Diabetologia (2004) 47:1957–1962
DOI 10.1007/s00125-004-1555-8

Diabetologia

Short Communication

Physical disability among older Italians with diabetes. The ILSA Study

S. Maggi[1] · M. Noale[1] · P. Gallina[1] · C. Marzari[1] · D. Bianchi[1] · F. Limongi[1] · G. Crepaldi[1] · for the ILSA Group

[1] CNR Institute of Neuroscience, Center on Aging, c/o Clinica Medica 1°, University of Padua, Padova, Italy

Abstract

Aims/hypothesis. We studied the role of diabetic complications and comorbidity in the association between diabetes and disability in the elderly.
Methods. Data were from a nationally representative sample of 5632 older Italians, aged 65 years and older, and who participated in the Italian Longitudinal Study on Aging. Clinical diagnoses of diabetes and other major chronic conditions were made by a physician, while disability was assessed by self-reported information on activities of daily living and physical performance tests.
Results. After adjusting for age, education and BMI, disability on the basis of activities of daily living was associated with diabetes in women, but not in men (odds ratio [OR] 1.65, CI: 1.22–2.23 and OR 1.21, CI: 0.84–1.75 respectively). In contrast, the association between severe and/or total disability on the basis of physical performance tests and diabetes was strong in both sexes (OR 2.81, CI: 1.44–5.41 and OR 2.16, CI: 1.25–3.73 respectively). Adjusting for traditional complications and comorbidity reduced the excess odds of disability by 38% in women and by 16% in men.
Conclusions/interpretation. Disability in older Italians with diabetes is frequent and only partially attributable to traditional diabetic complications and comorbidity.

Keywords Ageing · Comorbidity · Diabetes · Physical disability.

Received: 27 April 2004 / Accepted: 8 July 2004
Published online: 1 December 2004

S. Maggi (✉)
CNR Institute of Neuroscience, Center on Aging,
c/o Clinica Medica 1°, University of Padua,
Via Giustiniani 2, 35128 Padova, Italy
E-mail: smaggi@unipd.it
Tel.: +39-049-8211746, Fax: +39-049-8211818

Abbreviations: ADL, activities of daily living · ILSA, Italian Longitudinal Study on Aging · OR, odds ratio · PPT, physical performance tests

Introduction

The large increase in the incidence of diabetes among the elderly is an issue of great concern. Indeed, in addition to all traditional complications, higher rates of disability are reported [1], although the key factors explaining such a relationship are not yet very clear.

The ILSA Working Group: S. Maggi, N. Minicuci, A. Di Carlo, M. Baldereschi, Italian National Research Council (CNR); L. Candelise, E. Scarpini, University of Milan; P. Carbonin, Catholic University of the Sacred Heart, Rome; G. Farchi, E. Scafato, S. Brescianini, National Institutes of Health, Rome; F. Grigoletto, E. Perissinotto, G. Enzi, University of Padua; C. Loeb, Italian National Research Council, Genoa; C. Gandolfo, University of Genoa; N. Canal, M. Franceschi, San Raffaele Institute, Milan; A. Ghetti, R. Vergassola, Health Area 10, Florence; D. Inzitari, University of Florence; S. Bonaiuto, F. Fini, A. Vesprini, G. Cruciani, Italian National Institute of Research and Care on Aging, Fermo; A. Capurso, P. Livrea, V. Lepore, University of Bari; L. Motta, D. Maugeri, G. Carnazzo, P. Bentivegna, University of Catania; F. Rengo, University of Naples; all Italy

Table 1. Characteristics of study population, by diabetic status and sex, at baseline

