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Diabetes mellitus and functional impairment in Taiwanese older men and women

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ABSTRACT

Type 2 diabetes mellitus is strongly related to many kinds of functional impairment, even after adjusting for demographic and comorbid conditions. The current study examined sex differences in the relationships between Type 2 diabetes mellitus and functional impairment in an Asian population sample. Data were obtained from a national survey, the Social Environment and Biomarkers of Aging Study (SEBAS) in Taiwan. A total of 652 older adults aged ≥65 years were included in the study. Pearson's χ^2-test and multiple logistic regression analysis were used to examine the relationships between diabetes and functional impairments in older men and women. The reported numbers of impairments were significantly higher in women, in those aged ≥75 years, and in those with diabetes. There were sex and age differences in the relationships between diabetes and functional difficulties. Even after adjustment for age, education, and co-morbid conditions, men with diabetes were about four times more likely to have difficulties related to self-care, and women with diabetes were about two to three times more likely to have difficulties related to higher functioning than their non-diabetic counterparts. Sex differences should be considered when understanding the relationships between diabetes and functional impairments in older adults.

1. Introduction

Several cross-sectional and longitudinal studies have found that type 2 diabetes mellitus (DM) is strongly related to many kinds of functional impairments, including problems with mobility, balance, housework, and self-care, in older adults. These relationships remained significant even after adjusting for demographic factors (e.g., age, sex, education, and ethnicity) and common diabetes-related and diabetes-unrelated comorbidities (e.g., Rekeneire et al., 2003; Wray et al., 2005). Gender differences in functioning have been found in many studies involving older adults (Rahman and Liu, 2000; Liang et al., 2008). Although most of the studies focusing on diabetes and functioning partially accounted for the sex effect, only a few further explored the differences in the relationship between diabetes and functional impairment between older men and women (Gregg et al., 2000). Furthermore, it is unclear whether the results are applicable to older Asian people, because most of these studies took place in Western populations (e.g., Maty et al., 2004; Sinclair et al., 2008); Asian studies have been relatively rare (Chou and Chi, 2005).

In 2006, the prevalence of diabetes in Taiwan was around 14.5% in elderly men and 13.9% in elderly women (Chen et al., 2001); people with diabetes had relatively higher mortality rates (Tseng, 2004), and diabetes was ranked the fourth cause of death (Department of Health, Taiwan, 2006). The current study aimed to assess the sex differences in functional impairment related to diabetes in elderly Taiwanese people, and to examine if these relationships remained significant after adjusting for demographic factors and comorbidities.

2. Sample and methods

2.1. Study population

The data used in this study were from the Social Environment and Biomarkers of Aging Study (SEBAS) in Taiwan, which was a random subsample of an ongoing survey, the Taiwan Longitudinal Study on Aging (TLSA). The TLSA began in 1989 with a nationally representative sample of persons 60 years and older. The SEBAS survey procedures were approved by the institutional review boards at the Bureau of Health Promotion of the Department of Health, Taiwan, Princeton University, and Georgetown University, and conformed to the principles embodied in the Declaration of Helsinki. Details of the study are stated elsewhere (Bureau of Health Promotion, Department of Health, Taiwan, 2000). Among the 1,713 randomly selected respondents, 1,497 were interviewed, and

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1,023 participated in the physical examination, including physician evaluation and collection of blood and urine samples. The case selection criteria were: (1) older than 65 years old in year 2000; and (2) blood glucose data were available. A total of 652 people were included in this study.

2.2. Diabetes and other medical conditions

The information was gathered from blood tests and by trained personnel who conducted face-to-face interviews. A positive DM status was defined by: (1) fasting plasma glucose AC ≥ 126 mg/dl; or (2) self-reported DM history. The presence of other comorbid medical conditions was assessed with the question, "Do you have <disease>? or has your medical doctor told you that you have <disease>?" for the following medical conditions: high blood pressure, heart disease (not including palpitations), stroke, cataracts, cancer, respiratory problem (including bronchitis, emphysema, pneumonia, lung disease, asthma, or other lower respiratory tract diseases), arthritis or rheumatism, and hip fracture. Depressive mood was evaluated by a 10-item short version of the Center for Epidemiologic Studies Depression Scale (CES-D), and cognitive function was evaluated by selected items from the Short Portable Mental Status Questionnaire (SPMSQ).

