanisms.

We further explored the relationship of having diabetes and/or depressive symptoms on performance at work, which can often be a downstream consequence of functional disability; this was not investigated in previous studies (5). Those with depressive symptoms alone reported a greater impact of health status on missed days at work and cutting down on usual activities compared to those with diabetes alone. Thus, among this group of African Americans, depressive symptoms had a larger impact on functional performance than diabetes, both at work and at home.

Diabetes is a chronic disease that requires especially demanding skills and knowledge in daily self-management, including adherence to lifestyle and medication regimens. Previous studies have shown that AAs with diabetes are less likely than their white counterparts to undergo routine primary care and are more likely to have suboptimal glycemic control (30). Hyperglycemia is further related to the development of functional limitations (9). Whether social support also contributes to functional disability among AAs with diabetes remains to be explored.

The strengths of our study include the well-documented protocols of the Jackson Heart Study. A wide range of functional tasks were assessed. We were also able to explore the impact of health status on work and usual activities which may give further insight into downstream consequences of functional disability. We accounted for the presence of multiple confounders in our analyses including physical activity, cardiovascular comorbidities, and inflammatory markers. To our knowledge, our study is the first to investigate functional disability specifically among AAs according to diabetes and

depressive symptoms status. Further, we performed formal interaction analyses to explore the impact of having both diabetes and depressive symptoms on functional disability, which has not been reported in previous studies.

Our study also has some limitations. The study was cross-sectional and temporality cannot be inferred. The reverse association is possible; persons with functional disability may be at increased risk of developing diabetes (31). Our population was limited to African Americans in a specific geographical area and may not be generalizable outside of this region. The study sample may not necessarily be representative of the entire cohort. Participants who were excluded from the study due to missing data were similar in age and sex, but had higher education level compared to those included in the study [data not shown]. Also, the data for our study was collected more than a decade ago and may not necessarily reflect current trends. We used odds ratios which may overestimate the magnitude of the effect, particularly for outcomes that are common. Future studies that investigate prevalence ratios may give further insights. Our assessment of functional disability was self-reported; although self-reported disability identifies a broad range of disabilities in older age, it is possible that subclinical functional limitations may have been present and the use of performance-based measures may have provided different results (32). Based on availability of resources in the study, functional disability was assessed, on average, one year after diabetes and depressive symptoms status in our study which may have also impacted our results; however, this was the temporal direction of interest. Participants with undiagnosed diabetes were classified in the diabetes group but were not yet on glucose-lowering medicines which may have influenced the relationship with functional disability. The presence of cardiovascular comorbidities was self-reported or documented by use of medications; misclassification is possible and may have led to residual confounding. Finally, while we assessed depressive symptoms using the well-validated CES-D questionnaire, a formal diagnostic interview is needed for the diagnosis of major depression and results of our study may not be generalizable to persons diagnosed with depression in the clinical setting. Also, information on treatment for depression was unavailable and may have resulted in misclassification of these persons as not having depressive symptoms.

In summary, our study demonstrates that the burden of functional disability is highest among our group of AAs who have both diabetes and depressive symptoms. After accounting for important confounders, having depressive symptoms was associated with a significant two-fold increased likelihood of overall functional disability and was more strongly linked to physical functioning than diabetes among this group of African Americans. Future studies that explore mechanisms underlying differences in the burden of functional disability in persons of different races with diabetes and/or depression will help inform preventive care efforts to appropriately reduce the burden of functional disability in the future.

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Figure 1.

The prevalence of overall functional disability (1A) is shown by disease category (no diabetes or depressive symptoms, diabetes alone, depressive symptoms alone, both diabetes and depressive symptoms) as well as the ability to perform individual functional tasks (1B-1F). Overall functional disability was defined as not having the ability to perform any of the individual functional tasks. In general, those with both diabetes and depressive symptoms had higher overall functional disability. Participants were also asked about the

impact of health on usual activities or work (1G-1H). Participants with depressive symptoms alone and both diabetes and depressive symptoms had a similarly high prevalence of reporting missed days at work or cutting down on usual activities due to health reasons.

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Table 1
Baseline characteristics of study participants, Jackson Heart Study (n=2,989)*

	Total	No Diabetes or Depressive Symptoms	Depressive Symptoms Alone	Diabetes Alone	Diabetes and Depressive Symptoms	p-value
<i>n</i>	2,989	1,842	516	467	164	
<i>Demographics</i>						
Mean age (years)	54.5±12.5	53.3±12.4	52.4±13.2	60.0±10.2	59.4±10.8	<0.001
Age 65 years (%)	21.6	18.9	19.0	33.0	28.7	<0.001
Women (%)	64.8	61.8	71.9	65.1	74.4	<0.001
Education (%)						<0.001
>high school	68.5	73.8	59.4	66.1	44.5	
Current smoker (%)	11.7	10.4	19.4	6.9	15.3	<0.001
<i>Physical exam</i>						
Weight (kg)	90.7±21.0	88.9±20.4	89.3±21.4	96.7±19.9	98.4±24.8	<0.001
Height (cm)	169.0±9.2	169.5±9.2	167.9±9.0	168.9±9.2	167.2±8.9	<0.001
Body mass index (kg/m ²)	31.8±7.2	31.0±6.8	31.8±7.9	34.0±6.8	35.1±7.9	<0.001
<i>Laboratory</i>						
Hemoglobin A1c (%)	5.9±1.2	5.5±0.5	5.5±0.5	7.6±1.8	7.4±1.5	<0.001
hsCRP (mg/dl)	0.50±0.7	0.44±0.7	0.53±0.7	0.62±0.8	0.71±1.0	<0.001
<i>Clinical History</i>						
History of hypertension (%)	49.6	42.0	48.4	70.0	81.7	<0.001
History of cardiovascular disease (%)	8.6	5.3	10.3	15.0	22.0	<0.001
History of stroke (%)	3.1	2.2	3.1	4.9	7.3	<0.001
Blood pressure medications (%)	60.0	52.6	55.7	78.4	87.5	<0.001
Lipid-lowering medications (%)	13.3	9.7	8.1	27.7	26.9	<0.001
Diabetes medication type (%)						<0.001
None	---	---	---	28.9	28.8	
Orals only	---	---	---	46.8	39.4	
Insulin only	---	---	---	16.7	20.0	
Orals + insulin	---	---	---	7.6	11.9	
Mean CES-D score	10.9	7.4	22.6	7.6	22.6	<0.001