	Women			Men		
	Diabetic (*n*=349)	Non-diabetic (*n*=2237)	*p* value	Diabetic (*n*=246)	Non-diabetic (*n*=1666)	*p* value
Socio-demographic characteristics						
Age (mean ± SD)	73.4±0.3	72.7±0.1	0.05	71.5±0.3	72.0±0.1	NS
BMI (kg/m^2) (mean ± SD)	28.8±0.4	27.4±0.1	0.0004	27.3±0.3	26.3±0.3	<0.0001
Education (≤5 years, %)	83.8	75.4	0.0007	62.2	63.0	NS
Smoking status (%)	4.5	8.5	0.0103	22.6	21.8	NS
Health status						
Cancer (self-reported) (%)	10.4	6.1	0.0035	6.7	4.3	NS
Arthritis (self-reported) (%)	70.0	68.5	NS	52.8	50.0	NS
Angina (%)	12.7	6.1	<0.0001	11.1	7.3	0.04
MI (%)	7.1	4.5	0.04	16.6	9.8	0.0012
Heart failure (%)	14.6	6.3	<0.0001	5.1	5.5	NS
Stroke (%)	10.4	5.3	0.0002	11.2	6.9	0.0166
Dementia (%)	8.1	7.1	NS	4.1	5.3	NS
DSN (%)	22.0	4.1	<0.0001	20.9	4.3	<0.0001
Depressive symptoms (%)[a]	55.7	46.8	0.0094	33.0	24.8	0.0147
Urinary incontinence (%)	33.1	21.0	<0.0001	15.3	14.4	NS
Blood creatinine ≥132 µmol/l (%)	2.5	1.6	NS	6.7	5.3	NS
Heart rate (beats/min)	73.2±11.1	71.2±10.1	<0.002	68.8±8.5	68.3±9.0	NS
Diabetes treatment						
None or only diet (%)	23.8			35.4		
Oral hypoglycaemic agents (%)	59.9			49.0		
Insulin (%)	16.3			15.6		

Data are ILSA-weighted data. [a] Depressive symptoms cut-off for Geriatric Depression Scale [9]: >20. BMI was based on direct measures of height and weight. MI, myocardial infarction; DSN, distal symmetric neuropathy

Most studies have focused on difficulties encountered with activities of daily living (ADL), because they are strong predictors of morbidity and mortality [2, 3, 4]. The objective of this paper is to assess the burden of disability in a sample of older Italians with diabetes, and the role of comorbidity and diabetic complications in determining disability.

Subjects and methods

Study population and protocol. The Italian Longitudinal Study on Aging (ILSA) has been described in detail elsewhere [5]. A random sample of 5632 individuals aged 65 to 84 years, stratified by age and sex using an equal allocation strategy, was identified on the demographic lists of the registry offices of eight municipalities. This paper is based on data from the baseline survey, which was carried out in 1992 and included two phases:

1. A screening phase, with a personal interview on self-reported conditions, selected risk factors, a fasting blood sample, and an examination by a physician.
2. A second phase for participants who screened positive for angina, myocardial infarction, heart failure, hypertension, stroke, diabetes, distal symmetric neuropathy, Parkinsonisms, or dementia. This phase was based on the clinical assessment by a specialist. Details on the diagnostic criteria and prevalence rates of diseases have been previously published [6].

In particular, the criteria for a positive screening result for diabetes were: (i) self-reported diagnosis or treatment; (ii) fasting glycaemia 7.78 mmol/l or higher. Subjects who screened positive were evaluated by an internist, after a second blood glucose measurement of 7.78 mmol/l or higher and/or review of medical records.

Physical functioning was assessed on the basis of self-reported degrees of difficulty in various ADL, e.g. eating, continence, getting in and out of bed, toileting, dressing, bathing, and by selected physical performance tests (PPT), namely standing up from a chair, climbing one step, tandem walking, standing on one leg, number of steps to turn around, walking speed.

The ADL total score ranged from 0.33 to 1, and was ranked as follows: (i) 0.33: subject is completely independent; (ii) 0.33–0.56: subject dependent on help for 2 ADL at most; (iii) 0.56–0.78: subject dependent on help for 3 ADL at most; (iv) 0.78–1: subject dependent on help for 4 or more ADL.

With regard to PPT, the score range was 0 to 1, with the following ranking categories: (i) 1: the subject is completely independent; (ii) 0.66–1: mild dependency; (iii) 0.33–0.66: moderate dependency; (iv) 0–0.33: severe/total dependency.

The protocol and the aims of the study were fully explained to each subject before they provided written informed consent. The protocol was approved by the Ethics Committees of the participating centres.

