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ORIGINAL ARTICLE

Epidemiology of diabetes mellitus, pre-diabetes, undiagnosed and uncontrolled diabetes and its predictors in general population aged 15 to 75 years: A community-based study (KERCADRS) in southeastern Iran

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Abstract

Background: The goal of this research was to measure the age-sex standardized prevalence of pre-diabetes (pre-DM) and diabetes (DM), and the effectiveness of diabetes management (using HbA1C as the indicator) in an urban area in Iran.

Methods: Using a randomized cluster household survey, we recruited 5900 individuals whose age ranged from 15 to 75 from Kerman for assessing coronary artery disease risk factors (KERCADRS) including diabetes. In 2010 and 2011, all of the participants were interviewed by trained staff for medical history and physical activities, and were then examined for blood pressure and anthropometric measures. Venus blood sample was also collected for fasting plasma glucose and HbA1c.

Results: The age-sex standardized prevalence of pre-diabetes, diagnosed and undiagnosed was 18.7%, 6.3% and 2.7%, respectively. Diabetes increased by age (from 14.7% in the 15–24 years old group to 28.4% in the 65–75 years old group), particularly after 40 years. Occasional opium users had the highest prevalence of Pre-DM (34.6%). Seventy-nine percent of the depressed and 75.5% of the anxious participants with diagnosed-DM were identified as uncontrolled-DM. More than 60% of diagnosed diabetic cases had impaired HbA1c. Overweight and obesity (adjusted odds ratio (AOR) 1.6) and low physical activity (AOR 1.5) were the most preventable risk factors associated with diabetes.

Conclusion: Considerable prevalence of diabetes, susceptibility in progressing to diabetes and uncontrolled diabetes among individuals living in Kerman, suggested ineffective prevention and treatment of diabetes in urban areas in Iran. Successful experience regarding primary health-care in rural areas should be expanded to urban settings.

Keywords: diabetes mellitus, diabetes treatment, HbA1c, Iran, pre-diabetes, uncontrolled diabetes, undiagnosed diabetes.

Significant findings of the study: We found that diabetes and susceptibility in to diabetes was very common in Kerman. The prevalence increased by age, particularly after 40 years. Depression and anxiety are very common in uncontrolled diabetic patients in Iran.
What this study adds: A considerable number of people had their diabetes undiagnosed, while in those who have been diagnosed for diabetes, the treatment was not effective and more than 60% presented with impaired HbA1c test results.

Introduction

The diabetes pandemic will increase from 175 million patients with diabetes in 2000 to 353 million in 2030.[1] It is an important contributor to the burden of diseases, particularly in developing countries.[2]

According to the national coronary artery disease (CAD) risk factors surveillance report, the overall prevalence of diabetes in Iran is estimated to be 8.7% in adults aged 15–64 years, of whom half (4.1%) were the newly diagnosed cases.[3] Based on a systematic review, the prevalence of type 2 diabetes in Iran was estimated as one out of four among adults aged ≥40.[4]However, it is not clear how many are at pre-diabetes stage and are prone to suffer from diabetes, or vice versa, with timely interventions, the disease can be prevented.

In addition to late diagnosis, diabetes management is another big challenge in Iran since only 39.2% of individuals with diagnosed diabetes in Iran receive treatment.[5] Using fasting plasma glucose (FPG) ≥7.2 mmol/L the criteria for poor management of diabetes, about 57% of individuals with diagnosed diabetes had high level of plasma glucose.[6]

In this paper, we reported the age-sex standardized prevalence of diabetes at all stages including pre-diabetes (pre DM) and diabetes (DM). The research participants were between 15 to 75 years of age, and they lived in an urban setting in southeastern Iran, in Kerman. We also assessed the effectiveness of diabetes management (using HbA1C as the indicator) in people with diagnosed diabetes. The prevalence of main related CAD co-morbidities was also observed in pre-diabetic, diagnosed, undiagnosed and normal subpopulation.

Methods

The Kerman Coronary Artery Disease Risk Factors (KERCADR) Study is a population based cohort study with repeated surveys. In 2010–2011, 5900 individuals aged between 15 and 75 years recruited into the first round of the study. The subjects were recruited through a non-proportional to size one-stage cluster sampling household survey. The methodology of KERCADR study has been explained in detail elsewhere.[7]Only those who were able and provided written informed consent were recruited into the study. The study protocol was approved by the Ethical committee of Kerman University of Medical Sciences, Iran (Permission No. 88/110KA).