* Mean ±SD unless otherwise indicated

Table 2
Association of Depressive Symptoms Alone, Diabetes Alone, or Depressive Symptoms and Diabetes with Functional Disability**

	Depressive Symptoms Alone			Diabetes Alone			Depressive Symptoms and Diabetes		
	OR	p-value	95% CI	OR	p-value	95% CI	OR	p-value	95% CI
Unable to walk up the stairs									
Model 1	2.10	<0.001	1.43-3.09	1.90	0.001	1.30-2.80	3.14	<0.001	1.96-5.05
Model 2	2.07	<0.001	1.40-3.06	1.62	0.02	1.09-2.40	2.74	<0.001	1.70-4.42
Model 3	2.05	0.001	1.34-3.14	1.37	0.15	0.89-2.10	2.14	0.004	1.27-3.59
Unable to walk half mile									
Model 1	2.08	<0.001	1.51-2.87	2.04	<0.001	1.48-2.80	4.60	<0.001	3.10-6.83
Model 2	2.05	<0.001	1.48-2.85	1.77	0.001	1.28-2.45	4.02	<0.001	2.70-5.98
Model 3	1.91	<0.001	1.33-2.73	1.54	0.02	1.08-2.19	2.96	<0.001	1.92-4.57
Unable to do usual activities									
Model 1	2.45	<0.001	1.64-3.68	1.98	0.002	1.28-3.08	3.70	<0.001	2.21-6.19
Model 2	2.47	<0.001	1.64-3.71	1.93	0.004	1.24-3.02	3.57	<0.001	2.12-6.01
Model 3	2.24	<0.001	1.42-3.52	1.70	0.03	1.05-2.76	2.68	0.001	1.52-4.73
Unable to do heavy work									
Model 1	2.84	<0.001	2.19-3.68	1.87	<0.001	1.43-2.45	4.64	<0.001	3.24-6.65
Model 2	2.84	<0.001	2.19-3.69	1.68	<0.001	1.28-2.20	4.16	<0.001	2.90-5.97
Model 3	2.65	<0.001	1.98-3.53	1.34	0.05	1.00-1.80	3.10	<0.001	2.11-4.57
Unable to go to work									
Model 1	3.26	<0.001	2.25-4.73	2.52	<0.001	1.62-3.91	7.50	<0.001	4.42-12.73
Model 2	3.22	<0.001	2.22-4.68	2.34	<0.001	1.50-3.67	6.85	<0.001	4.01-11.70
Model 3	3.46	<0.001	2.28-5.27	1.72	0.04	1.03-2.87	5.04	<0.001	2.79-9.12
Overall functional disability***									
Model 1	2.52	<0.001	1.97-3.23	1.84	<0.001	1.43-2.37	4.39	<0.001	3.07-6.27
Model 2	2.52	<0.001	1.96-3.22	1.66	<0.001	1.28-2.14	3.92	<0.001	2.74-5.60
Model 3	2.30	<0.001	1.75-3.03	1.26	0.11	0.95-1.67	2.75	<0.001	1.88-4.04
Missed work for at least half a day due to health reasons									
Model 1	1.87	0.001	1.29-2.70	1.18	0.52	0.72-1.94	2.24	0.04	1.05-4.75
Model 2	1.85	0.001	1.28-2.68	1.12	0.65	0.68-1.85	2.04	0.07	0.95-4.38

	Depressive Symptoms Alone			Diabetes Alone			Depressive Symptoms and Diabetes		
	OR	p-value	95% CI	OR	p-value	95% CI	OR	p-value	95% CI
Model 3	1.92	0.003	1.25-2.95	1.07	0.81	0.62-1.85	1.85	0.15	0.81-4.25
Cut down on usual activities due to health reasons									
Model 1	2.75	<0.001	1.94-3.92	1.59	0.04	1.02-2.47	3.21	<0.001	1.88-5.48
Model 2	2.73	<0.001	1.92-3.89	1.52	0.06	0.98-2.38	3.04	<0.001	1.77-5.21
Model 3	2.64	<0.001	1.81-3.87	1.22	0.43	0.75-1.98	2.42	0.003	1.36-4.30

* Model 1 adjusted for age, sex, education, and current smoking status; Model 2 adjusted for model 1 and BMI; Model 3 adjusted for model 2 and history of cardiovascular disease, history of stroke, history of hypertension, use of blood pressure lowering medications, use of lipid-lowering medications, and hsCRP.

** Compared to persons with neither diabetes nor depressive symptoms.

*** Overall functional disability was defined as being unable to perform any of the five tasks without help.