Statistical analysis. All statistical analyses were run using SAS Software (SAS 8.02; SAS Institute, Cary, N.C., USA). Data were weighted according to sample scheme coefficients. The association of sex, selected conditions and diabetes was inves-

Table 2. Prevalence (%) of disability according to diabetes status at baseline

	Women			Men		
	Diabetic	Non-diabetic	*p* value	Diabetic	Non-diabetic	*p* value
Activities of daily living						
No disability	50.9	67.0	<0.0001	69.5	72.2	NS
Mild disability	40.3	26.5		24.4	22.5	
Moderate disability	5.4	4.0		4.6	3.3	
Severe disability	3.4	2.5		1.5	2.0	
Any kind of disability (mild or moderate or severe)	49.1	33.0		30.5	27.8	
Physical performance test						
Stand up from a chair			0.0047			NS
Unable	15.3	8.5		9.5	5.5	
With hands, >2 s	4.6	4.2		1.9	2.1	
With hands, ≤2 s	7.2	5.8		4.4	3.5	
Without hands, >2 s	4.2	4.0		1.9	3.0	
Without hands, ≤2 s	68.7	77.5		82.3	85.9	
Climb a 23-cm step			<0.0001			0.0301
Unable	33.3	23.7		17.9	12.2	
≤3 times	29.7	25.0		13.4	10.8	
>3 times	37.0	51.3		68.7	77.0	
Tandem walk			0.0001			NS
Unable	32.2	21.5		18.0	12.5	
>8 stops	12.2	9.2		2.8	3.0	
≤8 stops	55.6	69.3		79.2	84.5	
Standing on one leg			<0.0001			0.0123
Unable	23.3	15.8		15.1	8.6	
≤2 s	16.3	7.4		3.3	3.8	
>2 s	60.4	76.8		81.6	7.6	
5-metre course			0.0017			0.0076
Unable	20.0	12.9		15.1	8.3	
≤0.6 m/s	26.4	23.8		11.9	11.6	
>0.6 m/s	53.6	63.3		73.0	80.1	
Number of steps to turn round			0.0006			0.0351
Unable	12.2	8.1		10.4	5.7	
>5 steps	13.1	7.8		3.6	4.3	
≤5 steps	74.7	84.1		86.0	90.0	
Physical performance test (total)						
No disability	23.6	37.7	<0.0001	60.8	65.9	0.0376
Mild disability	39.5	39.4		20.8	21.8	
Moderate disability	17.2	11.1		5.7	5.4	
Severe disability	19.7	11.8		12.7	6.9	
Any kind of disability in PPT (mild or moderate or severe)	76.4	62.3		39.2	34.1	

Data are ILSA-weighted data. PPT, physical performance test

tigated with the chi square test. The comparison of mean age, BMI and heart rate by diabetic status was evaluated through the General Linear Model, after controlling the assumption of homoskedasticity with Levine's test.

A multinomial logistic regression model was used to assess the association between diabetes and disability based on ADL and PPT scores, while controlling for age, education and BMI.

A "basic" logistic model, with only age, education and diabetes, was constructed to evaluate the association between diabetes and disability in PPT; then, each comorbid condition was added separately to the basic model to evaluate its contribution to the association between diabetes and disability. Finally, the association of diabetes and disability was evaluated on the basis of simultaneous consideration of all comorbid conditions.

Results

Of 5632 participants, complete information on diabetes was available for 2586 women and 1912 men (80% of overall sample). Of these, 349 women (13.5%) and 246 men (12.9%) were diagnosed with

Table 3. Odds ratio (OR) and 95% CI of disability according to diabetes status at baseline