2.3. Classification of Functional Impairment

Participants were asked about 19 distinct physical tasks in three functional domains: (1) physical function – grasping or turning things with fingers, raising both arms over the head, lifting 11–12 kg, standing continuously for 15 minutes, squatting, walking 200–300 meters, climbing 2–3 flights of stairs, getting out of bed, and doing heavy housework; (2) higher functioning (IADLs) – personal shopping, managing money, riding bus or train by oneself, doing light housework, and using the telephone; and (3) self-care task (ADLs) – bathing, dressing, eating, moving around indoors, and using the toilet. Each function was assessed by the question, "Without help from another person or special equipment, do you have any difficulty <performing the task> by yourself?". The responses were categorized into 0 (no difficulty) or 1 (have difficulty). Participants were defined as having functional impairment in a particular domain if they reported having difficulty in any specific task in these three domains. The participants with functional impairment were further differentiated into three mutually exclusive functional impairment statuses: (1) physical function impairment only; (2) higher functioning impairment with/without physical function impairment; and (3) self-care impairment with/without any other impairment. This classification of functional impairment was adopted from two studies in the United States (Maty et al., 2004) and in Hong Kong (Chou and Chi, 2005), and these functional impairment statuses can be considered hierarchical, because a person with difficulty in progressively greater numbers of physical tasks is considered to have a more severe disability.

2.4. Analysis

DM status (present vs. absent) was used as the main independent variable. Sex and age were used as grouping variables while comparing each physical task. Age was used as a grouping variable (the "younger old" group: 65–74 years old and the "older old" group: ≥75 years old) because a previous national older population survey in Taiwan (Wu and Chang, 1997) found that people older than 75 years had significantly higher rates of functional impairment. The main effects of DM status, sex, and age groups on the reported numbers of difficulties were analyzed using the t-test. Then, any self-reported difficulties versus no difficulties for each task were compared by Pearson's χ^2-test for DM status. Furthermore, participants were classified into the three mutually exclusive functional impairment statuses by their report of disabilities. In order to assess the independent relationships of DM with each of the three functional impairment statuses in men and women, four sequential multiple logistic regression models were constructed. The first model was unadjusted, and the second model was adjusted for age and education. The third model was adjusted for age, education, and medical conditions that are generally related to diabetes (high blood pressure, heart disease, stroke, and cataracts). The fourth model was fully adjusted for age, education, depressive mood, cognitive function, and all comorbid medical conditions that had been assessed in the study. Participants with no functional impairments in any task served as the reference group in all logistic regression analyses.

3. Results

Of the 652 participants, 388 (59.5%) were men and 264 (40.5%) were female. The prevalence of diabetes was significantly lower for men than for women in the whole sample (13.9% vs. 28.4%, $\chi^2 = 20.8$, $p < 0.001$). However, there were no age-group differences in the prevalence of diabetes in either men or women. Compared to those without diabetes, men and women with diabetes were more likely to have high blood pressure (men: 51.9% vs. 36.5%; women: 50.7% vs. 36.7%). Women with diabetes were more likely to have respiratory problems (16.0% vs. 7.4%) and hip fractures (4.0% vs. 0.5%). No other significant differences were found (see Table 1).

