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ABSTRACT Previous studies on type 2 diabetes mellitus in the Islamic Republic of Iran were mainly performed in provinces with large populations. This study determined the prevalence and risk factors of diabetes mellitus in an adult population (40–80 years old) from Yazd district. Multistage, systematic cluster random sampling was used in a cross-sectional, population-based survey. Demographic, clinical and anthropometric data were collected, with diabetes defined as fasting blood sugar ≥ 7 mmol/L or a positive medical history of diabetes. The age- and sex-standardized prevalence of diabetes in 2090 individuals participants was 24.5% (95% CI: 22.2–26.8%), including 10.5% new cases. For each year of ageing, the

prevalence of diabetes increased significantly by 4% and this trend was more pronounced in females than males. Low education and hypertension were significantly associated with diabetes prevalence. The prevalence of diabetes mellitus in Yazd is greater than the average levels nationwide and those of nearby countries.

Prévalence et facteurs de risque du diabète sucré dans un district du centre en République islamique d'Iran : étude populationnelle chez des adultes âgés de 40 à 80 ans

RÉSUMÉ Les études antérieures sur le diabète sucré de type 2 en République islamique d'Iran ont été principalement menées dans des provinces très peuplées. La présente étude a déterminé la prévalence et les facteurs de risque du diabète sucré dans une population d'adultes (40 80 ans) du district de Yazd. Un échantillonnage en grappes aléatoire et systématique à plusieurs degrés a été utilisé dans une enquête populationnelle transversale. Des données démographiques, cliniques et anthropométriques ont été recueillies, tandis que le diabète a été défini par un taux de glycémie supérieur ou égal à 7 mmol/L ou par des antécédents médicaux positifs pour la maladie. La prévalence du diabète normalisée pour l'âge et le sexe chez 2090 participants était de 24,5 % (IC à 95 % : 22,2–26,8 %), avec 10,5 % de nouveaux cas. Pour chaque année supplémentaire de vieillissement, la prévalence du diabète augmentait de 4 % et cette tendance était davantage marquée chez les femmes que chez les hommes. Un faible niveau d'études et une hypertension étaient significativement associés à la prévalence du diabète. La prévalence du diabète sucré à Yazd est supérieure aux niveaux moyens à l'échelle nationale et dans les pays voisins.

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Introduction

Diabetes mellitus is a prevalent noncommunicable disease worldwide with a high rate of early death in some countries (1). Diabetes affects the quality of life among productive, middle-aged people, and has even been associated with a higher suicide rate (2). Considering disability-adjusted life years, diabetes mellitus has been placed in third or fourth place in the ranking of the global burden of diseases (1) and is therefore considered a major health problem worldwide (3,4).

It has been estimated that the Eastern Mediterranean region (EMR) will have the highest increasing rate in the prevalence of diabetes mellitus after African countries (5). Among the EMR countries, the Islamic Republic of Iran has the second largest population after Pakistan and is predicted to have a high rate of increase in diabetes prevalence until 2030 (5). The economic burden of diabetes is high, accounting for about 10% of the Iranian national health budget (6).

Previous studies on type 2 diabetes mellitus in this country were mainly performed in Tehran and Isfahan: provinces with the highest populations (7–10). According to a meta-analysis of studies published between 1996 and 2004, the aggregated prevalence of diabetes mellitus in the population aged over 40 years was 24%, and based on the national health profile survey Yazd was identified as a location with a high prevalence of diabetes mellitus (7). The current survey was conducted to provide updated data on the trend of diabetes mellitus in Yazd, taking into account the specific traits of the inhabitants of this desert region in central Islamic Republic of Iran. The results will be beneficial for public health planning and as a baseline for comparison with future epidemiological studies.

Methods

This study was designed as a cross-sectional, population-based survey of residents of urban and rural areas of Yazd, an administrative district of Yazd province (population about half a million). The study was approved by the ethics committee of Shahid Beheshti University of Medical Sciences and the participants took part in the study after giving written informed consent.

Sampling

The methodology of sampling has been published previously (11). In summary, a multistage, systematic cluster sampling method was used to select a representative sample of the population of the survey area. According to a 2006 national census, the total population of Yazd was around 526 000. The list of all residential regions and blocks was obtained from the Iranian National Statistical Office and used as the sampling frame. Using a stratified and systematic sampling strategy and probability proportional to population density method, 58 clusters were

chosen from 251 different residential blocks with each cluster containing 40 persons. In each cluster, eligible samples were recruited with a compact segment sampling method. Finally, 2320 non-institutionalized urban and rural dwellers of Iranian nationality, aged 40–80 years, who had been living in the district for at least 6 months during the previous year were eligible to enter the study.

