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Prevalence and risk factors of diabetes mellitus in the Isfahan city population (aged 40 or over) in 1993

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Abstract

The objective of this study was to estimate the prevalence of diabetes among people aged 40 or more and to compare selected factors such as systolic and diastolic blood pressure, body mass index and lipid profile in diabetic and non-diabetic subjects. This is a cross-sectional study of subjects aged over 40 in Isfahan. Selection of diabetic subjects were based on multi-stage random sampling. Diabetes status was defined by the World Health Organization criteria and was based on fasting plasma glucose and oral glucose tolerance test results. Data on age, body mass index, blood pressure and lipid profile were obtained. Results show that a total of 3910 eligible subjects were examined and classified into different diabetes status. The overall age-standardized prevalence of diabetes was 7.54% (95% CI: 6.24–8.84%) in males and 7.97% (95% CI: 6.75–9.19%) in females with no difference. Similarly, the overall age standardized prevalence was 7.76% (95% CI: 6.87–8.65%). The prevalence of diabetes was shown to increased in the older age groups. Multiple logistic regression analysis showed that age, systolic blood pressure, hypertriglyceridemia, being overweight and also obesity were independently associated with diabetes. A large number of newly-diagnosed diabetic subjects were identified, which necessitates powerful screening programs. High levels of blood pressure, body mass index and lipid profile should draw attention to probable presence of diabetes. © 1997 Published by Elsevier Science Ireland Ltd.

Keywords: Body mass index; Lipid profile; Systolic blood pressure

1. Introduction

Prevalence of diabetes is reported to range widely from less than 1 in Mapuche Indians to almost 50% in Pima American Indians [1]. Other epidemiologic studies have also shown that the

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prevalence varies widely [2,3]. This very wide range seems to be the result of differences in distribution of age, race, nutritional habits, patients' physical activity, study design, certain risk factors such as obesity and environmental factors selectively affecting those with a susceptible genotype [4–6].

An increase in the number of individuals has been reported in recent decades [7], a large proportion of which are NIDDM patients. This increase may in part be due to demographic and social transition [3], linked with industrialism in Iran, where a few limited programs for controlling diabetes have been started since 1970. Special attention has been paid to these programs after establishing the Iranian Diabetes Association (IDA) and Endocrine and Metabolism Research Center of Isfahan in May 1991, concentrating on screening of diabetes in the community, registering patients' general and clinical data, teaching and treating the diabetics, controlling their complications and performing basic and community based research all over the country. Along with the preventive and health care policies, the Endocrine and Metabolism Research Center of Isfahan examined diabetes prevalence and showed some of its independent risk factors among the 40 year old or more subjects, in Isfahan in 1993.

2. Materials and methods

This is a cross-sectional population-based study conducted in Isfahan, during a 6-month period, from June to December 1993. According to the 1991 census, the population of Isfahan consisted of 1 127 030 subjects. In the country as a whole, 17.6% of the subjects are aged over 40 and the percentage is roughly equal in Isfahan [8]. The population targeted were people in the city of Isfahan aged over 40. Isfahan city was divided into 41 equal clusters in which house to house systematic sampling was performed. Finally, about 100 subjects were selected based on simple random sampling from the selected houses in each cluster. The selected subjects are representative of the general population of Isfahan aged over 40, based on multi-stage random sampling. So, 4086 subjects were selected for the subsequent steps, but 3910 subjects (95.7% participation rate) were classified at the end.

The screening of diabetes is compatible with the American Diabetes Association recommendations for diabetes screening programs [9] and the diagnosis of diabetes is based on World Health Organization (WHO) criteria [10]. The self reported diabetes was used when a doctor had told the patients, or the patients were on oral hypoglycemic agents or insulin treatment. Diabetes was considered not to be present in subjects whose first fasting plasma glucose levels were less than 6.4 mmol/l, except for those with self-reported diabetes. The final classification of the subjects with fasting plasma glucose higher than 6.4 mmol/l were based on standard oral glucose tolerance test (OGTT) with 75 g of glucose in a 330 ml solution, if the second fasting test did not classify the subjects as diabetics. From 201 subjects who were supposed to be checked for OGTT, 58 were missed, due to refusing further studies. They were not considered in the final analysis. Similarly, 67 subjects who did not participate in the second fasting tests, were not considered in the analysis.

Data collection through clinical examination and a structured questionnaire were carried out by specially trained interns of the medical university of Isfahan between 08:00 and 18:00 h Saturday through Thursday and were conducted at least on 2 subsequent days. On the first day, data collection included asking age, sex, probable presence of diabetes treatment and measurements of weight, height and blood pressure. Weight was measured in light garments and without shoes and blood pressure according to the Hypertension Detection and Follow-up Program Protocol [11], so that the subjects underwent sitting blood pressure measurement on three different occasions after a 10-min rest. The mean of the three different occasions were used in the analyses. Hypertension was defined as systolic or diastolic blood pressure higher than 160 or 90 mmHg, respectively, or past history of it. BMI was classified into lean, normal, overweight, obese and very obese, with their own ranges shown in Table 3. On the second day a venous blood sampling was drawn from the ante-

Table 1
Age- and sex-specific and standardized prevalence of diabetes mellitus in Isfahan survey—1993.

