

Impact of Diabetes on Physical Function in Older People

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OBJECTIVE — To explore the nature of functional impairment in older people with diabetes.

RESEARCH DESIGN AND METHODS — A population-based case-control study with detailed assessment of diabetes and functional status was undertaken.

RESULTS — Altogether, 403 case subjects and 403 matched control subjects were studied (median age 75 years, 51% female). Subjects with diabetes had more comorbidities than control subjects (mean 2.5 vs. 1.9, $P < 0.0001$) and were more likely to have severe functional impairment (4 vs. 1%, Barthel score <5 , $P < 0.001$). Health status pertaining to physical function was reduced in case subjects (SF36 60 vs. 40, $P < 0.0001$). In a multivariate model controlling for age, hypertension, cerebrovascular disease, chronic obstructive pulmonary disease, cancer, osteoarthritis, and dementia, diabetes remained significantly associated with mobility limitation (odds ratio 2.1, $P < 0.001$).

CONCLUSIONS — Older people with diabetes have considerable functional impairment associated with reduced health status. This population may benefit from comprehensive geriatric assessment and tailored diabetes management.

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Diabetes is associated with a considerable personal health burden (1), but until recently this was considered to result primarily from vascular complications and associated medical comorbidities. Functional impairment and physical disability directly attributable to diabetes have been less frequently studied, although these are direct threats to personal independence and quality of life (2,3).

We report data from a large community-based case-control study that examined in detail the nature of the functional impairment in subjects with diabetes and sought to determine factors identifying those at highest risk of functional impairment.

RESEARCH DESIGN AND METHODS

Participants were recruited as part of a case-control study. We included those known to have diabetes, aged 65 years or over, from a sample of rural and urban general practices in Wales. At the time of recruitment, all of the case subjects met the World Health Organization criteria for the diagnosis of diabetes (4). The control group of nondiabetic participants was frequency matched with the case subjects for age, sex, and general practice. Matching by ethnicity was not possible because of the small numbers of non-Caucasians.

Laboratory testing was used to confirm that the entire control group had normal glucose tolerance, as evidenced

by fasting plasma glucose <6.5 mmol/l and no evidence of glycosuria. All study participants were interviewed by trained research nurses; a comprehensive assessment was carried out including demographic, medical, social, and functional details with information corroborated from family members and medical records when necessary. Specific questionnaires used and reported in this study were the Barthel index, a validated scale measuring basic activities of daily living from 0 to 20 with higher scores indicating greater independence (5); the Nottingham Extended Activities of Daily Living Scale, measuring extended activities of daily living such as shopping and driving from 0 to 22, with higher scores indicating greater independence (6); and the SF-36 health status questionnaire, a generic measure of health-related quality of life, with scores ranging from 0 to 100, higher scores indicating greater satisfaction (7). Data were also collected on cognition and visual acuity, reported elsewhere (8,9).

Univariate and multivariate regressions analysis were used, with summary results presented as odds ratios (ORs) and 95% CIs. Model parameters were retained if they were clinically important potential confounders or were statistically significant at the 0.05 level in univariate analysis.

RESULTS — The study population consisted of 403 case subjects and 403 matched control subjects. The median (interquartile range [IQR]) age was 75 years (69–80), and 51% were female. More of the subjects with diabetes lived in a care home compared with control subjects (7 vs. 4%, $P < 0.001$). Participants with diabetes were on diet alone (24%), oral hypoglycemics (59%), or insulin (17%); the mean (95% CI) for A1C was 7.8% (7.6–8.0), mean random glucose was 11.2 mmol/l (10.7–11.7), and median (IQR) duration of diabetes was 7 years (3–14). In both cohorts, 51% were current or ex-smokers. Diabetic subjects had more comorbidities than control subjects (mean 2.5 vs. 1.9, $P < 0.0001$), especially cardiovascular disease (Table 1).

There were significant differences in

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Abbreviations: COPD, chronic obstructive pulmonary disease; IQR, interquartile range.