Interview and measurements

All details of the measurement are presented elsewhere.[7] In brief, the trained interviewers assessed the study subjects for different CAD risk factors using a structural questionnaire. Part of the questionnaire that we used in this study included demographic information, cigarette smoking (yes/no), opium addiction (no/occasional/dependent), the level of physical activity (low/moderate/high), and the level of depression and anxiety (related BECK questionnaires). The subjects were asked about their past medical history and familial history of DM, and whether they were under insulin or non-insulin treatment.

Physical activity was determined by the Global Physical Activity Questionnaire, and Metabolic Equivalents were used to express the intensity of physical activities. Hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg, and/or taking any antihypertensive drugs. Overweight was defined as body mass index (BMI) between 25 to 29.9 kg/m^2 and obesity as BMI ≥30 kg/m^2.

Every individual with previously diagnosed diabetes (by a physician) and/or taking insulin or non-insulin drugs and/or FPG ≥7 mmol/L at the time of recruitment was considered a diabetic case. Others with FPG between 5.6–6.9 mmol/L were considered as pre-diabetes (pre-DM) cases. Subjects who had no previous history of diabetes or anti-diabetic medication, but turned out to have FPG ≥7 mmol/L at the recruitment were considered as undiagnosed diabetic cases.

To determine the glycemic control status of diagnosed diabetic patients, we tested every diabetic case for hemoglobin A1c (HbA1c). Here we reported the uncontrolled diabetes in both old and new definitions. In the *old definition*, uncontrolled diabetes was specified as HbA1c >53 mmol/mol (>7%) for all individuals. However, based

on the *new definition, the cut-off is* adjusted according to the patients' condition (American Diabetes Association, 2013).[8]Therefore, in those with onset or progression of early stage microvascular and chronic complications, and those aged more than 70 years HbA1c >64 mmol/mol (>8%) was considered as the cut-off for poor glycemic control (uncontrolled DM).

Laboratory measurements

All participants were asked not to eat for 12–14 h before coming to the clinic. The blood samples were obtained between 07.00 and 09.00 h, and FPG was measured (KIMIA Kit, Code 890410, Iran). Subjects who had FPG more than 5.6 mmol/L were recalled for another FPG test and HbA1c test (NYCOCARD Kit, Code 1042184, Austria). To measure serum lipid profiles, total cholesterol (KIMIA Kit, Code 890303, Iran) and triglycerides (KIMIA Kit, Code 890201, Iran) were also measured for all individuals.

Statistical analysis

All statistical analyses were conducted under survey data analysis using STATAv.12 (StataCorp, 2011 College Station, TX, USA). For age-sex direct standardizations, we used Kerman population reported in census 2006. All prevalence rates were weighted according to the sampling weight (reciprocal of the probability of selection) and individual response rate. The data were presented as absolute and relative frequencies as well as 95% confidence intervals (95% CI). Univariate and multivariate logistic regression models were applied to determine the predictors of diabetes (both diagnosed and undiagnosed DM). Crude and adjusted odds ratios (AOR) were also reported.

Results

Demographic characteristics

The 5895 people recruited in this study were on average 45.4 (SD 16.4) years old and 54.9% were female. According to a self-report, 14.0% had never been to school and a majority had not completed secondary education (67.1%).

Pre-DM prevalence

Overall, the age- and sex-standardized prevalence of prediabetes (Pre-DM) was 18.7% (men 23.4% vs women 13.7%) (Table 1). The Pre-DM prevalence constantly increased from 14.7% in young adults (age group 15–24 years) to 28.4% in elderly people (age group 65–75 years). One-quarter (25.9%) of the illiterate people had Pre-DM status, which decreased to 18.0% in people with primary to high school education. Pre-DM was more common among non-smokers (11.5% vs 18.8%). Regarding opium addiction, those who were reported to have occasional use of opium had the highest prevalence of Pre-DM (34.6%). Pre-DM prevalence was identified in 15.2% of the depressed people and 18.4% in those with anxiety symptoms. 16.1% of people with normal BMI had Pre-DM, which increased to 22.1% in overweight and 20.1% in obese people. The Pre-DM prevalence constantly decreased from 20.5% in less physically active to 15.2% in highly physically active people. Having familial history of DM increased the prevalence of Pre-DM to 19.6%.