	Male			Female		
	Total	Diabetes	(%)	Total	Diabetes	(%)
Age groups (years)						
40–49	660	42	(6.4)	1041	60	(5.8)
50–59	460	30	(6.5)	603	45	(7.5)
60–69	407	44	(10.8)	380	44	(11.6)
Over 70	186	13	(7.0)	173	18	(10.4)
Age standardized prevalence (%)			7.54			7.97
95% CI			(6.24–8.84)			(6.75–9.19)

CI, confidence interval.

cubital vein after an 8 h period of fasting, to determine the levels of glucose, total cholesterol and triglyceride. Hypertriglyceridemia (HT) and hypercholesterolemia (HC) were defined as levels higher than 2.2 and 6.2 mmol/l, respectively. The venous whole blood was drawn into tubes containing oxalate-fluoride because of protective effects of fluoride against breakdown of glucose [12]. Plasma glucose, cholesterol and triglyceride were determined on the same day, respectively, with glucose-oxidase, Liebermann–Buchard and enzymatic assay by RA-1000 auto-analyzer, in the central Isfahan laboratory. If the fasting time was less than 4 h or the blood samples for 2 h post-challenge plasma glucose were drawn more than 5 min too early or too late, or if the blood samples were hemolyzed, the glucose values were not accepted so these subjects underwent a repetitive fasting or OGTT.

Sex- and age-standardized prevalence were calculated using 10 year age groups and the 'Iran Standard Population' [8]. Confidence intervals (CI) of 95% were calculated assuming a normal distribution. The differences between normal subjects, glucose intolerance and diabetic subjects were showed with analysis of variance (ANOVA) and the correction of threshold for statistical significance for multiple comparisons were performed with the Tukey-B multiple range test [13]. Logistic regression analysis with forward stepwise method was used to determine the independent predictors of diabetes [14].

3. Results

The crude rate of diabetes among our samples was 7.5% for males and 7.6% for females. The age-, sex-specific and standardized prevalence of diabetes is presented in Table 1. The overall age-standardized prevalence was 7.76% (95% confidence interval (CI) of 6.87 through to 8.65%).Therefore, age-standardized prevalence was shown not to be statistically different. The number of new and known diabetic subjects was 139 and 157, respectively, (ratio: 0.90). Increasing prevalence of diabetes is observed in older age groups (χ^2: $P < 0.0001$). Mean of age, BMI, blood pressure, serum lipids, fasting plasma glucose and frequency distribution of hypertension, dyslipidemiia and different categories of BMI are presented in Tables 2 and 3. Correlation between diastolic hypertension and hyperlipidemia was significant (Spearman: $r = 0.1$, $P < 0.0001$). Logistic regression analysis shows that only yearly increments of age (Odds ratio = 1.02, 95% CI = 1.01–1.03, $P = 0.004$), being overweight compared with lean status (OR = 3.22, 95% CI = 1.66–6.27, $P < 0.001$), obesity compared with lean status (OR = 2.50, 95% CI = 1.21–5.13, $P = 0.013$), HT (OD = 2.73, 95% CI = 2.17–3.54, $P < 0.001$) and each 10 mmHg increment of systolic blood pressure (OR = 1.06, 95% CI = 1.01–1.12, $P = 0.028$) are independently associated with diabetes, after being adjusted for sex, HC and diastolic blood pressure. Hence, the logistic regression model was better defined without an interaction term.

Table 2
Mean and SD of age, BMI, blood pressure, fasting blood glucose and serum lipids in the subjects in Isfahan survey—1993.

Variables	Normal		IGT		Diabetes	
	Mean	SD	Mean	SD	Mean	SD
Men:						
n		1558		26		129
Age (years)	54.5	10.8	53.6	11.5	56.2	9.5
BMI (kg/m^2)	24.5	3.8	26.5	3.4***	25.9	4.1***
Systolic BP (mmHg)	132.0	20.0	145.2	22.4***	138.0	22.9***
Diastolic BP (mmHg)	82.0	12.0	88.4	13.4*	84.4	14.6*
FPG (mmol/l)	5.0	1.2****	6.8	0.3****	10.1	3.9****
Cholesterol (mmol/l)	5.5	1.2	5.8	1.3	5.8	1.2**
Triglyceride (mmol/l)	2.3	1.5	2.7	1.7	3.0	2.2***
Women:						
n		1998		32		167
Age (years)	51.7	10.4	53.7	11.1	54.7	10.2***
BMI (kg/m^2)	25.9	4.7	27.2	5.0	26.7	4.3**
Systolic BP (mmHg)	133.0	24.0	139.0	28.0	144.3	25.6***
Diastolic BP (mmHg)	82.0	17.0	83.2	14.0	86.0	13.0*
FPG (mmol/l)	5.0	1.2****	6.9	0.3****	9.8	4.2****
Cholesterol (mmol/l)	5.7	1.4	6.2	1.3	6.2	1.5***
Triglyceride (mmol/l)	2.2	1.3	3.2	2.6***	3.1	2.0***