Table 1
Demographic and clinical characteristics of 652 older Taiwanese by sex and diabetes status (%)

Parameters	Men			Women		
	−DM	+DM	p =	−DM	+DM	p =
Number	334	54		189	75	
Age, years						
65–74	59.0	53.7	0.466	59.8	48.0	0.081
≥75	41.0	46.3		40.2	52.0	
Education, ≤6 years	60.5	50.0	0.146	62.5	80.0	0.629
Comorbid conditions						
High BP	36.5	51.9	0.032	36.7	50.7	0.037
Heart disease	17.4	18.5	0.836	23.3	28.4	0.389
Stroke	4.2	1.9	0.408	2.6	8.0	0.050
Cataract	33.8	37.0	0.645	40.7	48.6	0.244
Cancer	2.7	0.0	0.222	4.2	2.7	0.548
Resp. problems	17.1	14.8	0.681	7.4	16.0	0.035
Arthritis	14.7	13.0	0.740	23.3	29.3	0.306
Hip fracture	1.5	1.9	0.847	0.5	4.0	0.038
Depressive, CESD >10	13.6	18.5	0.313	19.9	30.7	0.062
SPMSQ ≤7	2.4	3.8	0.562	9.4	17.3	0.659

3.1. Impairments on physical tasks

To get an overview on the functional impairments in the older adults, the main effects of sex, age, and DM status on the reported numbers of difficulties were analyzed first. Women reported difficulties on an average of 3.84±4.05 tasks, which was significantly higher ($t = 7.85$, $p < 0.001$) than men (1.60±2.77). People in the older old group reported difficulties on 3.56±4.11 tasks, which was significantly higher ($t = 6.35$, $p < 0.001$) than in the younger old group (1.74±2.78). People with diabetes

Table 2
Distribution of difficulties with various tasks by sex, age group, and diabetic status

