Diabetes, Major Depression, and Functional Disability Among U.S. Adults

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OBJECTIVE — The goal of this study was to determine prevalence and odds of functional disability in individuals with diabetes and comorbid major depression compared with individuals with either diabetes or major depression alone.

RESEARCH DESIGN AND METHODS — Data on 30,022 adults aged ≥18 years from the 1999 National Health Interview Survey (NHIS) were analyzed. Four disease categories were created: no diabetes and no major depression, major depression alone, diabetes alone, and diabetes and comorbid major depression. Prevalence of functional disability was calculated for each disease category. Multiple logistic regression was used to determine the odds and correlates of functional disability by disease category controlling for age, sex, race/ethnicity, education, income, census region, and disability-associated comorbidity. STATA was used for all analyses to account for the complex survey design of NHIS.

RESULTS — Prevalence of functional disability by disease category was as follows: no diabetes and no major depression (24.5%); major depression (51.3%); diabetes (58.1%); and diabetes and comorbid major depression (77.8%). With no diabetes and no major depression as reference and after adjusting for relevant covariates, the odds of functional disability was 3.00 (95% CI 2.62–3.42) for major depression, 2.42 (2.10–2.79) for diabetes, and 7.15 (4.53–11.28) for diabetes and comorbid major depression.

CONCLUSIONS — Individuals with diabetes and comorbid major depression have higher odds of functional disability compared with individuals with either diabetes or major depression alone. Additional studies are needed to establish a causal relationship.

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Functional disability, defined as difficulty performing activities of daily living and routine social activities, is a common problem in ambulatory patients (1). Functional disability is highly prevalent in individuals with chronic diseases (2), and it predicts functional dependence, increased health services use, increased health care costs, and increased risk of death (3–7). Diabetes and depression are common chronic conditions that are significantly associated with increased odds of functional disability.

In the U.S., 6.2% of the population or 17 million people have diabetes. Of this number, ~11 million are diagnosed and 6 million are undiagnosed (8). Diabetes is a leading cause of cardiovascular disease, stroke, blindness, end-stage renal disease, and nontraumatic lower limb amputations (8). In addition, diabetes is a major cause of functional disability (8). Specifically, individuals with diabetes have two- to threefold higher odds of functional disability compared with individuals without diabetes (9–11). In individuals with diabetes, functional disability is thought to be a consequence of the medical comorbidity that results from diabetes including cardiovascular disease, peripheral vascular disease, stroke, vision impairment, and neuropathy (10).

Similarly, depression is highly prevalent in the U.S., with ~19 million or 9.5% of the adult population ≥18 years being affected by a depressive disorder in any given year (12), and like diabetes, depression is a major contributor to functional disability. In the U.S., major depression was the second leading cause of disability-adjusted life-years (DALYs) lost in women and the tenth leading cause of DALYs in men in 1996 (13). DALYs are calculated as the sum of the years lost due to premature mortality in the population and the years of life lost due to disability (13). Depression is also a major cause of work place absenteeism, diminished or lost productivity, and increased use of health care resources (14). Functional disability in depressed patients is thought to result from decreased physical activity, decreased likelihood of seeking medical care, and increased susceptibility to disease (15).

The prevalence of depression is higher in people with diabetes than it is in people without diabetes. Approximately 30% of people with diabetes have depressive symptomatology (16), ~10% have major depression (16,17), and recent studies have shown that people with diabetes have twofold increased odds of depression compared with individuals without diabetes (16,18). Although, evidence indicates that individuals with diabetes and those with depression are more likely to have functional disability, it is unknown whether individuals with diabetes and comorbid major depression have similar or higher likelihood of functional disability compared with those with either diabetes or major depression alone. In addition, it is unclear whether diabetes and depression are associated with the same types of functional disability.

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Abbreviations: CIDI-SF, Composite International Diagnostic Interview Short Form; DALY, disability-adjusted life-year; NHIS, National Health Interview Survey.

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

This study used data from the 1999 National Health Interview Survey (NHIS), a representative sample of the civilian, noninstitutionalized, adult (aged ≥18 years) population of the U.S. to provide answers to the following two questions. *1*) What is the prevalence of functional disability in individuals with diabetes and comorbid major depression, and how does it compare with the prevalence of functional disability in individuals with diabetes alone, major depression alone, and neither diabetes nor major depression? *2*) Controlling for covariates, how do the odds of functional disability in individuals with diabetes and comorbid major depression differ from that in individuals with diabetes alone, major depression alone, and neither diabetes nor major depression?