Undiagnosed and diagnosed diabetes

In general, the standardized prevalence of diabetes was 9% (men 7.7% and women 10.3%), of which 2.7% were undiagnosed diabetes (men 2.8% vs women 2.6%) and 6.3% diagnosed (men 4.9% vs women 7.7%).

Undiagnosed DM was more prevalent in elderly individuals (6.8% among people aged 65–75 years), people with primary-to-high school education (2.8%), non-smokers (2.8%), opium dependent users (2.7%), people without anxiety symptoms (3.2%), obese people (4%), and those with positive familial history of DM (3.7%). There was nearly an equal prevalence of undiagnosed-DM in subpopulations regarding depression and physical activity.

The diagnosed-DM increased steadily from 1% in young adult (age group 15–24) to 26.3% in elderly people (aged 55–64 years). DM was diagnosed in 6.7% of (high school and more) educated people. Compared to non-cigarette smokers, prevalence of diagnosed-DM was more in smokers (6.3% vs 9.1%). The prevalence of DM was diagnosed in 7.0% of occasional opium users, while it was 4.0% among dependent users. The diagnosed-DM prevalence among individuals with depression and anxiety symptoms was 7.3% and 6.6%, respectively. Seven percent of overweight and 7.6% of obese people had diagnosed-DM. In people with high physical activity, diagnosed-DM prevalence was at a minimum of 3.7%. Compared to subjects with negative familial history of DM, people with positive history had higher prevalence of diagnosed-DM (4.3% vs 10.0%).

Diabetes mismanagement: old definition

Overall, in people with diagnosed-DM, the prevalence of uncontrolled DM was 76.5% (men 75.1% vs women 77.3%) (Table 2). The uncontrolled-DM increased from

Table 1 Standardized prevalence of pre-diabetes, undiagnosed and diagnosed diabetes, Community-Based Study (KERCADR – 1st Round: *n* = 5895), Kerman, Iran, 2010–2011

			Diabetes	
Subgroups	Normal	Pre-diabetes	Undiagnosed	Diagnosed
Overall	72.3 (70.8, 73.9)	18.7 (17.3, 20.1)	2.7 (2.3, 3.3)	6.3 (5.7, 6.9)
Sex				
Men	68.8 (66.3, 71.2)	23.4 (21.2, 25.9)	2.8 (2.2, 3.6)	4.9 (4.2, 5.7)
Women	76.0 (74.2, 77.8)	13.7 (12.2, 15.3)	2.6 (2.1, 3.4)	7.7 (6.8, 8.7)
