Association of Diabetes, Comorbidities, and A1C With Functional Disability in Older Adults

Results from the National Health and Nutrition Examination Survey (NHANES), 1999–2006

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OBJECTIVE — To examine the relationship of diabetes and functional disability in older adults and the possible mediating roles of comorbidities and A1C.

RESEARCH DESIGN AND METHODS — We analyzed data from a nationally representative sample of 6,097 participants aged ≥60 years in the National Health and Nutrition Examination Survey, 1999–2006. Diabetes was defined by self-report. Disability was defined as difficulty performing a physical task. We evaluated disability by grouping 19 physical tasks into five functional groups: lower-extremity mobility (LEM), general physical activities (GPA), activities of daily living (ADL), instrumental activities of daily living (IADL), and leisure and social activities (LSA).

RESULTS — Older U.S. adults with diabetes had the greatest disability in GPA (prevalence 73.6% [95% CI 70.2–76.9]), followed by LEM (52.2% [48.5–55.9]), IADL (43.6% [40.1–47.2]), ADL (37.2% [33.1–41.3]), and LSA groups (33.8% [30.8–36.9]). Diabetes was associated with two to three times increased odds of disability across functional groups (all $P < 0.05$). Comorbidities, mostly cardiovascular disease and obesity, and poor glycemic control (A1C ≥8%) together explained up to 85% of the excess odds of disability associated with diabetes, whereas poor glycemic control alone explained only ~10% of the excess odds. Adjustment for comorbidities, A1C, and diabetes duration fully attenuated the associations of diabetes with disability in all functional groups (all $P > 0.05$).

CONCLUSIONS — Older adults with diabetes have a high prevalence of disabilities with variable associations attributable to comorbidities and A1C. Aggressive management of cardiovascular risk factors and obesity may significantly reduce the burden of disability in this population.

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In the year 2005, >2 million adults with diabetes in the U.S. reported having a disability (1). Adults with functional disability consume a disproportionate share of health services and are at high risk for dependence, hospitalizations, and death (2,3). Approximately one-third of adults aged ≥65 years have diabetes (46% undiagnosed), and, by the year 2030, elderly individuals will constitute almost 20% of the U.S. population (4,5). Consequently, understanding the factors contributing to functional disability in older adults with diabetes has important clinical and public health implications.

Functional disability, defined as difficulty in performing routine physical tasks, is more common in older adults with diabetes than in those without diabetes (6–12). Older adults with diabetes have significantly greater difficulty walking one-quarter mile, climbing stairs, or doing housework and perform worse on measures of physical performance such as walking speed, muscle strength, chair stands, and tandem stand compared with their counterparts (6–12).

The higher prevalence of functional disability in older adults with diabetes may be a result of diabetes-related comorbidities such as cardiovascular disease, vision loss, obesity, and arthritis (6–12) or poor glycemic control (8,13). However, these factors do not consistently explain the association of diabetes with disability. This inconsistency in the literature may be due to variability in the measures of disability studied or the limited number of physical tasks and comorbidities examined. Previous studies have not specifically addressed the relative associations of comorbidities and glycemic control with disability among older adults with diabetes or whether these associations differ according to the type of physical task examined. Furthermore, the association of diabetes with leisure or social difficulties in older adults remains poorly described.

The objectives of the present study were to *1*) compare the prevalence of disability in adults with and without diabetes, *2*) assess the relative associations of individual comorbidities and poor glycemic control with the excess disability observed among older adults with diabetes, and *3*) determine the independent associ-

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ation of diabetes and disability across a wide range of physical tasks, after accounting for comorbidities and A1C, in a nationally representative sample of older adults.

RESEARCH DESIGN AND METHODS

— The National Health and Nutrition Examination Survey (NHANES) is a large, cross-sectional survey conducted by the National Center for Health Statistics (NCHS) designed to provide nationally representative estimates of health and disease in the U.S. civilian noninstitutionalized population. Details regarding data collection in NHANES are available elsewhere (http://www.cdc.gov/nchs/nhanes.htm).