	Women		Men	
	OR	95% CI	OR	95% CI
Activities of daily living (ADL)				
No disability	1.00		1.00	
Mild disability	1.64	(1.20–2.24)	1.14	(0.78–1.67)
Moderate disability	1.93	(0.90–4.15)	1.95	(0.78–4.92)
Severe disability	0.97	(0.15–6.28)	1.84	(0.26–13.09)
Any kind of disability in ADL (mild or moderate or severe)	1.65	(1.22–2.23)	1.21	(0.84–1.74)
Physical performance test (PPT)				
Stand up from a chair				
Unable	2.04	(1.12–3.69)	2.33	(1.03–5.27)
With hands, >2 s	0.96	(0.47–1.94)	1.23	(0.38–4.00)
With hands, ≤2 s	0.99	(0.54–1.83)	1.79	(0.82–3.87)
Without hands, >2 s	1.08	(0.55–2.10)	0.76	(0.26–2.23)
Without hands, ≤2 s	1.00		1.00	
Climb a 23-cm step				
Unable	1.51	(1.02–2.24)	1.94	(1.16–3.24)
≤3 times	1.38	(0.98–1.94)	1.14	(0.45–2.89)
>3 times	1.00		1.00	
Tandem walk				
Unable	1.45	(0.99–2.12)	1.94	(1.16–3.24)
>8 stops	1.47	(0.95–2.28)	1.14	(0.45–2.89)
≤8 stops	1.00		1.00	
Standing on one leg				
Unable	1.60	(1.05–2.46)	2.39	(1.98–4.14)
≤2 s	2.36	(1.56–3.58)	1.10	(0.47–2.59)
>2 s	1.00		1.00	
5-metres course				
Unable	1.12	(0.61–2.03)	3.29	(1.79–6.06)
≤0.6 m/s	1.18	(0.85–1.64)	1.17	(0.72–1.91)
>0.6 m/s	1.00		1.00	
Number of steps to turn round				
Unable	1.56	(0.81–2.99)	3.32	(1.65–6.68)
>5 steps	1.64	(1.04–2.57)	1.03	(0.45–2.35)
≤5 steps	1.00		1.00	
Total PPT				
Mild disability	1.39	(0.98–1.98)	1.07	(0.72–1.58)
Moderate disability	1.78	(1.08–2.94)	1.45	(0.68–3.07)
Severe or total disability	2.16	(1.25–3.73)	2.81	(1.44–5.41)
Independent	1.00		1.00	

Data are ILSA-weighted data

diabetes at baseline. General characteristics of the sample are presented in Table 1. Compared with participants without diabetes, women and men with diabetes had higher BMI and a higher prevalence of angina, myocardial infarction, stroke, distal symmetric neuropathy and depressive symptoms. Women with diabetes were older, had lower educational status and were more often current smokers. They were also diagnosed more often with heart failure, reported more cases of cancer and incontinence, and had higher heart rates. With regard to the treatment of diabetes, about 16% of all diabetic subjects were taking insulin, while about 60% of women and 50% of men were being treated with oral hypoglycaemic agents.

Prevalence rates of disability in ADL were higher among women with diabetes, while no significant differences were detected among men. With regard to PPT, the prevalence rates of disability were higher among diabetic patients in both sexes (Table 2).

The duration of the disease had no effect on the association with disability in either sex, while a positive association was found for disability according to PPT in insulin-treated men. Indeed, 68% of insulin-treated men had a PPT-based disability, compared with 38% of male patients treated with oral hypoglycaemic agents and 25% of male patients treated by diet (data not shown).

After adjustment for age, education and BMI, women with diabetes had higher odds of reporting dis-

Table 4. Effect of separately controlling for diabetic comorbidities on the percentage of excess odds of overall disability associated with diabetes

Model	Women			Men		
	Any disability		Reduction in excess odds (%)	Any disability		Reduction in excess odds (%)
Diabetes	180	(131–247)	–	139	(100–192)	–
Diabetes + BMI	151	(108–211)	16	128	(90–181)	8
Diabetes + arthrosis	175	(126–243)	3	132	(95–185)	5
Diabetes + myocardial infarction	179	(130–246)	1	134	(97–186)	4
Diabetes + angina	181	(132–249)	0	136	(99–189)	2
Diabetes + heart failure	168	(122–231)	7	139	(100–192)	0
Diabetes + stroke	171	(124–235)	5	137	(99–191)	1
Diabetes + CVD	170	(124–235)	6	132	(95–184)	5
Diabetes + CVD + BMI	145	(103–203)	19	123	(86–176)	12
Diabetes + peripheral neuropathy	162	(117–225)	10	129	(92–181)	7
Diabetes + depressive symptoms	162	(117–224)	10	133	(95–186)	4
Diabetes + incontinence	171	(124–235)	5	137	(99–191)	1
Diabetes + all comorbidities	112	(77–163)	38	117	(78–175)	16

Disability was defined according to physical performance test. Data are ILSA-weighted data. CVD, cardiovascular disease

ability in ADL (odds ratio [OR]=1.65, CI: 1.22–2.23), while for men diabetes was not an independent significant predictor of disability in ADL (OR=1.21, CI: 0.84–1.74). With regard to PPT, men with diabetes were more likely to be unable to perform on each test. Among women, significant odds were also found, except for the items 5-metres walk and turning around (Table 3).

