Patterns of Disability Related to Diabetes Mellitus in Older Women

Siobhan C. Maty, Linda P. Fried, Stefano Volpato, Jeff Williamson, Frederick L. Brancati, and Caroline S. Blaum

Departments of Epidemiology and Medicine, The Johns Hopkins Medical Institutions, Baltimore, Maryland.\footnote{1}\footnote{2}
Department of Clinical and Experimental Medicine, University of Ferrara, Italy.\footnote{3} Department of Medicine, Wake Forest University, Winston-Salem, North Carolina.\footnote{4} Department of Medicine, The University of Michigan, Ann Arbor.\footnote{5}

**Purpose.** To identify pattern(s) of disability related to diabetes in older women and to determine the extent to which disability is mediated by selected diabetes complications.

**Methods.** Cross-sectional analysis of data from a population-based study composed of a representative sample of 3570 noninstitutionalized women aged 65 years and older living in the Baltimore metropolitan area who agreed to be screened for the Women’s Health and Aging Study.

**Results.** 483 (13.5%) of the women reported physician-diagnosed diabetes. Compared to women without diabetes, women with diabetes were significantly more likely to report difficulty in 14 of 15 daily tasks, including walking 2–3 blocks, lifting 10 pounds, using the telephone, and bathing (range of odds ratios [OR] 1.5–2.8; all $p < .01$). After adjustment for age, race, and marital status, women with diabetes were about twice as likely to report difficulty in any one of four functioning groups (mobility, upper extremity, higher functioning tasks, or self-care) (OR 2.2; 95% confidence interval [CI] 1.8–2.7), and over three times as likely to report difficulty in a group combining higher functioning and self-care tasks (OR 3.2; 95% CI 2.4–4.1). Adjustment for self-reported heart disease, stroke, high blood pressure, and visual problems did not attenuate these associations.

**Conclusions.** Diabetes is strongly associated with a wide range of disabilities in older women. This association does not appear to be mediated by prevalent diabetes complications and risks, heart disease, high blood pressure, stroke, or eye disease. Other complications of diabetes (e.g., neuropathy, peripheral vascular disease) may mediate diabetes-associated disability in older adults.

Persons with diabetes are at increased risk of impaired physical function (1). Because diabetes prevalence rises with age, the impact of diabetes on disability is likely to be particularly significant in an aging population, where disability rates are known to be higher than in a younger population (2). According to the Third National Health and Nutrition Examination Survey (NHANES III), over 18% of people aged 60 years and older have diabetes by the American Diabetes Association fasting plasma glucose criterion (3), while an equal or slightly higher proportion would have diabetes using criteria based on an oral glucose tolerance test (4).

Diabetes is well known to be associated with atherosclerotic and microvascular complications, which in themselves can result in physical disability (5–8). In addition, diabetes is associated with other risks and conditions, including hypertension and dyslipidemia, that increase the risk of vascular diseases. Therefore, diabetes-related disability is often presumed to be related to the vascular complications of diabetes, such as heart disease, stroke, peripheral vascular disease, and visual disorders. Given the broad impact of diabetes on multiple diseases and conditions, diabetes may have a similarly broad effect on multiple functioning difficulties.

Most studies of the association of diabetes and disability have studied only a few indicators of functional impairment, have not focused on older adults, or have considered diabetes as one of several chronic conditions that affect disability (9,10). Recent research has begun to evaluate whether diabetes-related disability is mediated exclusively through diabetes complications, or if an independent or unmeasured effect of the disease is responsible. We conducted a cross-sectional study of women aged 65 and older to test two hypotheses about diabetes in older women: first, that type 2 diabetes in older women is associated with a broad range of functional difficulties, or physical disability; and second, that physical disability in women with diabetes would be explained mainly by the presence of prevalent diabetes-related conditions and complications: heart disease, stroke, hypertension, and visual impairment.

**METHODS**

**Setting**

The study population consisted of women aged 65 years and older screened for possible participation in the Women’s Health and Aging Study (WHAS), an on-going, longitudinal study of risk factors for the progression of disability (11,12). This screened sample used in our analyses included women with the entire range of disability, from completely able to disabled.