The present study was based on NHANES data collected from 1999 to 2006. In total, there were 39,352 participants in NHANES, 1999–2006. There were 6,472 adults aged ≥60 who completed both a questionnaire and a physical examination. We excluded participants who were missing information on diabetes status (n = 5), education (n = 26), BMI (n = 338), or smoking history (n = 6). Thus, our study sample consisted of 6,097 adults aged ≥60 years.

Assessment of diabetes

Diabetes was defined by either self-report of a physician diagnosis or insulin use. Only adults who self-reported a history of diabetes were also asked about noninsulin glucose-lowering medication use. Duration of diabetes was assessed by questionnaire.

Assessment of disability

The interviewer posed questions about physical functioning and asked all participants ≥20 years old about difficulties doing certain physical tasks because of any long-term physical, mental, and emotional problems or illness and without the use of any special equipment. A total of 19 physical tasks were assessed and derived from well-validated questionnaires (14–17). Participants were given the option of answering "no difficulty," "some difficulty," "much difficulty," or "unable to do." The 19 physical tasks were categorized into five functional groups according to published definitions (18). The groups included lower-extremity mobility (LEM) (walking one-quarter mile and walking up 10 steps); general physical activity (GPA) (stooping/crouching/kneeling, standing for 2 h, sitting for 2 h, standing up from an armless chair, reaching overhead, grasping/holding small objects, and lifting or carrying 10 lb); activities of daily living (ADL) (eating, dressing, getting out of bed, and walking between rooms on the same floor); instrumental activities of daily living (IADL) (managing money, doing household chores, and preparing meals); and leisure and social activities (LSA) (going to movies/shopping/events, doing leisure activities at home, and participating in social activities).

The primary outcome was functional disability, defined as any difficulty in a physical task, consistent with prior studies (6,10–12). We also assessed difficulties with fall, dizziness, or balance (1999–2004 only); the need for special assistance with walking or special equipment such as a cane, wheelchair, special bed, or special telephone; and the presence of a disability that prevented the participant from working.

Assessment of demographics and comorbidities

Information on age, sex, race/ethnicity, and smoking was ascertained from the questionnaire portion of the survey. History of arthritis, coronary heart disease (CHD) (including history of angina or heart attack), stroke, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD) (including emphysema or chronic bronchitis), and cancer (excluding nonmelanoma skin cancer) was also self-reported. We defined visual impairment as self-reported trouble seeing despite wearing glasses or contact lenses. Participants self-reported whether they were limited in any way because they have "difficulty remembering" or "experience periods of confusion." Only participants from 1999 to 2004 were asked about self-reported history of *1*) hearing difficulties, *2*) leg or foot ulcer that took >4 weeks to heal, and *3*) hip fracture.

Height, weight, waist circumference, and blood pressure were measured. Obesity was defined as BMI ≥30 kg/m^2. Hypertension was defined as an average blood pressure of ≥140 mmHg (systolic) or ≥90 mmHg (diastolic), antihypertensive medication use, or self-reported physician diagnosis. Hypercholesterolemia was defined as total cholesterol >240 mg/dl, use of cholesterol-lowering medications, or self-reported physician diagnosis. Chronic kidney disease (CKD) was defined as estimated glomerular filtration rate <60 ml/min per 1.73 m^2. We defined peripheral arterial disease (PAD) as an ankle-brachial index <0.90 in either leg and peripheral neuropathy as ≥1 insensate areas in either foot as assessed by monofilament testing (1999–2004 only). Amputations were documented after physical examination.

Measurement of A1C

A1C measurements were performed by the Diabetes Diagnostic Laboratory at the University of Missouri–Columbia using a CLC330/CLC 385 analyzer (Primus, Kansas City, MO) for 1999–2004 and by the Diabetes Laboratory at the University of Minnesota using an A1C 2.2 Plus Glycohemoglobin Analyzer (Tosoh Medics, San Francisco, CA) for 2005–2006. Both assays are Diabetes Control and Complications Trial-aligned.

