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Prevalence of diabetes mellitus in elderly people in Canada: report from the Canadian Study of Health and Aging

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Abstract

Aims: to estimate the age-specific prevalence of diabetes mellitus in elderly people in Canada, and to examine the effect of method of ascertainment on the estimation of prevalence.

Method: three measures of diabetes were used in a secondary analysis of the Canadian Study of Health and Aging—a 1991 nation-wide cross-sectional study of the prevalence of dementia in a sample of 10 263 elderly subjects (aged 65-106 years).

Results: of community-dwelling subjects, 10.3% reported diabetes. Supplementing this information with clinical reports and random plasma glucose measurements increased the prevalence to 12.0% in the community, 17.5% in institutions and 12.4% overall.

Conclusion: diabetes is common in elderly people, although the prevalence falls in the very elderly. The method of ascertainment influences estimation of prevalence.

Keywords: *Canada, diabetes mellitus, prevalence*

Introduction

Diabetes mellitus is common in elderly people and is associated with disability, morbidity, and mortality [1-4]. There are nevertheless controversies about the epidemiology of diabetes in old age. In particular, prevalence estimates range almost twofold between 8.9% [5] and 16.6% [6]. The range may reflect differences in the age structure of the populations studied, whether institutionalized subjects were included, and differences in the methods of defining and reporting diabetes, although these explanations are subject to controversy. Some studies suggest that the prevalence of diabetes, following glucose intolerance, continues to increase with increasing age [5, 7-9], while others suggest a decline at very advanced ages [10-12]. Estimates of the extent to which diabetes is under-diagnosed in old people vary [10, 13-15].

The Canadian Study of Health and Aging (CSHA) was a large, representative population survey of elderly Canadians [16] which included detailed clinical examinations [17], and gathered data on diabetes mellitus. It provided a convenient opportunity to estimate the prevalence of diabetes in Canada, as well as to address the relationship between prevalence and age when very elderly people, including those in long-term care institutions, are studied. In earlier CSHA reports, diabetes has been found to be associated with institutionalization [18] and vascular cognitive impairment [19], but not with Alzheimer's disease [20].

We therefore report, in a secondary analysis: (i) an estimate of the prevalence of self-reported diabetes mellitus in elderly people in Canada and (ii) an assessment of the importance of method of ascertainment (self-report, clinical report, random plasma glucose testing) in estimating the prevalence of diabetes mellitus.

Methods

The CSHA

The CSHA, a nation-wide investigation of the epidemiology of dementia and of the health of elderly people, completed its first phase (CSHA-1) in May 1993. It had four objectives: (i) to estimate the prevalence of dementia, including Alzheimer's disease, (ii) to estimate risks for Alzheimer's disease, (iii) to describe the frequency and pattern of care-giving in dementia and (iv) to describe the health of elderly people. These first three objectives have been reported separately [16, 21, 22]; here we address the fourth objective.

Data collection for CSHA-1 was conducted in 1991-92. Subjects were seen both in the community and in long-term care institutions. The community survey used the Modified Mini-Mental State Examination as a screening instrument for cognitive impairment [23]. Subjects who screened positive and a random sample of those who screened negative were invited for a clinical assessment. In institutions, the high prevalence of dementia meant that screening was not necessary, and all subjects were approached for clinical examinations.

In the community, subjects were selected from comprehensive sampling frames across the country. In nine provinces, this consisted of the master registration file of beneficiaries of the provincial medical insurance plans, which provide universal coverage. In Ontario, the provincial enumeration records were used. In each instance, the sample was stratified by age cohort, with over-sampling of those aged 75-84 and 85+, and clustered by area. The sample came from 36 cities and their surrounding rural areas, and did not include the Yukon and Northwest Territories, Indian reserves or military units. Data were collected through interviews, corroborated by relatives, and from clinical examinations. Similar studies were carried out in institutions. The national refusal rate was 27.9% in the community (range between regions 18.3-38.2%) and 18.3% in institutions (range 8.4-26.3%).

