BRIEF REPORT

Prevalence of Diabetes Mellitus in the Province of Girona, Spain: the REGICOR Study

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Our aim was to determine the prevalence of diabetes mellitus in the 25-to-74-year-old population in the province of Gerona, Spain. History of known diabetes mellitus was recorded, and fasting glycemia was measured in venous blood. The 1997 diagnostic criteria of the American Diabetes Association were used. Crude prevalence of known diabetes mellitus was 10.0%, and age-standardized prevalence was 7.7% (95% confidence interval [CI], 7.3%-8.1%). Crude prevalence of impaired fasting glucose was 8.6%, and age-standardized prevalence was 7.6% (95% CI, 7.25%-8.1%). Crude prevalence of known diabetes mellitus combined with diabetes mellitus according to glycemia value (total prevalence of diabetes mellitus) was 13.0%, and age-standardized prevalence was 10.0% (95% CI, 9.6%-10.5%). A higher prevalence in men and an increase in prevalence with age were observed. The figures are different from those of other studies in Spain.

Key words: *Diabetes mellitus. Risk factors. Population. Epidemiology.*

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Prevalencia de diabetes mellitus en la provincia de Girona, España: el estudio REGICOR

El objetivo fue determinar la prevalencia de diabetes mellitus en la población de 25 a 74 años de la provincia de Girona. Se obtuvieron los antecedentes personales de diabetes mellitus conocida y la glucemia en ayunas en sangre venosa. Se aplicaron los criterios diagnósticos de la American Diabetes Association de 1997. La prevalencia cruda de antecedentes de diabetes mellitus fue del 10% y la estandarizada por edad del 7,7% (intervalo de confianza [IC] del 95%, 7,3-8,1). La prevalencia cruda de glucosa alterada en ayunas fue del 8,6% y la estandarizada por edad del 7,6% (IC del 95%, 7,2-8,1). La prevalencia cruda de antecedentes de diabetes mellitus conocida más la definida por glucemia (prevalencia total de diabetes mellitus) fue del 13% y la estandarizada del 10% (IC del 95%, 9,6-10,5). Se observó una mayor prevalencia en varones y un aumento con la edad. Estas cifras difieren de las obtenidas en algunos estudios realizados en España.

Palabras clave: *Diabetes mellitus. Factores de riesgo. Población. Epidemiología.*

INTRODUCTION

Diabetes mellitus (DM) is one of the main cardiovascular risk factors in the general population and a predictor of a poor prognosis and death in patients with established cardiovascular disease.[1] The prevalence of DM is increasing worldwide and current projections suggest it will continue to rise until 2025.[2]

Better understanding over recent years of conditions associated with DM, such as obesity and insulin resistance, has led to increased interest in the disorder and its impact on cardiovascular disease. Based on just one study,[3] scientific societies recommend the use of secondary preventive measures for cardiovascular disease in persons with DM, even in the absence of known heart disease. In this study, the death rate from coronary heart disease in diabetic subjects without known ischemic heart disease was similar to that of non-diabetic patients with a history of myocardial infarction. However, caution should be exercised when extrapolating these recommendations to patients in our area, as more recent studies undertaken in other populations have failed to reproduce the same results.[4]

ABBREVIATIONS

DM: diabetes mellitus.
ADA: American Diabetes Association.
CI: confidence interval.
WHO: World Health Organization.
IGT: impaired glucose tolerance.
OGTT: oral glucose tolerance test.
IFG: impaired fasting glycemia.
REGICOR: Registre Gironí del Cor.

Several criteria exist for the definition and diagnosis of DM. In 1985, the World Health Organization (WHO) established criteria based on impaired fasting glycemia (IFG) and impaired glucose tolerance (IGT), as measured by the oral glucose tolerance test (OGTT).[5] In 1997, the American Diabetes Association (ADA) established new criteria based on IFG without the need for an OGTT. The ADA considered that fasting glucose levels were altered when blood glucose levels were 110-125 mg/dL and that DM was present when they were ≥126 mg/dL.[6] In 1999, the WHO revised its 1985 criteria and retained the use of the OGTT.

Several epidemiological studies in Spain have established the prevalence of DM at 6%-10%, depending on age and study population.[7] Almost all these studies used the 1985 WHO criteria. The aim of this study was to use the 1997 ADA criteria to determine the prevalence of DM in a population with a known incidence of acute myocardial infarction.