**Sample Selection**

A random, population-based sample of women residing in eastern Baltimore City, Maryland, was identified using...
Health Care Financing Administration Medicare eligibility records. This interview, successfully completed by 3841 women (72% of eligible sample), determined disability in four summary groups of functional tasks (mobility, upper extremity, basic self-care tasks (nonmobility activities of daily living [ADLs]), and higher functioning tasks (instrumental activities of daily living [IADLs]). Data on demographics, self-reported health status, physician-diagnosed medical history, and Folstein Mini-Mental State Exam (MMSE) (13) score were also collected. Women with a MMSE score of 15 or below (n = 179), with missing ethnicity data (n = 18), or with missing data for any significant variables used in the final regression models (n = 74) were excluded. The remaining 3570 women were the subjects of our analyses.

Data Collection
All information was gathered by trained personnel who conducted in-person interviews. Diabetes status was obtained by self-report in response to the question, “Has your physician ever told you that you have diabetes?”

Similarly, the presence of comorbid medical conditions was assessed with the question, “Has your physician ever told you that you have <disease>?” for the following medical conditions: myocardial infarction, angina, congestive heart failure, hypertension, other heart disease, arthritis, stroke, cancer, broken or fractured hip, lung disease, hearing problems, vision problems, and Parkinson’s disease. Women reporting myocardial infarction, angina, or congestive heart failure were classified as having “heart disease.”

Finally, participants were questioned about 15 distinct physical tasks in four functional domains: mobility, upper extremity function, self-care tasks, and higher functioning skills. For each task the participant was asked, “By yourself, that is without help from another person or special equipment, do you have any difficulty <performing task>?” The responses were dichotomized into “yes” difficulty versus “no” difficulty.

Classification of Disability
Functional groups were derived from several standardized scales [ADL (14), IADL (15), Rosow-Breslau (16,17)]. Individual tasks were grouped as follows: 1) mobility—walking 2–3 blocks, climbing 10 steps, getting in or out of bed or chairs, and heavy housework; 2) upper extremity function—raising arms, grasping, and lifting up to 10 pounds; 3) higher functioning tasks (IADLs)—using telephone, light housekeeping, meal preparation, and personal shopping; and 4) self-care tasks (ADLs)—bathing and showering, dressing, eating, and using the phone.

A woman was defined as having a physical disability in a particular group if she reported difficulty in any of the tasks specific for that category. However, individuals often reported difficulty for tasks in several groups. Therefore, study participants were further differentiated into six mutually exclusive domains of disability derived from the original four groups: 1) upper extremity only, 2) mobility only, 3) both mobility and upper extremity, 4) higher functioning, 5) self-care, and 6) higher functioning and self-care. The latter three generally included people who had mobility and/or upper extremity difficulty in addition to their higher functioning and/or self-care difficulty. These domains can be considered hierarchical because they describe women with difficulty in progressively more types of tasks considered to reflect worsening disability (18,19).

Analysis
Diabetes (present vs absent) was the main independent variable. Any difficulties versus no self-reported difficulties for each task were compared in diabetic versus nondiabetic women using the Pearson chi-square test (20). Women who reported any difficulty in any task were classified as “disabled.” Then, disability was aggregated into the six mutually exclusive domains described above. To assess the independent relationship of diabetes to each of the six mutually exclusive domains, we constructed four sequential multiple logistic regression models, with each one adding additional variables. Women with no disability in any task served as the reference group in each logistic regression calculation. The first logistic regression model was unadjusted. The second was adjusted for sociodemographic variables (age, race, marital status, and education). The third was adjusted for sociodemographic variables plus conditions generally related to diabetes (heart disease, high blood pressure, stroke, and vision problems). Finally, the fourth, a fully adjusted model, included sociodemographic variables, plus diabetes-related conditions, plus comorbid conditions unrelated to diabetes (Parkinson’s disease, arthritis, fractured hip, lung disease, hearing problems, cancer, and MMSE score).

Because the self-reported data did not include a measure of obesity, we performed identical analyses on a subset of women randomly sampled from the same sampling frame (total n = 763, with diabetes n = 113) as our study sample and for whom measured height and weight were available [women in this subsample were among the participants in the WHAS I (11) and WHAS II (12) studies]. For this subset, we included body mass index in unadjusted and adjusted models as described above. All analyses were performed using Statistical Analysis System software (SAS, Inc., Cary, NC) (21). All tests of significance were two tailed.