Statistical analysis

All analyses were performed using StataSE (version 10.0; StataCorp, College Station, TX) and incorporated population-based sampling weights (6- or 8-year combined weights) to obtain unbiased, nationally representative estimates from the complex NHANES sampling design. SEMs for all estimates were obtained using the Taylor series (linearization) method following NCHS-recommended procedures (19).

The Wald test was used to compare differences in baseline characteristics by diabetes status. We calculated the excess odds of disability conferred by individual comorbidities and suboptimally controlled glucose (A1C ≥8%) for each functional group as [(odds ratio [OR]_base − OR_adjusted)/(OR_base − 1)] × 100; where the base model was adjusted for age, sex, race/ethnicity, education, smoking, and diabetes and the adjusted model was also adjusted for individual comorbidities or A1C ≥8%.

Logistic regression models were created to assess the independent association of diabetes with disability in each functional group as follows: model 1 was adjusted for diabetes and demographic factors (age, sex, race/ethnicity, education, and smoking history); model 2 was adjusted for model 1 + A1C; model 3 was adjusted for model 2 + A1C + diabetes duration; model 4 was adjusted for model 3 + cardiovascular disease and risk factors (CHD, CHF, stroke, hypertension, and high cholesterol) + obesity (BMI ≥30 kg/m^2) + waist circumference; and model 5 was adjusted for model 4 + other diabetes-related comorbidities (leg ulcer, CKD, visual or hearing impairment, memory problems, hip fracture, arthritis, COPD, and cancer). Because information on important comorbidities (hearing impairment, leg ulcer, and hip fracture) was not assessed in all years, we conducted regression analyses limited to data from the 1999–2004 survey. We excluded PAD and peripheral neuropathy from this analysis because these were not ascertained for all participants. We performed an *F*-adjusted mean residual test to assess goodness of fit.

We performed additional analyses to explore correlation between continuous covariates and potential effect modification of the association between diabetes and disability by sex, race/ethnicity, or age-group (60–69 years, 70–79 years, ≥80 years). We also investigated whether the prevalence of disability differed by survey year. Sensitivity analyses were performed to examine whether the association between diabetes and disability was similar when disability was defined as inability in a physical task. Among older adults with diabetes, we further explored whether glycemic control (A1C ≥8% vs. <8%), duration of diabetes (<5, 5–10, or ≥10 years), or insulin use was independently associated with disability in logistic regression models.

RESULTS — The prevalence of self-reported diabetes in U.S. adults aged ≥60 years was 16.2% (95% CI 15.2–17.2%), with no significant secular trends across survey periods. Diabetes was significantly more common in non-Hispanic blacks and Mexican Americans, individuals with higher BMI or waist circumference and lower attained education level, and nonsmokers (Table 1). The mean A1C of older adults with diabetes was 7.1%. Most took oral medications alone, although 26.2% took insulin, including 10.8% taking combined therapy. The mean diabetes duration was 13.8 years.

Older adults with diabetes had a greater burden of comorbidities than adults without diabetes. This included a significantly higher prevalence of CHD, CHF, stroke, hypertension, hypercholesterolemia, neuropathy, PAD, leg ulcers or amputations, visual or hearing impairment, memory problems, obesity, and arthritis. CKD prevalence was slightly higher in the diabetic group but was not statistically significant compared with that for the nondiabetic group.

Older adults with diabetes were more likely to report difficulty performing tasks in each functional group compared with older adults without diabetes; we did not find significant secular trends or evidence for effect modification by sex, race/ethnicity, or age-group. Thus, overall results are presented (supplementary Fig. 1, available in an online appendix at http://care.diabetesjournals.org/cgi/content/full/dc09-1597/DC1). Among older adults with diabetes, the greatest difficulty was in GPA (prevalence 73.6% [95% CI 70.2–76.9]), followed by LEM (52.2% [48.5–55.9]), IADL (43.6% [40.1–47.2]), ADL (37.2% [33.1–41.3]), and LSA groups (33.8% [30.8–36.9]). Diabetes was significantly associated with having difficulty in at least one functional group after adjustment for demographic factors (adjusted OR 1.94 [1.57–2.40]; prevalence 76.9% [73.4–80.3]).