Measures

The presence of diabetes can be inferred from four data sources: the screening interview (self-report), the clinical interviews, the medication list and the laboratory testing. Not all data are available for all subjects. For community subjects but not those in institutions, self-report data are available for all respondents, while clinical data are available for the 1614 community subjects who had a clinical examination and for all institutionalized subjects. Presence of diabetes was recorded in the clinical examination based on patient report, informant report or health record. In addition to the self-report data and information from the clinical histories, the use of insulin and oral hypoglycaemic medications was also recorded at the clinical interviews, so that we have three data sources for 1542 subjects. Finally, 696 subjects who had screening assessments and clinical examinations also had random venous plasma glucose levels determined (values >11.1 mmol/l were taken as evidence of diabetes [24]).

Analysis

The estimation of diabetes prevalence made use of the statistical programs developed at the University of Ottawa for estimating the prevalence of dementia in the CSHA. As detailed elsewhere [16], these sample weights account for stratification, clustering and regional variation in response bias. When sample weights are used to estimate population parameters (e.g. prevalence) the data are reported as weighted; when statements are reported for sample proportions, they are referred to as unweighted. When taking into account factors such as the impact of false-positive and false-negative reports, we will use the term 'adjusted'; 'unadjusted' refers to estimates based directly on weighted or unweighted data.

To compare the relationship between diabetes and other variables, we report adjusted odds ratios and 95% confidence intervals. To test relationships between sources of information we used Cohen's κ to examine the strength of the association and χ^2 to test its statistical significance. The acceptable chance of type I error was set at $P < 0.05$.

Results

The proportion of the community sample who reported having diabetes was 9.9%. The relevant prevalence estimates for the community population are: 10.2% (65-74), 9.8% (75-84) and 7.8% (85 and older). This self-report estimate does not include those who could not be screened due to visual or hearing impairment; among these 59 subjects who proceeded directly to a clinical examination, four had clinical evidence of diabetes. The resulting estimate of prevalence, based on self-report and substituted assessment when self-report was not available is 10.3%. The prevalence of diabetes in the elderly subjects, using the combination of self-report data from the community and clinical reports for those who could not be screened and those in institutions is 11.6% (Table 1). In institutions, diabetes was recorded in 13.0% of subjects.

The use of self-report data to estimate the prevalence of diabetes is problematic, as it potentially under-counts those in whom diabetes has not been diagnosed and over-counts those wrongly said to have diabetes. Table 2 presents the agreement between self-report data and the clinical assessment for those with normal

Table 1. Prevalence of diabetes, by residence, for elderly people using information from all sources

Source	Prevalence, by residence		
	Community	Institution	All
Self-report	9.9%	NA	N/A
Self-report, adjusted for false-negatives	10.1%	NA	N/A
Self-report plus assessment	11.2%	17.2%	11.6%
Self-report plus clinical assessment on random plasma glucose >11.1 mmol/l	12.0%	17.5%	12.4%

NA, not available.

cognitive function. Using the false-negative data to adjust the estimate increases the weighted community prevalence from 9.9 to 10.1%.

Both self-report and clinical data yield biased estimates, as they do not account for diabetes which has not been diagnosed. In the case of community-dwelling subjects, of the 700 subjects who had a random plasma glucose determination, self-report data were available for 696. The proportion in whom diabetes was known by self-report was 84/696 (12.1%) of whom 29 had a random plasma glucose level >11.1 mmol/l. (For further estimation of prevalence we will assume that the remaining 55 out of 84 subjects with a self-report of diabetes and a random plasma glucose ≤11.1 mmol/l, represent diabetic control and not a false-positive report. This seems reasonable given that 28 out of 55 were taking oral hypoglycaemic agents or insulin and 44/55 were recorded as having diabetes in the clinical examination.)

Of the 612 who were not known to have diabetes by self-report, 16 had a random plasma glucose >11.1 mol/l. Of these 16, a clinical diagnosis of diabetes had been made in two, leaving an apparent false-negative estimate of 14 out of 612 (2.3%); these data provide the basis for the relevant adjustment in Table 1. Of these 14 subjects, nine had cognitive impairment. One of these was in 65-74-year age group, seven in the 75-84-year group and one was in the 85 or older group.