It was hypothesized that individuals with diabetes and comorbid major depression would have higher prevalence of functional disability and that after controlling for relevant covariates, they would have higher odds of functional disability compared with individuals with either diabetes or major depression alone.

RESEARCH DESIGN AND METHODS

Study setting and sample

Data from the sample adult core of 1999 NHIS (19) were analyzed. The NHIS is an ongoing national household survey of nonmilitary and noninstitutionalized individuals in the U.S. sponsored by the National Center for Health Statistics of the Centers for Disease Control and Prevention. Adults aged ≥18 years were 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 for the NHIS to reflect the unequal probability of selection and to adjust for nonresponse and poststratification so that estimates from the NHIS can be generalized to the adult civilian population of the U.S. Details about the methodology of the 1999 NHIS are available (19,20).

Diagnosis of major depression

In 1999, the NHIS introduced the World Health Organization Composite International Diagnostic Interview Short Form (CIDI-SF) as part of the survey questionnaire. 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 (21), and it was revised to screen for disorders defined in the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (22). The CIDI-SF is a valid and reliable diagnostic interview and has classification accuracy of 93% for major depressive disorder (23). The classification accuracy of the CIDI-SF is derived from comparing the CIDI-SF cases and noncases to those derived from structured clinical interviews performed as part of the National Comorbidity Survey (24).

CIDI-SF Scoring

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 (25). 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 number of positive responses (range 0–7). Based on the recommendations for scoring (25), an individual was classified as having major depression if they endorsed the stem questions and had positive responses to three or more of the symptom questions. Individuals who endorsed the stem questions but had fewer than three positive responses to the symptoms questions were defined as not having major depression.

Functional disability

In 1999, the NHIS assessed functional status by asking respondents about their ability to perform 12 routine tasks without special equipment. These questions, derived from the work of Nagi (26), Nagi and Marsh (27), and Rosow and Breslau (28), were first incorporated into the NHIS in 1997 (11). Respondents were asked the following questions: "By yourself and without using any special equipment, how difficult is it for you to: *1*) walk a quarter of a mile (approximately three city blocks); *2*) walk up 10 steps without resting; *3*) stand or be on your feet for approximately 2 h; *4*) sit for approximately 2 h; *5*) stoop, bend, or kneel; *6*) reach up over your head; *7*) use your fingers to grasp or handle small objects; *8*) lift or carry something as heavy as 10 pounds such as a full bag of groceries; *9*) push or pull large objects like a living room chair; *10*) go out to things like shopping, movies, or sporting events; *11*) participate in social activities such as visiting friends, attending clubs and meetings, or going to parties; *12*) do things to relax at home or for leisure (reading, watching TV, sewing, listening to music)?"

There were five response options: not at all difficult, only a little difficult, somewhat difficult, very difficult, or cannot do at all. For each of the 12 tasks, an individual was deemed to have a functional limitation if they reported difficulty performing the task without special equipment. Overall functional disability was defined by NHIS as difficulty performing one or more of the 12 tasks listed above without special equipment. The definition of functional limitations and functional disability are consistent with prior work (11,29).

Demographic and socioeconomic characteristics

Four racial/ethnic groups defined by NHIS were used: non-Hispanic white, His-

panic, non-Hispanic black, non-Hispanic other. Two age categories were created: 18–64 and ≥65 years. Education was classified as less than high school graduate and at least high school graduate or greater. Household income was categorized as <$20,000 and ≥$20,000. Geographic location was based on census region: West, South, Midwest, and Northeast.

Disease categories and disability-associated comorbidity

A multilevel variable that defined four disease categories was created. The four categories were: no diabetes and no major depression, major depression alone, diabetes alone, and diabetes and comorbid major depression. The diagnosis of diabetes was based on self-report of being diagnosed with diabetes by a physician excluding a diagnosis made during pregnancy. Major depression was defined as described above. To account for the potential confounding effect of comorbid conditions other than diabetes or major depression on odds of functional disability, a variable called disability-associated comorbidity was created. An individual was deemed to have a disability-associated comorbid condition if they had any of the following conditions: chronic arthritis (rheumatoid arthritis, osteoarthritis, or arthritis due to gout), chronic obstructive pulmonary disease, coronary artery disease, stroke, or heart failure. These conditions were selected because of their high prevalence and independent association with functional disability (29).