Age groups				
15–24	83.7 (80.4, 86.5)	14.7 (12.0, 17.9)	0.7 (0.3, 1.6)	1.0 (0.4, 2.3)
25–34	81.2 (78.3, 83.9)	15.1 (12.7, 17.9)	1.8 (1.1, 3.0)	1.9 (1.1, 3.2)
35–44	68.3 (64.9, 71.5)	20.9 (18.2, 23.8)	4.9 (3.4, 6.9)	6.0 (4.5, 7.9)
45–54	53.2 (50.0, 56.5)	24.6 (21.8, 27.5)	4.8 (3.5, 6.4)	17.4 (15.1, 20.0)
55–64	42.0 (38.5, 45.5)	25.1 (22.2, 28.2)	6.7 (5.1, 8.7)	26.3 (23.3, 29.5)
65–75	40.9 (36.2, 45.7)	28.4 (24.2, 33.0)	6.8 (4.7, 9.8)	23.9 (20.0, 28.3)
Education				
Illiterate	66.5 (50.9, 79.1)	25.9 (14.2, 42.5)	1.7 (1.1, 2.6)	6.0 (4.3, 8.2)
Primary to high school	72.9 (71.1, 74.7)	18.0 (16.4, 19.7)	2.8 (2.3, 3.5)	6.2 (5.5, 7.0)
Above high school	71.9 (68.7, 74.9)	19.5 (16.7, 22.6)	1.9 (1.2, 3.0)	6.7 (5.4, 8.2)
Current cigarette smoker				
No	72.1 (70.4, 73.7)	18.8 (17.3, 20.4)	2.8 (2.3, 3.4)	6.3 (5.7, 7.0)
Yes	77.8 (71.4, 83.1)	11.5 (9.3, 14.0)	1.6 (1.0, 2.7)	9.1 (4.9, 16.3)
Opium addiction				
No	72.4 (70.7, 74.0)	18.6 (17.1, 20.1)	2.6 (2.1, 3.2)	6.4 (5.8, 7.1)
Occasional user	56.8 (49.6, 63.7)	34.6 (28.1, 41.8)	1.5 (0.8, 2.7)	7.0 (5.1, 9.6)
Dependent user	60.0 (53.9, 65.8)	15.4 (10.4, 22.2)	2.7 (1.5, 5.0)	4.0 (2.9, 5.4)
Depression				
No	71.9 (70.0, 73.7)	19.6 (17.9, 21.4)	2.8 (2.2, 3.4)	5.7 (5.0, 6.4)
Yes	74.8 (72.2, 77.2)	15.2 (13.1, 17.6)	2.7 (1.9, 3.6)	7.3 (6.1, 8.7)
Anxiety				
No	72.8 (69.5, 75.9)	19.1 (16.3, 22.2)	3.2 (2.3, 4.4)	5.5 (4.1, 6.1)
Yes	72.5 (70.7, 74.2)	18.4 (16.8, 20.1)	2.5 (2.0, 3.2)	6.6 (5.9, 7.3)
Obesity				
Normal	76.9 (74.9, 78.8)	16.1 (14.4, 17.9)	1.8 (1.3, 2.5)	5.2 (4.4, 6.2)
Overweight	67.6 (63.9, 71.1)	22.1 (18.9, 25.8)	3.2 (2.5, 4.2)	7.0 (6.0, 8.2)
Obese	68.3 (63.2, 73.0)	20.1 (16.0, 25.1)	4.0 (2.4, 6.4)	7.6 (6.2, 9.2)
Physical activity				
Low	70.4 (67.7, 72.9)	20.5 (18.2, 23.0)	2.6 (2.0, 3.4)	6.5 (5.6, 7.5)
Moderate	72.7 (70.4, 74.9)	18.1 (16.1, 20.3)	2.8 (2.2, 3.7)	6.4 (5.6, 7.2)
High	77.8 (73.2, 81.9)	15.2 (11.7, 19.5)	3.2 (1.9, 5.4)	3.7 (2.3, 5.8)
Family History of DM				
No	75.3 (73.5, 77.1)	18.0 (16.4, 19.8)	2.3 (1.8, 2.9)	4.3 (3.8, 5.0)
Yes	66.7 (63.6, 69.7)	19.6 (17.0, 22.5)	3.7 (2.8, 4.9)	10.0 (8.6, 11.6)