Diabetes identification

Initially, information was obtained about each person's self-reported history of being diagnosed with diabetes mellitus (by a physician) or being prescribed insulin or oral medication for diabetes (by a physician). Then, fasting blood sugar (FBS) was measured by the trained nurses who accompanied fieldwork teams to the participants' homes. The Accu-Chek® active glucose meter was used and a fingertip blood sample was taken by needleprick after an overnight fast of at least 8 h. At this stage, FBS was done for all participants who had no history of known diabetes mellitus or were not on insulin or oral diabetic medication. In the second stage, all subjects with diabetes mellitus and those with a FBS ≥ 5.94 mmol/L on the initial glucometry were referred to a specific laboratory where a venous blood sample was taken; participants were instructed to fast overnight prior to this test.

Other medical assessments

Blood pressure, weight, height and body mass index (BMI) of all participants were measured and their medical and medication histories were recorded.

The following blood tests were done in this stage: FBS, haemoglobin (Hb), haematocrit (Hct), glycosylated haemoglobin (HbA1c) and fasting serum lipids. A random urine sample was also obtained to measure the albumin/creatinine ratio of urine.

Definitions

Diabetes mellitus was defined as having 2 separate FBS ≥ 7 mmol/L or being already diagnosed with diabetes mellitus and/or being on insulin or anti-diabetes medication (12). The first and second FBS tests were measured during the home visit using a glucometer and at a specific laboratory from the venous blood sample respectively. The blood HbA1c level was measured in participants with diabetes mellitus to determine the average blood glucose and estimate glycaemic control during the previous 2–3 months (12). Impaired fasting glucose (IFG) was defined as FBG level > 6.11 and

The subjects were classified into 6 BMI groups: underweight (BMI 40 kg/m2).

Hypertension was defined as a systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg (15), a self-reported physician-diagnosed history of hypertension, or use of antihypertensive medication.

Analysis

Crude and adjusted prevalence proportions of diabetes and the 95% confidence intervals (CI) were reported as the main outcomes in this study. To compute the adjusted prevalence of diabetes among the survey area population, a direct standardization method was used. The age and sex distribution of the Yazd district population was obtained from the Iranian national census in 2006. Logistic regression was used to evaluate the univariate and multivariate relationships of different factors with diabetes considering the cluster design of the study. All statistical analysis was performed by Stata, version 12.0. P-values

Results

Background data

Overall 2320 persons were invited to participate, of whom 2098 agreed to enrol in the study (response rate of 90.4%). Later, 8 people did not complete the necessary tests for diabetes, giving a final sample of 2090 (response rate of 90.1%), including 1098 women (52.5%) and 992 men (47.5%) (Table 1).

Crude and standardized prevalence of diabetes mellitus

A total of 539 people were found to have diabetes mellitus, of whom 56 were new (unaware) cases. Thus the crude prevalence of diabetes mellitus in the whole sample was 25.8% (95% CI: 23.5–28.0%), comprising 2.7% (95% CI: 2.1–3.3%) new cases and 23.1% (95% CI: 20.9–25.3%) previously diagnosed (aware) cases of diabetes. The age- and sex-standardized prevalence of diabetes was 24.5% (95% CI: 22.2–26.8%) (Table 1).

Associations of demographic and clinical variables

The crude prevalence of diabetes was similar in women (26.0%; 95% CI: 23.2–28.7%) and men (25.6%; 95% CI: 22.4–28.8%) (Table 1). Diabetes was more prevalent in older age groups. For example, the crude prevalence of diabetes was 37.0% (95% CI: 30.6–43.4%) among those aged 70–80 years and 15.8% (95% CI: 12.7–18.8%) among those aged 40–49 years (Table 1). For each year of ageing, the rate increased by 4% (P Figure 1).

The standardized prevalence of diabetes was 24.0% (95% CI: 21.7–26.3%) in urban and 30.2% (95% CI: 22.29–38.17%) in rural populations (Table 1). However, based on a multivariate logistic regression model (Table 2), the relationship between area of residence and diabetes mellitus was not statistically significant [odds ratio (OR) 1.4; 95% CI: 0.9–2.0; P = 0.11].

A significant relationship was found between level of education and prevalence of diabetes (P

As shown in Tables 1 and 2, the prevalence of diabetes was nearly 4 times higher in people with hypertension compared to those without hypertension (43.1% versus 13.8%; OR 4.8; 95% CI: 3.9–5.8).

The relationship between diabetes prevalence and BMI is illustrated in Table 1 and Table 2 . Diabetes was significantly and consistently more common in obese subjects; the prevalence of diabetes mellitus rose steadily across BMI groups from 24.8% in normal weight people to 38.1% in obese class III.

The multivariate logistic regression model using a backward method applied to evaluate the simultaneous effect of all risk factors (Table 2), revealed that hypertension, older age, lower educational level and higher BMI were significantly associated with diabetes.

Impaired fasting glucose

IFG was found in 40 people, a standardized prevalence of 1.9% (95% CI: 1.3–2.5%). The prevalence of IFG was not significantly associated with sex (P = 0.91) or age (P = 0.24) in a multiple logistic regression analysis (Table 3).