SD, Standard deviation; BMI, Body mass index; FPG, Fasting plasma glucose; BP, Blood pressure.
The correction of threshold for multiple comparisons were performed with Tukey-B multiple range test and the levels of significance were as follows: * $P<0.01$ comparison with normal group; ** $P<0.05$ comparison with normal group; *** $P<0.001$ comparison with normal group; **** $P<0.001$ difference in all groups.

4. Discussion

Although a very low prevalence of diabetes in France [15] and a very high prevalence of diabetes among American Indians [16] have been reported before, most reports from different parts of the world show the prevalence to be in the range of about 5–12% [17–23]. The prevalence of diabetes in our country is similar to those in other parts of the world and should be indicated as a health priority among the population aged over 40 in Isfahan. In some reports, the prevalence of newly diagnosed diabetes was considerably less than known diabetes [17,20,22], but in this study it was approximately equal. Similar results are presented by other reports [16,18,19,21,22]. This finding necessitates conducting powerful screening programs.

In this study, it was observed that the subjects within the 40–49-year old age group, showed the least prevalence of diabetes. The prevalence increased per age group, so that age was considered to be an independent risk indicator of diabetes. The above mentioned reports have also emphasized the increment of diabetes prevalence in older age groups [16,18,19]. Other studies have also reported that there is an increased risk of diabetes in overweight and obese subjects [16,18,24] and could be due to insulin resistance syndrome [25]. Lack of association between the very obese group and diabetes is due to the small number of subjects in this group.

Mean of cholesterol was higher in diabetics compared with normal subjects, but the distribution of HC was not different among the three groups. Mean of cholesterol was the same in IGT and diabetics, but lack of significant difference between mean of cholesterol of IGT group compared with that of normal subjects is due to the small number of IGT subjects. The interesting findings in this study are the high prevalence of HC and HT and high mean values of cholesterol

Table 3
Frequency distribution of BMI patterns, hyperlipidemia and hypertension in Isfahan survey—1993

Variables	Normal		IGT		Diabetes	
	n	(%)	*n*	(%)	*n*	(%)
BMI						
<20 (kg/m^2)	324	(9.1)	3	(5.2)	10	(3.4)*
20–24.9 (kg/m^2)	1521	(42.8)	15	(25.9)**	83	(28.0)**
25–29.9 (kg/m^2)	1262	(35.5)	26	(44.8)	157	(53.0)**
30–39.9 (kg/m^2)	435	(12.2)	14	(24.1)*	45	(15.2)
>40 (kg/m^2)	14	(0.4)	–	–	1	(0.3)
Systolic hypertension	500	(14.1)	15	(25.9)**	61	(20.6)**
Diastolic hypertension	1291	(36.3)	22	(37.9)	109	(36.8)
Overall hypertension	1377	(38.7)	25	(43.1)	117	(39.5)
Hypercholesterolemia	979	(27.5)	24	(41.4)	92	(31.1)
Hypertriglyceridemia	1400	(39.4)	29	(50.0)	199	(67.0)**-***

SD, Standard deviation; BMI, Body mass index.
The correction of threshold for multiple comparisons were performed with Tukey-B multiple range test and the levels of significance were as follows: * $P<0.01$ comparison with normal group; ** $P<0.001$ comparison with normal group; *** $P<0.001$ comparison with IGT.

and triglycerides even in normal subjects, which are compatible with previous researches in Isfahan [26,27]. On the other hand, there is some evidence that supports the linkage between prevalence of diastolic hypertension with hyperlipidemia, such as significant association between diastolic hypertension with HC or HT. In addition, their roughly similar prevalence and their equal distribution among the three groups, except for HT in diabetics, support this linkage. The association of diastolic borderline hypertension with abnormal lipid profile has also been shown by another study [28]. The mechanism could be the process of atherosclerosis. On the other hand systolic hypertension does not appear to be under the direct influence of dyslipidemia, so compared with diastolic hypertension, it is less prevalent and its significant association with diabetes can be explained by other known mechanisms [25,29].

HT is an expectant finding in diabetes and may be due to both overproduction of very low density lipoproteins in the liver and a disposal defect in the periphery [30], so that its prevalence is even higher in diabetics compared with IGT or normal subjects. Although subjects with HT are 2.7 times more likely to have diabetes, neither hyperlipidemia nor hypertension have necessarily causal effects. However, the association is well established in this study and several other studies [24,25,29,31]. Finally, the presence of independent predictors of diabetes should draw attention to probable presence of diabetes.

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