When taken together, comorbidities and suboptimally controlled glucose (A1C ≥8%) were associated with 59% (ADL), 72% (IADL), 79% (GPA), and

Table 1—*Nationally representative demographic and clinical characteristics of older U.S. adults with and without diabetes, NHANES, 1999–2006*

	History of diagnosed diabetes	No history of diagnosed diabetes	*P* value
n	1,166	4,931	
Demographics			
Age-group			<0.001
60–69 years	50.6 ± 0.2	48.0 ± 0.1	
70–79 years	36.0 ± 0.2	34.2 ± 0.1	
≥80 years	13.4 ± 0.1	17.8 ± 0.1	
Mean age (years)	70.4 ± 0.3	70.9 ± 0.2	0.05
Male sex	54.9 ± 1.8	56.3 ± 0.7	0.48
Race/ethnicity†			<0.001
White	72.0 ± 2.2	84.0 ± 1.3	
Black	13.3 ± 1.4	7.2 ± 0.8	
Mexican American	5.6 ± 1.0	2.8 ± 0.5	
Education level (<high school)	36.9 ± 1.9	27.0 ± 1.3	<0.001
Current smoker	10.2 ± 0.1	12.7 ± 0.6	0.04
Metabolic status			
Mean BMI (kg/m^2)	30.8 ± 0.2	27.8 ± 0.1	<0.001
Mean waist circumference (cm)	107.5 ± 0.6	98.9 ± 0.2	<0.001
Mean A1C (%)	7.1 ± 0.06	5.6 ± 0.02	<0.001
Diabetes medication use			
Oral agents only	58.6 ± 2.1	—	—
Insulin only	15.4 ± 1.6	—	—
Oral agents and insulin	10.8 ± 1.3	—	—
Mean diabetes duration (years)	13.8 ± 0.5	—	—
Comorbidities			
Coronary heart disease	29.9 ± 1.9	16.6 ± 0.7	<0.001
Stroke	14.0 ± 1.3	5.9 ± 0.4	<0.001
Congestive heart failure	15.6 ± 1.3	5.5 ± 0.4	<0.001
Hypertension	71.9 ± 1.9	51.0 ± 0.9	<0.001
Hypercholesterolemia	59.6 ± 2.1	54.4 ± 0.8	0.03
Neuropathy‡	33.9 ± 1.8	19.4 ± 0.7	<0.001
Visual impairment	34.2 ± 1.7	21.4 ± 0.8	<0.001
Chronic kidney disease	40.0 ± 2.3	36.6 ± 0.7	0.17
Hearing impairment‡	50.5 ± 2.1	43.6 ± 1.2	0.01
Memory problems	17.8 ± 1.6	11.1 ± 0.6	<0.001
PAD‡	21.1 ± 3.2	12.1 ± 0.8	0.01
Leg ulcer or amputation‡	9.4 ± 1.1	3.0 ± 0.3	<0.001
Obesity (BMI ≥30 kg/m^2)	48.6 ± 1.9	29.0 ± 0.8	<0.001
Arthritis	56.8 ± 1.9	49.6 ± 0.8	0.001
Hip fracture‡	2.1 ± 0.6	2.5 ± 0.3	0.54
COPD	13.2 ± 1.5	11.7 ± 0.7	0.30
Cancer	14.9 ± 1.5	15.4 ± 0.6	0.77

Data are % ± SEM unless otherwise indicated. †Other ethnicity not shown. ‡1999–2004 only.