	DM	Men, 65–74 y			Women, 65–74 y			Men, >75 y			Women, >75 y		
		%[a]	OR (CI)[b]	p =	%[a]	OR (CI)[b]	p =	%[a]	OR (CI)[b]	p =	%[a]	OR (CI)[b]	p =
Physical functions													
Grasping	Yes	6.9	3.6 (0.6–20.5)	0.128	8.3	1.6 (0.4–6.8)	0.507	8.0	1.9 (0.4–10.0)	0.442	20.5	1.9 (0.7–5.5)	0.215
	No	2.0			5.3			4.4			11.8		
Raising arms	Yes	10.3	7.5 (1.4–38.9)	0.006	8.3	1.6 (0.4–6.8)	0.507	4.0	2.8 (0.2–32.2)	0.386	20.5	3.0 (1.0–9.4)	0.050
	No	1.5			5.3			1.5			7.9		
Lifting 11–12 kg	Yes	17.2	1.1 (0.4–3.0)	0.892	44.4	1.3 (0.6–2.7)	0.557	44.0	1.8 (0.7–4.2)	0.191	74.4	0.8 (0.3–2.1)	0.695
	No	16.2			38.9			30.7			77.6		
Standing 15 min	Yes	20.7	4.4 (1.5–13.1)	0.004	27.8	3.0 (1.2–7.5)	0.019	16.0	1.3 (0.4–4.4)	0.623	48.7	2.1 (0.9–4.5)	0.072
	No	5.6			11.5			12.4			31.6		
Squatting	Yes	20.7	1.0 (0.4–2.5)	0.938	47.2	1.5 (0.7–3.2)	0.283	36.0	1.2 (0.5–3.0)	0.650	74.4	2.9 (1.2–6.8)	0.012
	No	21.3			37.2			31.4			50.0		
Walking 200 m	Yes	17.2	2.7 (0.9–8.2)	0.066	25.7	1.4 (0.6–3.5)	0.428	32.0	1.7 (0.7–4.3)	0.273	51.3	2.0 (0.9–4.4)	0.077
	No	7.1			19.5			21.9			34.2		
Climbing stairs	Yes	24.1	2.4 (0.9–6.3)	0.065	41.7	2.4 (1.1–5.3)	0.029	28.0	1.2 (0.5–3.2)	0.677	69.2	3.1 (1.4–7.0)	0.006
	No	11.7			23.0			24.1			42.1		
Getting out of bed	Yes	3.4	7.0 (0.4–115)	0.114	5.6	6.6 (0.6–74.9)	0.082	4.0	2.8 (0.2–32.2)	0.386	10.3	2.7 (0.6–12.9)	0.187
	No	0.5			0.9			1.5			4.0		
Heavy housework	Yes	27.6	2.0 (0.8–4.8)	0.135	55.6	2.3 (1.1–4.9)	0.032	37.5	1.2 (0.4–2.9)	0.709	74.4	1.7 (0.7–4.0)	0.227
	No	16.2			35.4			33.6			63.2		
Higher functioning													
Personal shopping	Yes	6.9	3.6 (0.6–20.4)	0.128	13.9	4.4 (1.1–17.4)	0.023	16.0	3.1 (0.8–11.1)	0.074	30.8	1.8 (0.7–4.4)	0.186
	No	2.0			3.5			5.8			19.7		
Managing money	Yes	0.0	NA		11.1	1.1 (0.9–1.2)	0.226	4.0	1.0 (0.9–1.1)	0.712	20.5	1.1 (0.9–1.3)	0.143
	No	2.0			5.3			5.8			10.5		
Traveling by bus	Yes	10.3	2.2 (0.6–8.4)	0.255	41.7	2.8 (1.2–6.3)	0.011	20.0	1.5 (0.5–4.3)	0.502	61.5	1.9 (0.9–4.1)	0.116
	No	5.1			20.4			14.7			46.1		
Light housework	Yes	6.9	2.0 (0.4–10.1)	0.390	16.7	3.6 (1.1–11.9)	0.029	20.0	2.4 (0.8–7.4)	0.124	38.5	1.9 (0.8–4.3)	0.134
	No	3.6			5.3			9.5			25.0		
Using telephone	Yes	3.4	1.0 (0.1–8.2)	0.977	22.2	2.6 (1.0–7.2)	0.050	4.0	0.5 (0.1–4.3)	0.547	28.2	0.9 (0.4–2.1)	0.819
	No	3.6			9.7			7.3			30.3		
Self-care													
Bathing	Yes	3.4	7.0 (0.4–115)	0.114	8.3	5.0 (0.8–31.4)	0.057	4.0	1.9 (0.2–18.6)	0.592	5.1	0.5 (0.1–2.7)	0.440
	No	0.5			1.8			2.2			9.2		
Dressing	Yes	3.4	2.3 (0.2–23.0)	0.463	2.8	1.6 (0.1–18.0)	0.708	4.0	1.9 (0.2–18.6)	0.592	2.6	0.4 (0.0–3.3)	0.359
	No	1.5			1.8			2.2			6.6		
Eating	Yes	0.0	NA		0.0	NA		0.0	NA		2.6	0.6 (0.1–6.4)	0.702
	No	0.5			0.0			1.5			3.9		
Moving indoors	Yes	6.9	14.5 (1.3–165)	0.005	2.8	NA		4.0	5.7 (0.3–93.7)	0.173	7.7	1.5 (0.3–7.1)	0.606
	No	0.5			0.0			0.7			5.3		
Using toilet	Yes	3.4	7.0 (0.4–115)	0.114	5.6	6.6 (0.6–74.9)	0.082	4.0	1.9 (0.2–18.6)	0.592	7.7	1.5 (0.3–7.1)	0.606
	No	0.5			0.9			2.2			5.3		

[a] Percentage of participants with any difficulty.
[b] Unadjusted odds ratios (95% confidence interval) for the presence of any difficulty vs. no difficulty in participants with DM vs. without DM.
NA = not available.

Table 3
Unadjusted and adjusted associations of diabetes with any disability by disability status