Statistical analyses

Statistical software, STATA (30), which accounts for the multistage sampling, clustering, and stratification design of national surveys such as the NHIS (31), was used for statistical analyses and to generate population estimates. Three sets of analyses were performed. First, demographic characteristics and the distribution of disability-associated comorbid conditions were compared across the four disease categories (no diabetes and no major depression, major depression only, diabetes only, and diabetes and comorbid major depression) using χ^2 statistics. Second, proportions of respondents with functional limitations were compared across the four disease categories. Similarly, the proportions of respondents with overall functional disability (defined as difficulty performing one or more of the 12 previously mentioned tasks without special equipment) were compared across the four disease categories using χ^2 statistics. Third, multiple logistic regression was used to determine the independent odds of functional limitations and overall functional disability across the four disease categories controlling for age, sex, race/ethnicity, education, household income, census region, and disability-associated comorbidity. For each of the 12 tasks, a multiple logistic regression model was run with inability to perform the task without special equipment (functional limitation) as the dependent variable (yes versus no) and disease category (four-level variable) as the independent variable, controlling for age, sex, race/ethnicity, education, household income, census region, and disability-associated comorbidity. Similarly, for overall functional disability, the dependent variable was overall functional disability (yes versus no), and disease category, age, sex, race/ethnicity, education, household income, census region, and disability-associated comorbidity were entered as independent variables. Additional analyses were performed to determine whether there was an interaction between the effects of diabetes and major depression on functional disability. Separate logistic regression models were run with functional disability as the dependent variable and diabetes, major depression, and an interaction term (diabetes and major depression) as independent variables along with other covariates.

RESULTS — In 1999, 30,801 individuals aged ≥18 years were interviewed, and the overall response rate was 70%. Of this number, 30,022 with complete data on relevant variables were included in the analysis. Approximately 170 individuals had both diabetes and major depression, 1,624 had only diabetes, 1,852 had only major depression, and 26,376 individuals had neither diabetes nor major depression. Extrapolating to the U.S. population in 1999, ~1 million individuals had both diabetes and major depression, 9.4 million had diabetes alone, 11 million had major depression alone, and 174 million had neither diabetes nor major depression.

Table 1 compares demographic characteristics and distribution of disability-associated comorbid conditions across the four disease categories. There were significant differences in demographic characteristics across the four disease categories. In addition, there were significant differences in the prevalence of disability-associated comorbidity (chronic arthritis, chronic obstructive pulmonary disease, coronary artery disease, stroke, and heart failure) across the four disease categories; however, individuals with diabetes and major depression had significantly higher prevalence of these conditions compared with the other categories.

Table 2 shows the proportion of respondents with functional limitations and overall functional disability by disease category, and Table 3 shows the adjusted odds of functional limitations by disease category. There seemed to be a progressive increase in the proportion of individuals with functional limitations and overall functional disability across the four disease categories. A significantly higher proportion of individuals with diabetes and major depression reported having overall functional disability compared with the other three groups. Specifically, ~78% of individuals with diabetes and comorbid major depression reported having overall functional disability in contrast with 58% of those with diabetes, 51% of those with major depression, and 25% of individuals with neither diabetes nor major depression.

Table 4 shows factors that are independently associated with overall functional disability. All variables entered into the multiple logistic regression model were independently associated with odds of functional disability, but the magnitude of effect differed across the variables (Table 4). Independent of disease category, individuals with one or more disability-associated comorbid condition, the elderly, women, people with lower household income, those with less than high school education, and residents of the Southern and Northeastern regions of the U.S. had significantly higher odds of functional disability. On the contrary, non-Hispanic blacks and Hispanic/others had significantly lower odds of functional disability compared with non-Hispanic whites.

Table 5 shows the unadjusted and adjusted odds of functional disability by disease category. In the unadjusted model, individuals with diabetes and major depression (odds ratio [OR] 9.18, 95% CI 6.29–13.41) had significantly higher