Table 2—*Nationally representative ORs for the association of diabetes and disability among older U.S. adults after adjustment for A1C, diabetes duration, and diabetes-related comorbidities, NHANES, 1999–2004*

	Model 1: demographics	Model 2: A1C	Model 3: diabetes duration	Model 4: cardiovascular disease/obesity	Model 5: other comorbidities
LEM	2.06 (1.65–2.55)	1.91 (1.49–2.45)	1.51 (1.09–2.10)	1.23 (0.75–1.39)	0.90 (0.62–1.29)
GPA	1.97 (1.52–2.54)	1.78 (1.36–2.33)	1.80 (1.26–2.55)	1.37 (0.92–2.03)	1.20 (0.81–1.77)
ADL	2.53 (1.98–3.24)	2.37 (1.75–3.21)	2.07 (1.41–3.04)	1.49 (1.00–2.24)	1.33 (0.84–2.09)
IADL	2.10 (1.68–2.61)	2.23 (1.77–2.83)	1.72 (1.27–2.34)	1.19 (0.87–1.64)	1.08 (0.76–1.54)
LAS	2.38 (1.94–2.91)	2.25 (1.83–2.76)	1.85 (1.42–2.42)	1.16 (0.89–1.51)	1.11 (0.79–1.56)

Data are ORs (95% CI) for disability, defined as having at least one task in the specified functional group described as “some difficulty,” “much difficulty,” or “unable.” Model 1 was adjusted for diabetes and demographics (age, sex, race/ethnicity, education, and smoking history); model 2 was adjusted for model 1 + A1C; model 3 was adjusted for model 2 + A1C + diabetes duration; model 4 was adjusted for model 3 + cardiovascular disease and risk factors (CHD, CHF, stroke, hypertension, and high cholesterol) + obesity (BMI ≥30 kg/m^2) + waist circumference; and model 5 was adjusted for model 4 + other comorbidities (leg ulcer, CKD, visual impairment, hearing impairment, memory problems, hip fracture, arthritis, COPD, and cancer).

85% (LEM and LSA) of the excess odds of disability observed in older adults with diabetes. Cardiovascular disease (including CHD, CHF, and stroke) and obesity together were associated with 37% (ADL), 40% (IADL), 53% (GPA and LEM), and 46% (LSA) of the excess odds of disability linked with diabetes across functional groups. Suboptimally controlled glucose alone was associated with 0% (IADL), 5% (LEM and ADL), 9% (LSA), and 10% (GPA) of the excess odds of disability.

In logistic regression models, diabetes was associated with significantly higher odds of disability across all functional groups after adjustment for demographic factors (adjusted ORs ranged from 1.97 to 2.53, all $P < 0.05$) (Table 2, model 1). Adjustment for A1C and diabetes duration moderately attenuated these associations, but they remained statistically significant across all groups (Table 2, models 2 and 3). However, further adjustment for cardiovascular disease and obesity largely attenuated the ORs (Table 2, model 4), resulting in nonsignificant associations between diabetes and disability in all functional groups. An overall F-adjusted test statistic of 0.70 ($P = 0.71$) represented good model fit.

ORs for the association of other covariates including demographics, A1C, diabetes duration, and comorbidities with disability in fully adjusted models (as described in Table 2, model 5) across functional groups are provided in supplementary Table 1 (available in an online appendix). Among older adults, the ORs for diabetes are weaker than those for comorbidities such as hip fracture, arthritis, and memory problems, which all have adjusted ORs >2. However, because the ORs for these conditions (in particular memory problems) were self-reported, they may not be as reliable. In addition, visual impairment, hearing difficulties, and COPD were associated with significantly greater disability across all groups (adjusted ORs ranged between 1.46 and 2.44; all $P < 0.05$). In contrast, the ORs for CHD and stroke were weaker and nonsignificant ($P > 0.05$) for most but not all groups.