Figure 2 illustrates the prevalence of daily physical activity by glycaemic status. The frequency of exercise or occupational-related activity was lower in the IFG group (10.5%) compared with the diabetes (26.5%) or normoglycaemic groups (25.5%). Compared with those with IFG, normoglycaemic people were 9 times more likely to have daily physical activity (OR = 8.9; 95% CI: 2.7–29.4). Patients with diabetes were 3 times more likely to be physically active (OR = 2.9; 95% CI: 0.9–9.1), although the relationship was not statistically significant

Laboratory findings

The laboratory test results of participants with diabetes and IFG are shown in Table 4 . The mean levels of haemoglobin and serum lipids were not significantly different comparing participants with diabetes and those with IFG (all P-values > 0.5). Nevertheless HbA1c and urine albumin levels were significantly higher in participants with diabetes than those with IFG (P

Disc

ussion

In situations in which routine data from a national information system are as yet unavailable it is important to conduct intermittent population-based studies to obtain updated information regarding the nation's health-care needs. In the current study, the prevalence of diabetes mellitus among the 40–80-year-old population in Yazd was found to be about 25%, which shows a high prevalence of this disease. This finding is consistent with previous reports from the Islamic Republic of Iran; at the national level a diabetes prevalence of 16.2% and 16.8% was found in the 45–54 and 55–64 year age groups respectively (16), while in the capital city, Tehran, diabetes prevalence was about 13% in the over 20-year-old population (8). In contrast, almost 2 decades before, the nationwide prevalence of diabetes was reported to be much lower, with an overall prevalence of 7.8% in those aged over 40 years (9), which is evidence for concern about a diabetes epidemic in this country. This finding could be related to many influences such as genetic and ethnic factors, inactive lifestyles and incorrect dietary habits.

Age-specific prevalence rates of diabetes in some neighbouring countries and also previous studies in the Islamic Republic of Iran are compared in Table 5 (8,16–20). As the table shows, the prevalence of diabetes in Yazd is greater than the average national level in Islamic Republic of Iran and those of the nearby countries. Conversely, it is comparable to the metropolitan urban population of the Islamic Republic of Iran (16).

In most studies, the prevalence of diabetes is higher in urban populations (16,21–23). Nevertheless, we observed a higher prevalence among participants living in rural areas. It should be mentioned that our classification of urban/rural settings was based on the Iranian National Statistical Office. The proportion of people living in rural areas in this district is relatively low compared with other districts and the people live closer to urban residential areas. This may have had some effect on their lifestyle and nutrition and consequently resulted in a higher prevalence of diabetes. Furthermore, other studies from Islamic Republic of Iran and a study in India have reported an increasing trend of diabetes among rural dwellers (24,25). Although this finding should be confirmed by more extended studies with higher sample sizes of rural populations, it may raise some concerns regarding the importance of preventive and management strategies in rural as well as urban settings in developing countries.

Although the total prevalence of diabetes was not significantly different between men and women, diabetes was more common in older women in this study, which illustrates that an interaction between age, sex and diabetes exists. This findings is not surprising because men have higher all-cause mortality rates than women at older ages. A systematic review showed a similar pattern in South Africa and among subjects with Indian ethnicity, but diabetes was significantly higher in men in the Middle and Eastern African countries (26). Further studies are

required to investigate the relationship of diabetes mellitus and sex.

In the current study the proportion of known cases of diabetes was relatively high and comprised more than 89% of the total cases with diabetes. This is an unusual finding because in previous studies from the Islamic Republic of Iran only 50–70% of patients were aware of their diabetes (21,27). It should be mentioned that a national programme for the prevention and control of type 2 diabetes was introduced and implemented in the Islamic Republic of Iran since 1996 (28,29). According to this programme, community members at-risk for diabetes are detected and periodically screened by the primary and secondary health-service providers in the different provinces including Yazd. This may explain the small proportion of undiagnosed diabetes in our study.

A correlation between diabetes and obesity has been confirmed by many large epidemiological studies (30), and such a relationship was observed in our study too. In addition, the statistically significant association between diabetes and hypertension in our study was consistent with previous studies in this field (31,32).

As in some other studies, in India (33), Germany (34) and Saudi Arabia (35), we found a correlation between lower education levels and higher prevalence of diabetes. This emphasizes the importance of health promotion and education programmes for illiterate or less educated people.

There were some limitations to the current study. Due to logistic and financial limitations, instead of 2 venous blood samples, the initial screening sample was obtained from a capillary vessel and tested by a valid glucometry method. Venous blood tests were only obtained from subjects with suspected or definite diabetes. To increase the sensitivity of diagnosis, all those with a FBS ≥ 5.94 mmol/L rather than FBS ≥ 6.94 mmol/L in glucometry were considered as suspected diabetes and a complete blood test was taken to confirm the diagnosis of diabetes mellitus. In addition, laboratory tests were only done for participants with diabetes mellitus. Therefore, it was not possible to compare biochemical metabolic risk factors such as dyslipidaemia, microalbumin and HbA1c among participants with and without diabetes. Finally, only people aged 40–80 years were recruited into this study. Due to the increasing number of young people with diabetes and the serious burden of early-onset diabetes mellitus, future surveys need to study the younger age groups too.

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