	+DM N (%)	−DM N (%)	Unadjusted Model 1 OR (CI)[a]	p =	Adjusted Model 2[b] OR (CI)[a]	p =	Adjusted Model 3[c] OR (CI)[a]	p =	Adjusted Model 4[d] OR (CI)[a]	p =
Men										
No Disability	26 (48.1)	182 (54.5)	1.0 (reference)		1.0 (reference)		1.0 (reference)		1.0 (reference)	
Mobility only	18 (33.3)	104 (31.1)	1.2 (0.6–2.3)	0.561	1.2 (0.6–2.3)	0.580	1.2 (0.6–2.4)	0.570	1.1 (0.5–2.2)	0.837
Higher functioning[e]	5 (9.3)	39 (11.7)	0.9 (0.3–2.5)	0.835	0.9 (0.3–2.6)	0.842	1.0 (0.3–2.8)	0.934	0.7 (0.2–2.4)	0.525
Self-care[f]	5 (9.3)	9 (2.7)	3.9 (1.2–12.5)	0.023	3.6 (1.1–11.8)	0.034	4.2 (1.2–14.9)	0.027	4.4 (1.1–18.6)	0.035
Disability in any category	28 (51.9)	152 (45.5)	1.3 (0.7–2.3)	0.387	1.3 (0.7–2.3)	0.415	1.3 (0.7–2.4)	0.407	1.1 (0.6–2.2)	0.736
Women										
No Disability	10 (13.3)	48 (25.4)	1.0 (reference)		1.0 (reference)		1.0 (reference)		1.0 (reference)	
Mobility only	17 (22.7)	73 (38.6)	1.1 (0.5–2.6)	0.800	1.1 (0.4–2.7)	0.852	1.0 (0.4–2.6)	0.962	0.8 (0.3–2.0)	0.629
Higher functioning[e]	39 (52.0)	58 (30.7)	3.2 (1.5–7.1)	0.004	3.3 (1.4–7.7)	0.006	3.0 (1.2–7.3)	0.014	2.1 (0.9–4.9)	0.086
Self-care[f]	9 (12.0)	10 (5.3)	4.3 (1.4–13.4)	0.011	4.6 (1.4–15.3)	0.013	3.5 (1.0–12.2)	0.055	2.1 (0.6–7.8)	0.257
Disability in any category	65 (86.7)	141 (74.6)	2.2 (1.1–4.6)	0.036	2.0 (0.9–4.5)	0.078	1.9 (0.8–4.2)	0.135	1.7 (0.7–4.2)	0.248

[a] Odds ratio (95% confidence interval) for presence of any difficulty vs. no difficulty in participants with DM vs. without DM. [b] Model 2 adjusted for age and education [c] Model 3 adjusted for age, education, and medical conditions potentially related to DM (high blood pressure, heart disease, stroke, and cataracts). [d] Model 4 adjusted for age, education, DM-related comorbidities, other medical conditions (cancer, respiratory problem, arthritis or rheumatism, and hip fracture), depressive mood (CESD), and cognitive function (SPMSQ). [e] Higher functioning disability with/without mobility disability. [f] Self-care disability with/without any other disabilities.

reported difficulties, on average, on 4.03±4.37 tasks, which was significantly higher ($t = 4.65$, $p < 0.001$) than for those without diabetes (2.13±3.17).

Further explorations on each physical task found that men in the younger old group with diabetes were significantly more likely to report functional impairment in three tasks (raising both arms over the head, standing continuously for 15 minutes, and moving in the house) than those without diabetes. Women in the younger old group with diabetes were significantly more likely to report functional impairment in six tasks (standing continuously for 15 minutes, climbing 2–3 flights of stairs, doing heavy housework, personal shopping, riding bus or train by oneself, and doing light housework) than those without diabetes. Older old women with diabetes were significantly more likely to report functional impairment in two tasks (squatting and climbing 2–3 flights of stairs) than those without diabetes. However, there were no significant differences in the probability of reporting functional impairment between older men with or without diabetes in any of the 19 tasks (Table 2).

3.2. Diabetes and different functional impairment statuses

In general, 51.9% of men with diabetes and 45.5% without diabetes reported functional impairment in at least one task. Men with diabetes were significantly more likely to report functional impairment related to "self-care impairment with/without any other impairment" than those without diabetes (9.3% vs. 2.7%). The higher probability was still significant after adjustment for age and education (second model), for medical conditions generally related to diabetes (third model), and after full adjustment (fourth model). However, there were no significant differences between men with and without diabetes in other functional impairment statuses (Table 3).