Results
Baseline Characteristics
Of 3570 women, 483 (13.5%) reported having diabetes mellitus. Characteristics of the women by diabetes status are displayed in Table 1. Compared to women without diabetes, women with diabetes were more likely to be black and less likely to have completed high school. As expected, women with diabetes were more likely to have a history of heart disease (myocardial infarction or angina or congestive heart failure, 32.9% vs 20.5%), high blood pressure (69.4% vs 50.0%), stroke (14.9% vs 6.7%), and vision problems (81.4% vs 73.7%).

Disability in Specific Tasks
Compared to women without diabetes, women with diabetes were significantly more likely to report difficulty
with 14 of the 15 tasks (Table 2). The percentage of women with diabetes reporting some task-specific difficulty ranged from 5.0% for eating to 57.7% for doing heavy housework. Overall, women with diabetes were 1.5 to 2.8 times more likely than women without diabetes to report some difficulty with tasks.

Disability in Different Domains

Compared to women without diabetes, women with diabetes were more likely to report disability related to “mobility only” (14.7 vs 13.8%), “mobility and upper extremity” (11.6 vs 8.5%), “higher functioning” (9.7 vs 7.8%), and “higher functioning and self-care” (27.3 vs 14.4%) (Table 3). The association of diabetes with “upper extremity only” and “self-care” was not significant in any models. Overall, 73.9% of diabetic women reported disability in at least one functional domain compared to only 56.5% of women without diabetes. When women without any disability were used as the reference group, the unadjusted odds of disability associated with diabetes ranged from 1.4 in “self-care” to 3.2 in “higher functioning and self-care.”

The observed associations between diabetes and the disability domains were either unchanged or strengthened after adjustment for age, race, marital status, and education. (Table 3; model 2). Prevalent diabetes-related comorbidities attenuated the association of diabetes with the disability domains (model 3), but an independent association of diabetes with disability remained. Likewise, in the four disability domains significant in unadjusted models, the associations remained significant although somewhat attenuated in a final model that adjusted simultaneously for all four diabetes-related conditions as well as seven comorbid conditions unrelated to diabetes. Finally, in the subset of women for whom body mass index was available, inclusion of that variable in either the unadjusted or adjusted models did not change the relationships of diabetes to any of the six disability groupings.

Discussion

Our research shows that diabetes is associated with a wide range of disabilities in every major task and summary grouping. These associations are independent of age, race, and education, and they are not completely explained by the excess prevalence of heart disease, high blood pressure, stroke, or vision problems in women with diabetes, or by multiple comorbid conditions unrelated to diabetes. Our use of a population-based data set with both healthy and disabled women, an excellent response rate, and a high quality survey lend confidence to our findings.

Of the studies that document the cross-sectional association of diabetes with functioning limitations and disability, most include diabetes among many chronic diseases that are associated with disability. Different studies have reported increased associations of diabetes with poor physical performance measured by functional (5,10,22–24), IADL (5,10,22,23,25), and ADL limitations (5,10,22–28). However, few of these studies have simultaneously considered multiple tasks and disability categories. We evaluated a broad array of disability measures and found that diabetes is significantly associated with nearly every functional task

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Women With Diabetes</th>
<th>Women Without Diabetes</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 65–74 y</td>
<td>54.2</td>
<td>46.8</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>75–84 y</td>
<td>30.0</td>
<td>30.9</td>
<td>NS</td>
</tr>
<tr>
<td>85+ y</td>
<td>15.7</td>
<td>22.3</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Race Black</td>
<td>40.8</td>
<td>22.7</td>
<td>&lt; .0001</td>
</tr>
<tr>
<td>Married currently</td>
<td>28.4</td>
<td>28.4</td>
<td>NS</td>
</tr>
<tr>
<td>Completed high school</td>
<td>30.6</td>
<td>43.5</td>
<td>&lt; .0001</td>
</tr>
</tbody>
</table>