Among both women and men, BMI was the single most important condition explaining the increased risk among diabetic patients of disability according to PPT (16% and 8% of the increased risk respectively). When cardiovascular diseases were added to BMI, this accounted for 18% and 13% respectively. Controlling for other conditions, including depressive symptoms and distal symmetric neuropathy, explained only a modest increase of disability. When all conditions were controlled for, this explained 38% of the excess risk in women and 16% in men (Table 4).

Information on peripheral artery disease was only available in a subsample. The excess risk of disability explained by it was about 8% in women and 5% in men. With regard to selected diabetic complications, such data were collected only for subjects who screened positive and underwent the second phase. We didn't have a full evaluation for autonomic neuropathy, but based on reported symptoms (postural hypotension, diarrhoea, and excessive sweating), we estimated a prevalence rate of 20.2% in women and 12% in men with diabetes. A significant association with disability according to ADL and PPT was only found in men (p<0.002). Retinopathy was reported in 25% of women and 16% of men, but a significant association with disability according to ADL and PPT was present only in women (p<0.001) (data not shown).

Discussion

In this study we found prevalence rates of diabetes of around 13%, similar to those found in previous studies [7]. Women had significantly higher rates of ADL disability, a result which is consistent with previously reported data [2].

Of great importance is the extremely high prevalence in both sexes of physical limitations based on PPT. This is a matter of concern, because previous studies have shown that impairments in physical functioning of the lower extremities are independent predictors of loss of autonomy [3, 4, 8]. Diabetes is often accompanied by vascular and neurological disorders, as well as depressive symptoms and dementia, but these cannot explain completely the increased risk of disability. Therefore, other factors, not included in these analyses, are possibly major determinants of disability in older diabetics. These could include cognitive impairment, which has been reported to be more frequent in diabetic individuals [1], as well as muscle wasting, a condition frequently associated with diabetes and aging per se, with detrimental effects on physical functioning.

In conclusion, understanding the pathway from diabetes to disability is very important, because diabetes may be one of the few reversible causes of disability. Our findings should prompt clinicians to find secondary and tertiary preventive strategies for optimising the quality of life of older people with diabetes. In addition to appropriate glycaemic control and management of diabetes and its complications, a multidimensional assessment should always be performed.

References

1. Gregg EW, Engelgau MM, Narayan V (2002) Complications of diabetes in elderly people. BMJ 325:916–917
2. Gregg EW, Beckles GL, Williamson DF et al. (2000) Diabetes and physical disability among older U.S. adults. Diabetes Care 23:1272–1277
3. Gregg EW, Mangione CM, Cauley JA et al. (2002) Diabetes and incidence of functional disability in older women. Diabetes Care 25:61–67
4. Volpato S, Blaum C, Resnick H, Ferrucci L, Fried LP, Guralnik JM (2002) Comorbidities and impairments explaining the association between diabetes and lower extremity disability: the Women's Health and Aging Study. Diabetes Care 25:678–683
5. Maggi S, Zucchetto M, Grigoletto F et al. for the ILSA group (1994) The Italian Longitudinal Study on Aging (ILSA): design and methods. Aging Clin Exp Res 6:464–473
6. The Italian Longitudinal Study on Aging working group (1997) Prevalence of chronic diseases in older Italians: comparing self-reported and clinical diagnoses. Int J Epidemiol 26:995–1002
7. Harris MI, Flegal KM, Cowie CC et al. (1998) Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults. The Third National Health and Nutrition Examination Survey, 1988–1994. Diabetes Care 21:518–524
8. Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB (1995) Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. N Engl J Med 332:556–561
9. Yesavage JA (1988) Geriatric depression scale. Psychopharmacol Bull 24:709–711