PATIENTS AND METHODS

The REGICOR study established the incidence of acute myocardial infarction[8] and the prevalence of cardiovascular risk factors in the province of Girona, in northeast Spain.[9] The latter was established in a cross-sectional study undertaken in 1995 and 1996 in a random representative sample of 1748 persons. The study involved different stages, with the random selection of 33 towns and later the random selection of 3000 persons aged 25-74 years. The cohort was stratified by age decade and by sex (10 strata). The modified 1997 ADA diagnostic criteria were used for the present study.[6] The glycemia level was obtained from one blood sample stored in vacuum tubes with a separating gel. After 30-45 min at room temperature, the sample was centrifuged, aliquotted, and immediately frozen at –120°C in liquid nitrogen. The glycemia measurement was made in an aliquot of serum no more than 15 days later. The whole transport process of the samples was in accordance with the quality standards for storing biological samples.

The response rate and participation were 72%. Telephone interviews with the majority of the non-participants revealed no differences in sex, age or the main medical history between participants and non-participants (data not shown). The methodology consisted of a health questionnaire which included a history of known DM. Participants were considered to have known DM when they reported that a doctor had diagnosed this disease or they were using insulin or oral antidiabetic agents. Participants with no history of DM were classified as diabetic when the single glycemia measurement showed a level >125 mg/dL.

Three groups were established: persons with a history of DM, persons with IFG (glycemia level of 110-125 mg/dL) and persons who, independently of a history of DM, had glycemia levels =126 mg/dL, which represented all persons with DM. The specific rates are presented by age groups and standardized for the world age distribution, with weighting of 4, 12, 11, 8, and 5 out of 50 for the age groups 25-34, 35-44, 45-54, 55-64, and 65-74 years, respectively.

RESULTS

Table 1 shows the crude prevalence rates for persons aged 25-74 years. The overall prevalence of a history of DM, according to the survey given to the participants, was 10.0%, 11.3% in men and 8.7% in women; the standardized rate was 7.7% (95% confidence interval [CI], 7.3-8.1). The overall prevalence of IFG (110-125 mg/dL) was 8.6%, 11.5% in men and 6.0% in women; the standardized rate was 7.6% (95% CI, 7.2-8.1). The overall prevalence of known DM or DM determined by glycemia levels (≥126 mg/dL), i.e. the overall prevalence of DM, was 13.0%, 14.9% in men and 11.2% in women; the standardized rate was 10.0% (95% CI, 9.6-10.5). In all categories there was a rising trend according to age and a greater prevalence in men. The adjusted rates for the three age groups between 35-64 years were 11.6% (95% CI, 10.5-12.8), 10.3% (95% CI, 9.3-11.3), and 15.3% (95% CI, 14.0-16.6), respectively.

Table 2 shows the characteristics of the participants grouped according to sex and the presence or absence of DM. The diabetic persons were older, had a greater body mass index and higher levels of lipids, fibrinogen, and glycemia.

DISCUSSION

A recent review of several studies undertaken in Spain during the 90s showed the prevalence of DM to be between 5.5%-18.7%.[7] The only study in Catalonia,[10] which used the WHO 1985 criteria in a representative sample of the population, determined

TABLE 1. **Crude Prevalence of a History of Diabetes Mellitus, Impaired Fasting Glucose and Overall Diabetes Mellitus***

Age, Years	History of DM		IFG, 110-125 mg/dL		Overall DM Found	
	Men	Women	Men	Women	Men	Women
25-34	1.4	2.6	4.2	2.0	1.4	2.6
35-44	4.2	2.6	7.7	5.1	7.7	3.1
45-54	11.6	6.0	15.0	7.5	14.5	8.0
55-64	16.9	14.7	16.4	5.9	23.0	18.6
65-74	20.7	17.7	12.4	9.5	25.4	24.1
25-74 crude	11.3	8.7	11.5	6.0	14.9	11.2

*DM indicates diabetes mellitus; IFG, impaired fasting glucose. Results are expressed as percentages.