Women with diabetes were significantly more likely to report functional impairment related to "higher functioning impairment with/without physical function impairment" (52.0% vs. 30.7%) and to "self-care impairment with/without any other impairment" (12.0% vs. 5.3%) than those without diabetes. The probability of reporting impairment in at least one task was significantly higher in women with diabetes than in those without (86.7% vs. 74.6%). After adjusting for age and education (second model), the significant association of diabetes with "higher functioning impairment" and with "self-care impairment" remained, while the association with "impairment in any task" was attenuated ($p = 0.078$). With further adjustment for the four medical conditions that generally related to diabetes (third model), the significant association of diabetes with "higher functioning impairment" still remained, but the association with "self-care impairment" was attenuated ($p = 0.055$), and the association with "impairment in any task" became insignificant. After full adjustment (fourth model), the significant association of diabetes with "higher functioning impairment" was attenuated ($p = 0.086$), and the association with self-care impairment became insignificant.

4. Discussion

The present research shows that sex and age differences should be considered when understanding the relationships between diabetes and functional impairments in older adults. Women in the younger old group with diabetes were at higher risk for functional impairment than their counterparts without diabetes in three of nine physical function tasks and in three of five higher functioning tasks. However, women in the older old group with diabetes were only at higher risk in two of the nine physical function tasks. The reason for this might be the increasing rate of functional impairments in those older old women without diabetes. For instance, functional impairment was reported in 35.4% of the younger old women without diabetes, but increased to 63.2% in the older old women group for the heavy housework task. A similar pattern was also seen in men; younger old men with diabetes were at higher risk in three tasks, while no significant differences were found in any tasks in the older old men group. These results indicate that having diabetes might be a stronger risk factor for functional impairment around 65 to 74 years, especially in women.

Sex differences were found after the analysis of functional impairment status. The strongest association between diabetes and functional impairment was found in the "self-care impairment with/without any other impairment" status in men, and in the "higher functioning impairment with/without physical function impairment" status in women. These associations were not

substantially reduced by the most common vascular complications of diabetes (heart disease, stroke, and cataracts) and one highly co-occurring chronic condition (high blood pressure).

Compared to findings of Maty et al. (2004) in older women, we found no significant difference in the "physical function only" status, and the significant difference in the "self-care impairment with/without any other impairment" was attenuated after adjusted for diabetes-related medical conditions in Taiwanese old women. However, our results in old women were similar to the findings in Hong Kong old adults (Chou and Chi, 2005), although their study did not classify patients by sex. We do not know if these differences among Eastern and Western studies are caused by cultural differences. In a review paper (Chia et al., 1997) concerning attitudes toward women in Taiwan, it was pointed out that Taiwanese men and women were less liberal and egalitarian than Americans. This might imply that the traditional gender roles, such as the most important "job" for women is to serve their husband and raise their children, was more acceptable in Taiwan than in the USA. Thus, it may be reasonable to assume that older Taiwanese women reporting difficulties with higher functioning tasks would be culturally more acceptable than reporting problems with self-care related tasks. We do not know if these hypotheses are true in older American populations. A longitudinal study (Murtagh and Hubert, 2004) that took place in the United States also found that older women tended to report "a greater degree of disability, particular among IADL categories". Further studies are needed to clarify if there really are cultural or ethnic differences.

Besides providing data relating to Asian populations, the other major strengths of the current study are that it: (1) used a nationally representative sample of Taiwanese older people; (2) had blood glucose data to identify people with or without diabetes more objectively; (3) focused on sex and age differences to further explore the relationships between diabetes and functional impairments. However, like all cross-sectional studies, our study cannot provide enough information to make any inferences over time. Since the TLSA is an ongoing survey, further explorations of related issues may be possible in the near future.

5. Conclusion

Based on data from an Eastern population, Taiwan, the current study found gender and age differences in the relationship between of diabetes and functional impairment. Even after adjustment for age, education, and co-morbidities, men with diabetes were about four times more likely to have difficulties related to self-care impairment; while women with diabetes were about two to three times as likely to have difficulties related to higher functioning impairment, than their non-diabetic counterparts. Thus, it is suggested that gender differences should be considered in understanding the relationships between diabetes and functional impairment in older adults.

Conflict of interest statement

None.

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