Table 1—*Sample characteristics*

	No diabetes and no major depression (%)	Major depression (%)	Diabetes alone (%)	Diabetes and comorbid major depression (%)	*P* value
N (*n*)	173,833,043 (26,376)	11,050,391 (1,852)	9,385,893 (1,624)	932,298 (170)	
Age ≥65 years	15.5	7.0	41.7	19.6	<0.0001
Women	51.2	67.5	51.9	64.5	<0.0001
Race/ethnicity					<0.0001
Non-Hispanic white	75.1	77.8	68.6	67.4	
Hispanic	10.2	7.8	11.4	12.9	
Non-Hispanic black	10.8	10.7	16.6	13.0	
Non-Hispanic other	3.9	3.7	3.4	6.7	
Education					
High school or more	83.0	81.9	70.5	71.7	<0.0001
Annual income					
≥$20,000	80.6	69.7	68.4	55.0	<0.0001
Census region					0.004
West	18.8	20.9	16.6	18.8	
South	35.9	37.2	38.3	41.7	
Midwest	25.8	26.5	24.5	17.7	
Northeast	19.5	15.4	20.6	21.8	
Disability-associated comorbidity*					
Chronic arthritis	10.8	20.9	27.9	46.4	<0.0001
Chronic obstructive pulmonary disease	4.7	13.4	8.3	15.3	<0.0001
Coronary artery disease	9.4	14.0	32.2	46.4	<0.0001
Stroke	1.6	3.0	6.8	13.1	<0.0001
Heart failure	0.9	0.8	6.9	9.9	<0.0001
≥1 disability-associated comorbidity	21.1	37.3	52.3	67.2	<0.0001

n = 30,022; *N* = 195,201,625. *n*, unweighted sample size; *N*, weighted sample size; %, weighted percentage. *These conditions are typically associated with significant functional limitation/disability. Chronic arthritis is defined as having rheumatoid arthritis, osteoarthritis, gouty arthritis, or other types of arthritis.

odds of overall functional disability compared with individuals with either major depression (3.21, 2.89–3.57) or diabetes (4.18, 3.74–4.67). This pattern remained even after adjusting for relevant covariates: diabetes and major depression (6.15, 3.86–9.80), major depression (3.02, 2.66–3.44), and diabetes (2.46, 2.15–2.82). In addition, in both unadjusted and adjusted models, the odds of overall functional disability in individuals with diabetes and comorbid major depression (OR 6.15) was significantly higher than the sum of the independent odds of functional disability in individu-

Table 2—*Prevalence of functional limitations and overall functional disability* by disease category*

	No major depression and no diabetes (%)	Major depression (%)	Diabetes only (%)	Diabetes and major depression (%)	*P* value
Difficulty walking 12 city blocks	10.9	26.7	39.0	60.2	<0.0001
Difficulty climbing 10 steps	8.1	20.1	30.7	51.7	<0.0001
Difficulty standing on feet for 2 h	13.2	30.1	40.0	61.6	<0.0001
Difficulty sitting for 2 h	7.3	23.9	17.1	35.9	<0.0001
Difficulty stooping, bending, or kneeling	15.9	35.3	44.0	59.7	<0.0001
Difficulty reaching over head	5.5	18.0	17.0	32.0	<0.0001
Difficulty grasping small objects	5.4	14.4	18.9	30.9	<0.0001
Difficulty lifting 10 pounds	7.1	19.5	25.4	49.5	<0.0001
Difficulty pushing or pulling heavy objects	10.2	26.2	32.2	55.5	<0.0001
Difficulty shopping	5.1	17.3	20.5	39.8	<0.0001
Difficulty visiting friends	4.0	16.8	15.6	34.7	<0.0001
Difficulty watching television or listening to music to relax	2.1	12.2	7.6	22.3	<0.0001
Overall functional disability	24.5	51.3	58.1	77.8	<0.0001

*Functional disability defined as difficulty performing any 1 of the 12 tasks listed above without special equipment. %, Weighted percentage.

Table 3—*Adjusted odds of functional limitation by disease category*

	Major depression only	Diabetes only	Diabetes and major depression
Difficulty walking 12 city blocks	2.86 (2.44–3.34)	2.74 (2.34–3.22)	8.09 (5.12–12.78)
Difficulty climbing 10 steps	2.61 (2.20–3.08)	2.43 (2.05–2.88)	7.00 (4.41–11.07)
Difficulty standing on feet for 2 h	2.56 (2.23–2.94)	2.34 (2.00–2.73)	6.34 (4.13–9.74)
Difficulty sitting for 2 h	3.15 (2.71–3.66)	1.51 (1.26–1.80)	3.52 (2.32–5.35)
Difficulty stooping, bending, or kneeling	2.61 (2.26–3.02)	2.32 (2.00–2.70)	4.61 (2.98–7.13)
Difficulty reaching over head	3.24 (2.73–3.84)	1.73 (1.45–2.07)	3.67 (2.35–5.73)
Difficulty grasping small objects	2.32 (1.96–2.76)	2.11 (1.77–2.52)	3.82 (2.47–5.93)
Difficulty lifting 10 pounds	2.76 (2.36–3.22)	2.26 (1.90–2.68)	7.10 (4.58–11.01)
Difficulty pushing or pulling heavy objects	2.75 (2.37–3.19)	2.20 (1.87–2.59)	6.44 (4.28–9.70)
Difficulty shopping	3.30 (2.77–3.92)	2.42 (2.01–2.91)	6.16 (4.01–9.45)
Difficulty visiting friends	4.13 (3.49–4.88)	2.12 (1.76–2.54)	5.66 (3.61–8.90)
Difficulty watching television or listening to music to relax	5.65 (4.55–7.00)	1.96 (1.52–2.53)	6.63 (3.93–11.17)