that the overall crude prevalence of DM was 10.3%, the standardized rate was 6.3%, and that the rate of IGT was 11.6%. However, the participation in this study ranged between 57.7% for those who were studied and 42.3% for those who were interviewed by telephone. This study, like ours, showed an increasing prevalence with age but, unlike ours, no greater prevalence was found in men. Strangely, the study by Castell et al[10] found a lower prevalence of DM than our study, even though it included an older age group (74-89 years), from which a greater prevalence would be expected. The difference in the prevalence figures for overall DM between our study (standardized for age, 10.0%) and that of Castell et al[10] (6.3%) may be due to the different participation rates, methodological differences in the measurement of glycemia (venous compared with capillary blood, although both are accepted by the WHO) and, perhaps more importantly, the different diagnostic criteria for DM. Another cross-sectional study in the Canary Isles comparing the WHO and the ADA

criteria showed the crude prevalence rates for DM to be 18.7% and 15.9%, respectively.[11] Both these figures are higher than those seen in our study or in other studies carried out in mainland Spain.

Although the aim of the study was not to analyze and discuss the association of DM with cardiovascular risk factors, Table 2 shows that the diabetic persons had a worse risk profile (age, obesity, hypertension, dyslipidemia). This observation is not surprising and is consistent with the known association between DM and these risk factors.

Since the publication of the 1997 ADA criteria, concern has arisen about possible discrepancies between the figures for DM resulting from the application of these criteria or the 1985 WHO criteria (revised in 1999). An earlier study concluded that the 1997 ADA criteria underestimate the prevalence of DM.[12] However, contrary to what we expected, the prevalence was higher in our study than that of Castell et al.[10] Further debate concerns the epidemiological importance of IGT and IFG in the prediction of DM

TABLE 2. **Characteristics of the Participants***

	Non-Diabetic		Diabetic	
	Men, n (%)	Women, n (%)	Men, n (%)	Women, n (%)
Age, years	50.0 (13.9)	49.7 (13.4)	59.5 (10.4)	61.1 (10.5)
SBP	131.4 (19.0)	126.9 (20.8)	142.9 (17.5)	142.2 (18.4)
DBP	78.7 (10.9)	74.2 (11.9)	81.8 (9.8)	80.3 (9.8)
Hypertension†	266 (37.5)	285 (35.5)	80 (64.0)	68 (68.0)
Waist-to-hip ratio	0.920 (0.083)	0.814 (0.084)	0.961 (0.060)	0.874 (0.070)
BMI	26.4 (4.03)	26.1 (4.61)	27.9 (4.12)	29.4 (6.74)
Total cholesterol	221.6 (43.3)	221.2 (45.2)	228.9 (40.5)	235.2 (48.9)
HDL cholesterol	48.1 (13.8)	57.8 (14.2)	44.4 (15.0)	50.8 (14.2)
LDL cholesterol	150.5 (39.8)	145.5 (40.9)	155.4 (32.7)	158.6 (42.6)
Triglycerides	119.9 (82.1)	91.9 (45.9)	154.1 (163.8)	129.7 (69.5)
Lp(a)	0.366 (0.403)	0.363 (0.386)	0.418 (.427)	0.484 (.527)
Fibrinogen	296.3 (67.0)	313.5 (62.0)	321.9 (73.5)	326.4 (58.2)
Glycemia	98.6 (9.8)	94.1 (9.9)	144.5 (48.0)	157.1 (89.4)

*SBP indicates systolic blood pressure; DBP: diastolic blood pressure; BMI, body mass index; Lp(a), lipoprotein(a).
†Blood pressure >139/89 mm Hg or a history of antihypertensive therapy.

and possible poorly defined "prediabetic states," which are of great importance for the prevention of cardiovascular disease but about which no clear agreement exists. The prevalence of IGT in the study by Castell et al[10] was 11.6%, higher than that for IFG in our study, both the crude prevalence (8.6%) and the age-standardized prevalence (7.6%). A study undertaken in several European countries, which did not include Spain, concluded that IFG is less predictive of mortality than IGT.[13] These discrepancies suggest the desirability of homogenizing concepts and criteria in this field, in order to facilitate comparison of results.

One limitation of our study is that participants with no history of DM were classified as diabetic after only one blood glucose test >125 mg/dL. This method should be considered only an indirect measurement of the true situation.

The standardized prevalence rate of DM in the province of Girona was 13.0% (crude rate, 10.0%) in persons aged 25-74 years; it was greater in men than women and increased with age. This figure differs from those of other cross-sectional studies in our area. The age-standardized prevalence of IFG in our population was 7.6% (crude, 8.6%). Diabetic persons of both sexes had a more unfavorable cardiovascular risk profile than non-diabetic persons.

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