Comorbid conditions

- Heart disease: 32.9 vs 20.5, p < .0001
- High blood pressure: 69.4 vs 50.0, p < .0001
- Parkinson’s disease: 0.8 vs 0.9, NS
- Stroke: 14.9 vs 6.7, p < .0001
- Mini-Mental Status
  - Score ≤23: 17.4 vs 14.6, NS
  - Arthritis: 63.8 vs 57.6, p < .05
  - Fractured hip: 3.9 vs 5.7, NS
  - Lung disease: 12.0 vs 9.5, NS
  - Hearing problems: 24.2 vs 20.6, NS
  - Vision problems: 81.4 vs 73.7, p < .001
  - Cancer: 13.3 vs 14.0, NS

Notes: *All data represent percent of women with and without diabetes reporting the characteristic.
*Individuals with Mini-Mental Status scores <15 were excluded from this analysis.
NS = not significant.
association of diabetes with three functioning measures after controlling for vascular complications of diabetes, obesity, and nondiabetes-related comorbidities (5). However, this analysis concentrated only on three specific functioning measures (walking a quarter mile, climbing steps, and housework) and did not explore the full range of physical limitations and disability related to diabetes. Volpato and colleagues evaluated severe mobility and ADL disability in older women who were already disabled, and also found that these limitations were not explained by body mass index, multiple diabetes-related impairments and conditions, and other comorbidities. Substantial decrease in the independent relationship of diabetes to the two functional outcomes studied was only obtained when multiple comorbidities and impairments were accounted for by statistical adjustment (34).

Because we used self-reported data, we could not study the associations of disability with precise measures of vascular disease, or with diabetes complications and potentially related conditions and risks that are not amenable to self-report such as peripheral vascular disease, neuropathy, renal disease, or hyperlipidemia. Study participants were asked about arthritis (the type of arthritis cannot be specified from self-report); control for arthritis did not change the association of diabetes with disability in our study sample. There was no measure of obesity in our self-reported data, although in the subgroup of women (n = 763) who participated in the WHAS studies, control for body mass index did not change associations of diabetes with disability measures. A reasonable hypothesis is that other unmeasured complications of diabetes, both vascular and nonvascular, mediate the association between diabetes and disability. Besides unmeasured vascular complications (peripheral neuropathy, peripheral vascular disease, and renal disease), other conditions and risks may be involved, including hyperlipidemia, depressive symptoms, and cognitive decline. While obesity is independently associated with disability (35), our subgroup analysis, consistent with other studies (5,34,36), did not suggest that obesity accounts for the relationship of diabetes to disability. In older women, it is possible that level of hyperglycemia, catabolic complications, alterations in the inflammatory system, and even geriatric syndromes (28) such as undernutrition, falls, incontinence, and weight loss may be pathways for the effects of diabetes on disability. Psychosocial variables not evaluated during the WHAS screening interview may also influence disability (9).

Our study has several limitations. Our data involved older women exclusively, and therefore cannot evaluate potential effects of sex and age on the relationship between diabetes