Data are OR (95% CI). Note: No diabetes and no major depression is the reference disease category. ORs are adjusted for age, sex, race/ethnicity, education, income, census region, and disability-associated comorbidity. Disability-associated comorbidity is defined as having any one of the following: chronic arthritis, chronic obstructive pulmonary disease, coronary artery disease, stroke, or heart failure.

Table 4—*Factors independently associated with overall functional disability*

	Adjusted OR	95% CI
Disease category		
No diabetes and no major depression (reference)	1.00	1.00–1.00
Major depression	3.00	2.62–3.42
Diabetes	2.42	2.10–2.79
Diabetes and major depression	7.15	4.53–11.28
Age		
<65 years (reference)	1.00	1.00–1.00
≥65 years	2.83	2.61–3.08
Sex		
Men (reference)	1.00	1.00–1.00
Women	1.45	1.35–1.56
Race/ethnicity		
Non-Hispanic white (reference)	1.00	1.00–1.00
Hispanic	0.52	0.46–0.60
Non-Hispanic black	0.82	0.74–0.92
Non-Hispanic other	0.65	0.55–0.78
Education		
≥High school (reference)	1.00	1.00–1.00
<High school	1.54	1.39–1.70
Household income		
≥$20,000 (reference)	1.00	1.00–1.00
<$20,000	1.54	1.41–1.67
Census region		
West (reference)	1.00	1.00–1.00
South	1.36	1.21–1.53
Midwest	1.03	0.92–1.15
Northeast	1.31	1.15–1.49
Disability-associated comorbidity*		
No (reference)	1.00	1.00–1.00
Yes	4.94	4.60–5.31

*Disability-associated comorbidity is defined as having any one of the following: chronic arthritis, chronic obstructive pulmonary disease, coronary artery disease, stroke, or heart failure. Chronic arthritis is defined as having rheumatoid arthritis, osteoarthritis, gouty arthritis, or other types of arthritis.

als with diabetes and major depression (OR 5.48), which suggest a synergistic effect rather than an additive effect.

CONCLUSIONS — This study, which assessed the relationship among diabetes, major depression, and functional disability in a nationally representative sample of U.S. adults, has two important findings. First, it provides evidence that the odds of functional disability are significantly higher in individuals with diabetes and comorbid major depression than in individuals with either diabetes or major depression alone. Second, it indicates that there is a synergistic relationship between coexistent diabetes and major depression and functional disability even after controlling for relevant confounding factors.

There is a growing body of literature on the relationship between diabetes and depression and the effect of diabetes and comorbid depression on health outcomes and costs. Specifically, there is evidence that ~10% of individuals with diabetes have comorbid major depression (16,17) and that the coexistence of diabetes and major depression is associated with increased health care use (18), increased health care costs (18,32), and adverse health outcomes for diabetes (33,34). The finding of this study, which has not been previously reported, adds to that body of literature. It shows that individuals with diabetes and comorbid major depression have higher odds of functional limitations and higher odds of functional disability

Table 5—*Unadjusted and adjusted odds of functional disability by disease category*

Disease category	Unadjusted OR	95% CI	Adjusted OR	95% CI
Major depression	3.21	2.89–3.57	3.02	2.66–3.44
Diabetes	4.18	3.74–4.67	2.46	2.15–2.82
Diabetes and major depression*	9.18	6.29–13.41	6.15	3.86–9.80

*Separate logistic models for major depression, diabetes, and interaction (diabetes and major depression). ORs are adjusted for age, sex, race/ethnicity, education, income, census region, and disability-associated comorbidity. Adjusted ORs differ slightly from those in Table 4 because those in Table 4 were based on comparisons with a different reference point (no diabetes and no major depression).

compared with individuals with either major depression or diabetes alone.