In sensitivity analyses, when disability was defined as inability to perform a task, we found that diabetes remained significantly associated with disability across functional groups as follows: LEM (demographics adjusted OR 2.91 [95% CI 2.39–3.54]), GPA (2.64 [2.14–3.27]), ADL (3.93 [2.39–6.47]), IADL (2.58 [1.87–3.56]), and LSA (3.67 [2.54–5.31]). Diabetes was also associated with an increased odds of having a history of falls, dizziness, or balance problems (adjusted OR 1.75 [95% CI 1.40–2.19]; prevalence 40.3% [35.6–44.9]), needing special assistance or an assistive device (adjusted OR 2.60 [2.02–3.35]; prevalence 22.7% [18.9–26.5]), or having a disability that prevented the participant from working (adjusted OR 2.12 [1.80–2.51]; prevalence 27.1% [23.7–30.5]) after adjustment for demographic factors. Among older adults with diabetes, we found that neither glycemic control, insulin use, nor duration of diabetes was significantly associated with disability in any functional group after adjustment for demographics and comorbidities (all $P > 0.05$).

CONCLUSIONS — Our results suggest that older community-dwelling U.S. adults with diagnosed diabetes are more likely to have difficulties in each of the five physical functioning groups and a significantly higher prevalence of comorbidities compared with adults without diabetes. Adjustment for A1C, diabetes duration, and comorbidities fully attenuated the association of diabetes and disability in all functional groups. Together, A1C and comorbidities accounted for up to 85% of the excess odds of disability, largely due to cardiovascular disease and obesity, whereas poor glycemic control (A1C ≥8%) alone only accounted for up to 10% of the excess odds of disability associated with diabetes across all groups.

Our findings support previous studies that also reported a two to three times greater odds of difficulty in performing mobility, upper-extremity, ADL, and IADL tasks among older adults with diabetes compared with adults without diabetes (6–12). The prevalence of disability we report is consistent with findings in other nationally representative samples of adults of similar age (6). We also found a high degree of difficulty in performing leisure and social activity tasks, which has not been examined in previous studies. However, we found that our results were similar when we defined disability as inability in a physical task, a more specific measure.

In addition, past studies did not explore the relative associations of multiple comorbidities and poor glycemic control to the relationship between diabetes and disability nor examine whether these associations varied by type of task, which were both important aims of our study. Comorbidities contribute greatly to the health-related quality of life in adults with diabetes, although social and environmental factors are probably also important. Glycemic control is an important goal of diabetes management although higher A1C targets (e.g., A1C <8%) may be reasonable in an older population (20). Our data suggest that, in contrast with poor glycemic control (A1C ≥8%), comorbidities are more greatly associated with excess disability in diabetes across all functional groups. In contrast, De Rekeneire et al. (8) and Bossoni et al. (13) reported that poor glycemic control was significantly associated with the excess subclinical LEM limitations and IADL disability observed in diabetes. Diabetes duration was also associated with disability in our study, similar to previous reports (6). We found that the greater difficulties in LEM, GPA, ADL, and IADL groups observed in older adults with diabetes compared with those without diabetes are largely associated with comorbidities and corroborate prior findings that diabetes-associated cardiovascular disease and obesity are linked with much of the excess disability observed in these tasks (6,7,11). Interestingly, the higher prevalence of disability we report in leisure and social activities among older adults with diabetes was also largely associated with prevalent comorbidities.

Diabetes may be associated with functional disability through mechanisms linked to decreased cardiopulmonary reserve, restricted physical movement, inflammatory/sarcopenic processes, extremes of blood glucose, or inflexible treatment regimens. We confirm that older adults with diabetes have a high burden of cardiovascular disease and obesity; both these conditions are associated with limited cardiopulmonary reserve and exercise tolerance. Further, other prevalent comorbidities in adults with diabetes such as visual impairment or stroke may restrict physical movement and participation in routine activities. Decreased muscle strength, lower muscle quality, and accelerated loss of muscle mass, especially in the lower extremities, have all been documented in individuals with diabetes (21).