Applying the false-negative proportion to adjust the weighted data yields an estimate of the prevalence of diabetes in the community of 10.1%. For the three age groups, the prevalence estimates are 10.3% (65-74), 10.1% (75-84) and 7.1 (85+).

In the case of the 1255 subjects in nursing homes, of the 719 who had a random plasma glucose determination, none had a glucose of >11.1 mmol/l. Of these 719, 67 (9.3%) had clinically defined diabetes mellitus. Thus no additional adjustment is required for this part of the population.

When the prevalence of diabetes [evaluated using information from all sources (self-report, clinical, random plasma glucose)] was related to age and gender, we found that in women the prevalence reaches a plateau after age 80 while in men, it rises to age 85 and then falls.

Table 2. Agreement between clinicians' assessment and self-reports of diabetes for community subjects ($n = 1542$)

Clinical assessment	Self-report	
	Present	Absent
Present	144	29
Absent	25	1344

$\kappa = 0.82$; $\chi^2 = 1043$; $P < 0.0001$.

Discussion

We found diabetes mellitus to be common in elderly people. While rising at earlier ages, the prevalence appears to plateau in very elderly women and to decline somewhat among very elderly men. The method of ascertainment (i.e. self-report/clinical assessment/random plasma glucose measurement) affected the estimation of prevalence, with the above methods each resulting in, respectively, higher estimates.

These data, however, need to be interpreted with some caution. As a secondary analysis, the data on diabetes are not as complete as we would have wished. For example, we did not perform glucose tolerance tests, which are more sensitive than random plasma glucose measures and thus would have resulted in a higher estimate of previously unrecognized diabetes. In addition, we did not distinguish between type I (insulin-dependent) and type II diabetes (non-insulin-dependent) diabetes, although it is likely that most of those reporting diabetes in this study are, in fact, type II diabetics. We also did not distinguish between obese and lean elderly diabetic patients, in whom different pathogenetic mechanisms appear to operate [25]. None of our analyses however, rests on such distinctions. Moreover, against these limitations is the large and representative nature of the sample and the combination of data from several sources.

Non-response, which in this study was close to 28%, is another potential source of bias in these data. Most [24, 26-28], but not all [29] Canadian surveys of elderly people in which the health of non-respondents has been investigated find that they tend to be less healthy than respondents. The result of such bias is to make estimates of disease parameters conservative.

Our estimate of the prevalence of diabetes in an elderly population is within the middle of the range of other estimates. The Framingham study reported a 10% prevalence of diabetes in those aged 65 years and older [5]. In that study, diabetes mellitus became more common as people aged, with the prevalence in the very elderly (85+) reaching 25% [5]. The National Health and Nutrition Examination Survey reported the prevalences of diabetes in a non-institutionalized sample of Americans aged 65-74 to be 9.1% for men and 8.8% for women [7]. Phillips *et al.*, using data from a representative sample of elderly residents of Rochester, MN, USA found that, for the same groups, the prevalence was 12.1% and 9.9% respectively, using self-reported data [8]. The US National Long Term Care Surveys found that the prevalence of diabetes in elderly people was 16.6%; this higher figure includes subjects in institutions [6]. A review of reports of the prevalence of diabetes in elderly populations in the USA and Europe concluded that, by excluding those in institutions, most current surveys underestimate the true prevalence of diabetes in the elderly [1]. Our data however, although including institutionalized subjects, do not give substantially higher estimates, despite the role of diabetes as an independent risk factor for institutionalization [18].

Some of the studies which report that diabetes persistently increases with age have not included very elderly subjects (over 75 or 79 years) [9, 15]. As noted, other investigators have reported that, while the prevalence of type II diabetes increases with age, it is lower in very elderly subjects [10-12]. Muggeo *et al.* found that diabetes prevalence sharply increased after age 35, until age 79 when it began to decline [12]. They found the peak prevalence to be 10% in men aged 65-69 and 11.5% in women aged 75-79. In subjects over 84 the prevalences were 6.6% for men and 7.8% for women. Similar results were found by Laakso and Pyorala [11]. They also found that the prevalence of diabetes peaked before age 75: for men at 65-69 (5%) for women at 70-74 (10%). In those aged 80 or above, the prevalences declined to approximately 3% (men) and 8.5% (women).