The results of this study, which show that major depression and diabetes each independently increase the odds of functional disability, are consistent with the work of others (9–11,35–38). The mechanism by which major depression and diabetes each affects physical and psychosocial functioning and thus mediate functional disability is not clearly understood. Depression is hypothesized to decrease physical health by a combination of biological and psychological mechanisms (15). Psychological distress and subsequent neurohormonal and immunological changes are thought to increase susceptibility to disease, persistent somatic symptoms of depression is thought to worsen physical health over time, and depressed mood is thought to interfere with physical recovery by impeding treatment seeking, adherence to treatment, and adoption of healthy lifestyles (15). Diabetes, on the other hand, is assumed to mediate functional disability via the development of multiple complications (39). In this study, functional limitations in individuals with diabetes and comorbid major depression encompassed both physical and psychosocial function, which suggest that multiple mechanisms are likely to mediate the relationship between diabetes and comorbid major depression and functional disability.

Previous studies have shown that certain factors including older age, female sex, minority race/ethnicity, and multiple chronic diseases increase the risk of functional disability (9,29). In this study, similar factors were independently associated with odds of functional disability except race/ethnicity. Specifically, disability-associated comorbid conditions, older age, female sex, lower income, lower educational attainment, and living in the Southern and Northeastern regions of the U.S. were independently associated with higher odds of functional disability. However, individuals of minority ethnicity had lower odds of functional disability in contrast to previous reports. The reason for this finding is unclear and will need to be clarified in future studies.

The results of this study have two major public health implications. First, the burden of functional disability is tremendous. Extrapolating to the adult population of the U.S., ~54.5 million of an estimated 195 million adult population in the U.S. have a functional disability. Similarly, 5.6 million of an estimated 11 million adults with major depression, 5.5 million of an estimated 9.4 million adults with diabetes, and 0.7 million of an estimated 1 million adults with diabetes and comorbid major depression have a functional disability. The public health implication of these estimates are further magnified if put in the context of available evidence, which indicate that functional disability predicts further functional decline, functional dependence, increased health services use, increased health care costs, and increased risk of death (3–7).

Second, evidence from the literature indicate that recognition and treatment of major depression is less than ideal (40–43), that control of diabetes is suboptimal (44,45), and that the coexistence of diabetes and comorbid depression has adverse effects on health outcomes (18,33,34,46). These findings suggest that individuals with coexisting diabetes and major depression represent a subgroup at high risk of diminished quality of life, increased health care use and costs, and increased mortality. Unlike the situation with diabetes, where functional disability probably occurs after years of living with the disease (39), functional disability resulting from depression starts early and spans the course of the illness if untreated (15,47). However, there is good evidence that effective treatment for depression decreases functional disability (48–50); therefore, strategies to improve detection and treatment of depression, particularly in individuals with diabetes and comorbid depression are critical to improving functional outcomes and decreasing disability.

The findings of this study are subject to several limitations. First, as with all cross-sectional studies, this study cannot speak to causality or temporality. Functional disability may have preceded diabetes or major depression; however, this is unlikely to be the case because currently available data indicate that diabetes and major depression most often precede functional disability (10,15,47). Second, this study may have underestimated the prevalence of functional limitations and functional disability because the sample excluded institutionalized individuals such as people in nursing homes and rehabilitation facilities, who may have higher prevalence of disability. In addition, the definition of disability excluded those individuals that used assisting devices to compensate for functional limitations, which may have further underestimated the overall prevalence of functional disability. Similarly, the complex statistical adjustment procedures incorporated into the NHIS may not have adequately accounted for lower response rates for individuals with functional disability, which may have further underestimated the prevalence of functional disability.

Third, due to unavailability of reliable data in the NHIS on duration of diabetes, diabetes severity, or comorbid psychiatric conditions, the effect of these factors could not be ascertained, and future studies will need to address their effect on functional disability. Fourth, the questions used to assess functional disability in this study did not include all domains of disability such as body function, body structures, activities and participation, and environmental factors as recommended by the International Classification of Functioning, Disability, and Health (51). In addition, the disability questions did not assess other perspectives such as institutional or societal perspectives as detailed in the International Classification of Functioning, Disability, and Health (51). Finally, the diagnosis of diabetes was based on self-report. This is unlikely to have biased the estimates because previous studies have established

the reliability of self-reported diabetes as a measure of diagnosed diabetes (52,53).

Despite these limitations, this study provides evidence that the odds of functional disability are significantly higher in individuals with diabetes and comorbid major depression than in individuals with either diabetes or major depression alone and that there is a synergistic relationship between coexistent diabetes and major depression and functional disability even after controlling for relevant confounding factors.

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