Through these mechanisms, older adults with diabetes may be more likely to develop frailty (22), a clinical condition in which an older individual is coping just above the disability threshold but is liable to become disabled in response to a physiological or psychological stressor. Hyperglycemia may activate inflammatory pathways that subsequently cause muscle catabolism and disability as part of the frailty process (21,22). On the other hand, physical and cognitive impairment may lead to difficulties in diabetes self-management and subsequent hyperglycemia; thus, the relationship between hyperglycemia and disability is potentially bidirectional. Because of the limitations of the study design, we were unable to address the directionality of the observed associations. A1C may also reflect health care access, patient self-management, and physician prescribing practices. Support for an association between hyperglycemia and disability comes from previous studies reporting a significant correlation between higher A1C levels and disability (8,13). However, our findings suggest that among older adults with diagnosed diabetes, poor glycemic control is not greatly associated with the excess disability observed. Interestingly, even among a population of older adults with diabetes and relatively well-controlled glucose levels such as ours, there exists a significantly increased risk of falling, balance, and dizziness difficulties compared with older adults without diabetes. Further, restrictive treatment regimens, especially for patients taking insulin, may be associated with greater difficulty participating in leisure activities.

A strength of our study is the evaluation of disability in diabetes across different functional groups. Fried et al. (23) previously provided a strong rationale for categorizing physical tasks into functional groups, and self-reported physical functioning has been demonstrated to be a reliable measure (24). Our study was based on difficulty in 19 individual tasks, including leisure and social activities, which has not been ascertained in most previous studies. This comprehensive assessment allowed us to explore the association of diabetes-related comorbidities and A1C with disability in each functional group. Other strengths of our study include the rigorous data collection procedures in NHANES and the ability to generate nationally representative estimates, which allows for comparison with other studies that used national samples (6).

Limitations of our study include the cross-sectional design, which does not permit us to draw conclusions regarding the temporality of the observed associations and renders our study vulnerable to survival bias. Individuals with diabetes are more likely to die at younger ages compared with their counterparts without diabetes and may be systematically missing from this study of older adults (survival bias). Also, NHANES does not include institutionalized individuals who probably have a more severe and higher prevalence of disability than the general population. As a result, the prevalence of disability may be underestimated in our study.

Although highly specific for most outcomes, self-reported information for cardiovascular disease and other comorbidities is a limitation and probably underestimates the true prevalence of these conditions. This is of particular concern for our measure of cognitive function; the critical relationship between cognitive impairment and disability cannot be fully accounted for in this study and is a crucial area in which additional work is needed. Subclinical or undiagnosed cases of disease are also not captured by these self-reported measures. In particular, subclinical cardiovascular disease is probably prevalent among older adults with diabetes but may be missed by self-reported measures. Because this study focused on diagnosed diabetes, individuals with undiagnosed disease are included in the nondiabetic group. Those with undiagnosed diabetes probably have disability intermediate between that of individuals with diagnosed diabetes and without true diabetes; consequently, the prevalence of disability in both groups (diabetes or no diabetes) may be overestimated in our study. Analyses using different definitions of diabetes may result in different findings. Furthermore, diabetes in the older adult population is heterogeneous and includes individuals with both middle-age and elderly-onset diabetes; the latter group has been shown to have a lower burden of complications, especially microvascular disease (25) and has less disability in our study (data not shown).

In summary, there is growing recognition that the presence of functional disability significantly influences the clinical care of older adults with diabetes. Our data demonstrate that older adults with diabetes have a high prevalence of disabilities, across a range of physical tasks, with variable associations attributable to diabetes-related comorbidities and A1C. Our results suggest that cardiovascular disease and obesity, in particular, are associated with a greater burden of disability in this population, whereas the association of hyperglycemia with disability needs further investigation. Future studies to examine the prospective association of diabetes and disability should provide greater insight into the direction of this relationship; in particular, how diabetes leads to disability and how disability, in turn, can lead to worsening hyperglycemia.

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