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Table 1—Comorbidities and complications in older people with diabetes (case subjects) and control subjects

	Case subjects	Control subjects	OR (95% CI)	P
n	403	403		
Age (years)	75 ± 7.1	75 ± 6.9		
Male sex	197 (49)	197 (49)		
BMI (kg/m ²)	27.6 ± 4.8	26.5 ± 4.4		
Hypertension	170 (42)	136 (34)	1.44 (1.08–1.93)	0.012
Myocardial infarction	83 (21)	42 (10)	2.23 (1.49–3.35)	<0.0001
Peripheral vascular disease	150 (38)	78 (19)	2.50 (1.80–3.46)	<0.0001
History of dementia	30 (7)	22 (5)	1.39 (0.79–2.46)	0.252
Stroke	89 (22)	49 (12)	2.04 (1.39–3.00)	0.0002
Peripheral neuropathy	184 (46)	99 (25)	2.63 (1.93–3.58)	<0.0001
History of osteoarthritis	165 (41)	177 (44)	0.89 (0.67–1.18)	0.427
History of COPD	91 (23)	101 (25)	0.87 (0.63–1.21)	0.409
History of cancer	56 (14)	42 (10)	1.4 (0.91–2.14)	0.125
History of Parkinson's disease	9 (2)	4 (1)	2.28 (0.69–7.48)	0.162

Data are means ± SE and n (%).

the distribution of Barthel scores between cohorts (case subjects median 20 [IQR 17–20], control subjects 20 [19–20], $P < 0.0001$). The main differences were seen at the lower end of the Barthel score, with 4 versus 1% being highly dependant (Barthel 0–5) and 4 versus 2% being moderately dependant (Barthel 6–11).

Significant differences were seen in mobility measured by the Nottingham extended activities of daily living scale; median (IQR) for subjects with diabetes 0.5 (0–1) compared with 5 (3–6) for control subjects ($P < 0.0001$).

Subjects with diabetes were more likely to use a mobility aid than control subjects: 7 versus 2% used a wheelchair regularly, 7 vs. 3% a frame, and 33 vs. 26% a walking stick. Overall, 187 of 403 of case subjects (46%) compared with 125 of 403 control subjects (31%) used some form of mobility aid ($P < 0.0001$).

There were significant differences in the physical function domain of the SF36; the median (IQR) SF36 for physical function was 60 (30–85) in control subjects versus 40 (10–70) in those with diabetes ($P < 0.0001$).

Mobility limitation

We ascribed use of a mobility aid as a marker of perceived mobility limitation. In a multivariate model controlled for age, hypertension, cerebrovascular disease, COPD, cancer, osteoarthritis, and dementia, diabetes remained significantly associated with mobility limitation: OR (95% CI) 2.10 (1.50–2.83) ($P < 0.001$).

CONCLUSIONS— The main findings of this study are a reduction in phys-

ical function and health status in patients with diabetes compared with age- and sex-matched control subjects living in the same community. Along with our previous findings of impaired cognition in this cohort (8), we have provided additional evidence of the impact of diabetes on global function.

Likely explanations for lower-limb dysfunction are peripheral neuropathy and peripheral vascular disease caused by diabetes. Other important contributors to mobility limitation include age, hypertension, cerebrovascular disease, COPD, cancer, osteoarthritis, and dementia.

There is growing recognition that older people with diabetes have needs over and above those related to management of the metabolic disturbance and its complications alone, in particular relating to lower-limb mobility and function (1,016). The increase in functional limitation in diabetes seen in this study is similar to that reported in studies from the U.S. (1,012) (17,18) and Hong Kong (19); one previous study from Norway has also shown a link between lower-limb disability and quality of life (20).

There is a growing body of evidence demonstrating that physical activity, in particular resistance training (21), is a key component in the management of diabetes in older people, and it is likely that exercise will have benefits both in terms of metabolic control and improving daily function, especially mobility. Older people with diabetes are at increased risk of falls, through mechanisms such as lower-limb dysfunction, cardiovascular disease, polypharmacy, and impaired balance (22). There is robust clinical evidence

supporting the role of targeted exercise programs (23) and comprehensive geriatric assessment (16,24) and interventions in falls prevention. Given the multifactorial problems facing the older person with diabetes, it would seem reasonable to recommend a comprehensive intervention, similar to that used in falls prevention programs (25).

References

1. Sinclair AJ, Barnett AH: Special needs of elderly diabetic patients. *BMJ*:1142–1143, 1993
2. Gregg EW, Engelgau MM, Narayan V: Complications of Diabetes in Elderly People. *BMJ* 325:916–917, 2002
3. Maddigan SL, Feeny DH, Majumdar SR, Farris KB, Johnson JA: Understanding the determinants of health for people with type 2 diabetes. *Am J Public Health* 96: 1649–1655, 2006
4. World Health Organization: *Diabetes Mellitus: Report of a Study Group*. Geneva, World Health Org., 1985 (Tech. Rep. Ser., no. 727)
5. Mahoney FI, Barthel DW: Functional evaluation: the Barthel index. *Md State Med J* 14:61–65, 1965
6. Lincoln NB, Gladman JRF: The extended ADL scale: a further validation. *Disabil Rehabil* 14:41–43, 1992
7. Lyons RA, Perry HM, Littlepage BNC: Evidence for the validity of the SF-36 questionnaire in an elderly population. *Age Ageing* 23:182–184, 1994
8. Sinclair AJ, Girling AJ, Bayer AJ: Cognitive dysfunction in older subjects with diabetes mellitus: impact on diabetes self-management and use of care services. *Diabetes Res Clin Pract* 50:203, 2000
9. Sinclair AJ, Bayer AJ, Girling A, Woodhouse K: Older adults, diabetes mellitus