### Table 2. Distribution of Difficulty With Selected Tasks by Diabetes Status in 3570 Women Aged 65 and Older

<table>
<thead>
<tr>
<th>Domain</th>
<th>Task</th>
<th>Diabetes Status</th>
<th>% With Any Difficulty</th>
<th>Unadjusted Odds Ratio* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>Walking 2–3 blocks</td>
<td>Yes</td>
<td>51.8</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>35.4</td>
<td>(1.6, 2.4)</td>
</tr>
<tr>
<td></td>
<td>Climbing 10 steps</td>
<td>Yes</td>
<td>38.5</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>22.4</td>
<td>(1.8, 2.6)</td>
</tr>
<tr>
<td></td>
<td>Getting in/out of bed or chairs</td>
<td>Yes</td>
<td>19.9</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>14.4</td>
<td>(1.2, 1.9)</td>
</tr>
<tr>
<td></td>
<td>Heavy housework</td>
<td>Yes</td>
<td>57.7</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>37.2</td>
<td>(1.9, 2.8)</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>Raising arms</td>
<td>Yes</td>
<td>16.8</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>10.6</td>
<td>(1.3, 2.2)</td>
</tr>
<tr>
<td></td>
<td>Grasping</td>
<td>Yes</td>
<td>22.2</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>14.9</td>
<td>(1.3, 2.1)</td>
</tr>
<tr>
<td></td>
<td>Lifting up to 10 lb</td>
<td>Yes</td>
<td>37.8</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>25.2</td>
<td>(1.5, 2.2)</td>
</tr>
<tr>
<td>Higher functioning</td>
<td>Using phone</td>
<td>Yes</td>
<td>7.2</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>4.6</td>
<td>(1.1, 2.3)</td>
</tr>
<tr>
<td></td>
<td>Light housekeeping</td>
<td>Yes</td>
<td>20.9</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>3.6</td>
<td>(1.9, 3.2)</td>
</tr>
<tr>
<td></td>
<td>Meal preparation</td>
<td>Yes</td>
<td>18.2</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>7.3</td>
<td>(2.2, 3.7)</td>
</tr>
<tr>
<td></td>
<td>Personal shopping</td>
<td>Yes</td>
<td>31.5</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>17.7</td>
<td>(1.7, 2.7)</td>
</tr>
<tr>
<td>Self-care</td>
<td>Bathing/showering</td>
<td>Yes</td>
<td>29.9</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>17.6</td>
<td>(1.6, 2.5)</td>
</tr>
<tr>
<td></td>
<td>Dressing</td>
<td>Yes</td>
<td>13.5</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>7.5</td>
<td>(1.4, 2.6)</td>
</tr>
<tr>
<td></td>
<td>Eating</td>
<td>Yes</td>
<td>5.0</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>3.3</td>
<td>(1.0, 2.4)</td>
</tr>
<tr>
<td></td>
<td>Using toilet</td>
<td>Yes</td>
<td>12.9</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>7.8</td>
<td>(1.3, 2.4)</td>
</tr>
</tbody>
</table>

Notes: *483 women with diabetes; 3087 women without diabetes.

*Odds ratio for presence of any difficulty vs no difficulty in women with diabetes vs women without diabetes.

CI = confidence interval.
and disability. Like all cross-sectional studies, our study cannot provide direct support for causal inferences. Because we lacked clinical data, we were unable to classify diabetic women as to diabetes type (although one would expect that the vast majority had type 2 diabetes), level of obesity, diabetes duration or severity, or level of metabolic control. Also, we had no information on the severity of comorbid diseases.

Finally, we used self-report for data on diabetes, diseases, and disability. However, Rathouz and colleagues found significant internal validity and reliability with similar self-reported functional measurements used during weekly assessments of the WHAS study cohort (37). In addition, the reliability of self-reported medical diagnoses has been high among independent elderly individuals in outcomes research related to incontinence (38,39), dependence (40), and falling (41). Finally, the self-reported prevalence of diabetes we found, as well as its associations with increased heart disease and vision problems, is consistent with published research on nationally representative sample data (3) and lends credibility to the self-report of diabetes in this survey.

Our study shows that disability associated with diabetes is common, affects many common activities, and is at least partially independent of the most prevalent vascular comorbidities and risks. While causation cannot be established in our cross-sectional data, our findings support the notion that diabetes might produce disability via alternative pathways involving more-difficult-to-measure vascular complications, excess hyperglycemia, or catabolism, and that management of the most prevalent vascular complications of diabetes alone may not necessarily eliminate the burden of functional limitations and disability attributable to diabetes. More research is needed on possible pathways from diabetes to disability and the pathophysiological mechanisms responsible for these pathways in order to design interventions for type 2 diabetes that will substantially decrease the overall burden of disability of older women with diabetes.

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Dr. Maty is now an Assistant Professor of Community Health at Portland State University, Portland, Oregon; Dr. Blaum is also a Visiting Assistant Professor of Medicine, The Johns Hopkins University. The results were presented in part at the 57th Scientific Sessions of the American Diabetes Association, Boston, Massachusetts, June 1997.

Address correspondence to Caroline S. Blaum, MD, Division of Geriatrics, The University of Michigan Medical Center, Rm. 1111–CCGCB, 1500 East Medical Center Dr., Ann Arbor, MI 48109-0926. E-mail: cblaum@umich.edu

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