The reasons for the decline of diabetes mellitus are not clear. Perhaps a healthy survivor effect operates. This might also account for the seeming paradox that glucose intolerance increases with age, a step which may precede the onset of frank diabetes by some years [15, 30]. Those with glucose intolerance may be especially at risk for adverse health outcomes and thus do not live long enough to express the natural history of their disease. This speculation is in keeping with the proposal by Buchner and Wagner that frailty is signalled by impaired metabolic control, so that frail people with impaired glucose tolerance do not live long enough to become frankly diabetic [31]. Elucidation of this disease in late life may therefore require a more broadly based understanding of how dynamic regulatory mechanisms change with age [31-34].

Key points

- Diabetes is common in elderly people but the prevalence falls in the very elderly.
- The method of ascertainment influences estimation of prevalence.
- Self-reports underestimate diabetes prevalence.

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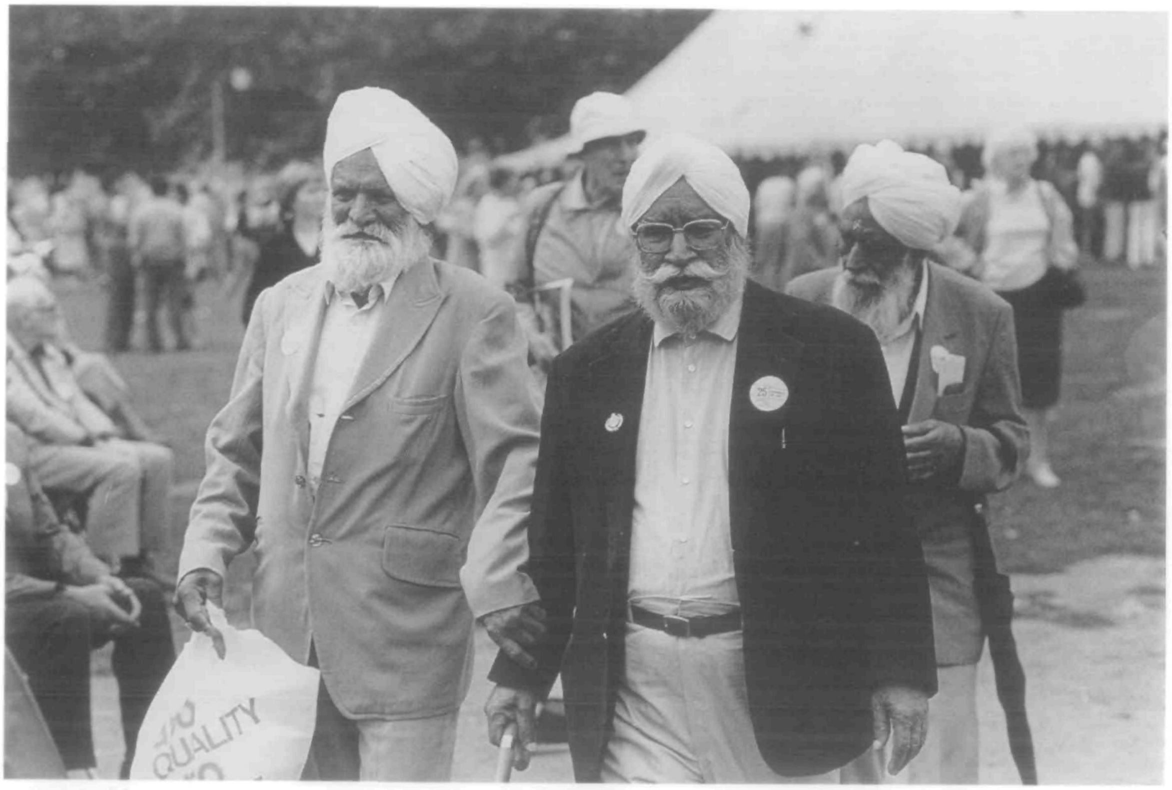

Pensioners demonstrate to complain of low pensions. © Sally and Richard Greenhill.