- and visual acuity: a community-based case-control study. *Age Ageing* 29:335–339, 2000
10. Gregg EW, Beckles GL, Williamson DF, Leveille SG, Langlois JA, Engelgau MM, Narayan KM: Diabetes and physical disability among older U.S. adults. *Diabetes Care* 23:1272–1277, 2000
 11. Volpato S, Blaum C, Resnick H, Ferrucci L, Fried LP, Guralnik JM: Comorbidities and impairments explaining the association between diabetes and lower extremity disability: the Women's Health and Aging Study. *Diabetes Care* 25:678–683, 2002
 12. Volpato S, Ferrucci L, Blaum C, Ostir G, Cappola A, Fried LP, Fellin R, Guralnik JM: Progression of lower-extremity disability in older women with diabetes: the Women's Health and Aging Study. *Diabetes Care* 26:70–75, 2003
 13. Wang L, van Belle G, Kukull WB, Larson EB: Predictors of functional change: a longitudinal study of nondemented people aged 65 and older. *J Am Geriatr Soc* 50:1525–1534, 2002
 14. Seeman TE CP, Berkman LF, Tinetti ME, Guralnik JM, Albert M, Blazer R, Rowe JW: Predicting changes in physical performance in a highfunctioning elderly cohort: Macarthur Studies of successful aging. *J Gerontol* 49:M97–M108, 1994
 15. Roos NP, Havens B: Predictors of successful aging: a twelve-year study of Manitoba elderly. *Am J Public Health* 81:63–68, 1991
 16. Gregg EW MC, Cauley JA, Thompson TJ, Schwartz AV, Ensrud KE, Nevitt MC: Study of Osteoporotic Fractures Research Group: diabetes and incidence of functional disability in older women. *Diabetes Care* 25:61–67, 2002
 17. Al Snih S, Fisher MN, Raji MA, Markides KS, Ostir GV, Goodwin JS: Diabetes mellitus and incidence of lower body disability among older Mexican Americans. *J Gerontol A Biol Sci Med Sci* 60:1152–1156, 2005
 18. Centers for Disease Control and Prevention: Mobility limitation among persons aged ≥ 40 years with and without diagnosed diabetes and lower extremity disease—United States, 1999–2002. *MMWR* 54:1183–1186, 2005
 19. Chou K-L, Chi I: Functional disability related to diabetes mellitus in older Hong Kong Chinese adults. *Gerontology* 334–339, 2005
 20. Ribu L, Hanestad BR, Moum T, Birkeland K, Rustoen T: A comparison of the health-related quality of life in patients with diabetic foot ulcers, with a diabetes group and a nondiabetes group from the general population. *Qual Life Res* 16:179–189, 2007
 21. Willey KA, Singh MAF: Battling insulin resistance in elderly obese people with type 2 diabetes: bring on the heavy weights. *Diabetes Care* 26:1580–1588, 2003
 22. Wallace C, Reiber GE, LeMaster J, Smith DG, Sullivan K, Hayes S, Vath C: Incidence of falls, risk factors for falls, and fall-related fractures in individuals with diabetes and a prior foot ulcer. *Diabetes Care* 25:1983–1986, 2002
 23. Gillespie LD, Gillespie WJ, Robertson MC, Lamb SE, Cumming RG, Rowe BH: *Interventions for Preventing Falls in Elderly People (Cochrane Review)*. Chichester, U.K., John Wiley & Sons, Ltd., 2004
 24. Stuck AE, Siu AL, Wieland GD, Adams J, Rubenstein LZ: Comprehensive geriatric assessment: a meta-analysis. *Lancet* 342:1032–1036, 1993
 25. Araki A, Murotani Y, Aoyagi Y: [Comprehensive geriatric assessment and treatment of elderly diabetic patients]. *Nippon Ronen Igakkai Zasshi* 39:396–399, 2002