DM, diabetes mellitus; numbers are reported as % and (95% confidence interval).

60% in young adults to 77.8% in elderly people. The frequency of uncontrolled-DM among people without and with (both insulin and non-insulin) treatment was 57.9% and 92.9%, respectively. Less educated people had worse uncontrolled DM in comparison with highly educated individuals (78.1% vs 68.3%). Uncontrolled-DM among non-smokers was higher than smokers (77.3% vs 70.5%). The frequency of uncontrolled-DM varied from 76.1% among non opium users to 81.3% in dependent opium users. Among the diagnosed-DM people, 79.5% of depressed and 75.5% of anxious people were identified as uncontrolled-DM. Regarding obesity, uncontrolled-DM ranged from 79.9% (normal BMI) to 72.7% (obese subgroup). People with low physical activity had a higher frequency of uncontrolled-DM (79.4%), which decreased to 66.7% in people with high level of physical activity. More than 74% of the diabetic patients who had positive history of familial DM were uncontrolled.

Table 2 Prevalence of control and un-controlled diabetes among diagnosed diabetic patients ($n = 536$), Community-Based Study (KERCADR – 1st Round: $n = 5895$), Kerman, Iran, 2010–2011

	Uncontrolled diabetes	
Subgroups	Old definition	New definition
Overall	76.5 (72.7, 79.9)	60.8 (56.6, 64.9)
Sex		
Men	75.1 (68.7, 80.6)	59.7 (52.8, 66.2)
Women	77.3 (72.5, 81.5)	61.5 (56.2, 66.6)
Age groups		
15–34	60.0 (34.8, 80.8)	60.0 (34.8, 80.8)
35–44	59.5 (43.2, 73.9)	59.5 (43.2, 73.9)
45–54	77.7 (70.6, 83.5)	70.1 (62.6, 76.6)
55–64	77.8 (71.4, 83.1)	60.8 (53.7, 67.5)
65–75	77.8 (68.5, 85.0)	47.5 (37.9, 57.2)
DM Treatment		
None	57.9 (48.7, 66.6)	44.7 (35.9, 53.9)
Non-insulin	80.1 (75.7, 83.9)	63.8 (58.8, 68.6)
Insulin	89.1 (76.4, 95.4)	69.6 (54.9, 81.1)
Insulin and non-insulin	92.9 (62.7, 99.0)	85.7 (56.9, 96.5)
Education		
Illiterate	78.1 (70.4, 84.3)	48.2 (39.9, 56.6)
Primary to high school	77.3 (72.6, 81.4)	65.8 (60.6, 70.7)
Above high school	68.3 (55.6, 78.8)	61.7 (48.9, 73.0)
Current cigarette smoker		
No	77.3 (73.3, 80.8)	61.1 (56.5, 65.4)
Yes	70.5 (58.2, 80.4)	59.0 (46.6, 70.4)
Opium addiction		
No	76.1 (72.0, 79.9)	60.1 (55.3, 64.7)
Occasional user	74.5 (60.9, 84.6)	64.7 (50.8, 76.5)
Dependent user	81.3 (67.7, 89.9)	62.5 (48.2, 74.9)
Depression		
No	72.9 (67.1, 78.0)	61.8 (55.6, 67.5)
Yes	79.5 (74.4, 83.8)	60.4 (54.5, 66.0)
Anxiety		
No	78.3 (69.5, 85.1)	63.2 (53.8, 71.7)
Yes	75.9 (71.7, 79.7)	60.5 (55.8, 65.1)
Obesity		
Normal	79.9 (72.7, 85.5)	66.4 (58.6, 73.5)
Overweight	77.2 (71.5, 82.0)	59.8 (53.5, 65.7)
Obese	72.7 (64.7, 79.4)	59.0 (50.4, 67.0)
Physical activity		
High	66.7 (44.7, 83.2)	57.1 (36.0, 76.0)
Moderate	74.4 (68.7, 79.4)	59.7 (53.6, 65.5)
Low	79.4 (74.0, 83.9)	62.3 (56.1, 68.0)
Family History DM		
No	78.6 (72.8, 83.4)	60.3 (53.8, 66.4)
Yes	74.4 (69.0, 79.1)	59.9 (54.1, 65.4)

New definition

With the new definition (details are mentioned above in the method), the overall uncontrolled-DM was observed in 60.8% of the diagnosed DM cases (men 59.7% vs women 61.5%). Using the new definition, the prevalence of uncontrolled-DM decreased by 7% to 30% in different subpopulations. The biggest difference was observed in the elderly group (47.5%), those receiving insulin therapy (69.6%), illiterate (48.2%), Opium dependent users (62.5%), people with depression symptoms (60.4%) and those with no familial history of DM (60.3%).

Predictors of diabetes

In crude analysis, sex (male vs female), age, education, opium addiction, depression, increased BMI category, lower physical activity, and DM familial history turned to be potential significant predictors for DM (Table 3). While in the multivariate model, after removing confounding effects, it was shown that the odds of diabetes increased significantly only by age group (AOR 5.0 to 18.2), depression (AOR 1.2), overweight and obesity (AOR 1.6, and 1.5), moderate and low physical activity, (AOR 1.5, and 1.4) and the positive familial history of DM (AOR 2.2). The other variables did not have a statistically significant association with diabetes.[19]

Diabetes-related co-morbidities

The maximum prevalence of co-morbidities among patients with diagnosed DM were anxiety (87.5%), depression (57.9%) and overweight/obesity (47.1%); among people with undiagnosed DM, most frequent co-morbidities were again anxiety (73.2%) and overweight/obesity (55.6%) while hypercholesterolemia (54.3%) also become very common, too (Table 4). Among individuals with pre-diabetes, again anxiety (76.2%), overweight/obesity (50.5%) and hypercholesterolemia (35.4%) were the most frequent co-morbidities. The least frequent co-morbidity was hypertension (9.4% to 17.1%).

Sex and age interacted on diabetes

The standardized prevalence of diabetes was almost comparable in men and women by age of 45 years (Fig. 1). In comparison to the trend observed for younger people, the DM prevalence significantly increased at about 40 years in both sexes, while later, women disproportionately turned out to be diabetic in comparison to men. DM prevalence peaked in men (33.8%) at age of 60–64 years and in women (38.9%) at age of 65–69 years and then started to decrease.

Discussion

In our analysis, we found one out of four individuals living in an urban area in Iran either had impaired glucose level (pre-diabetes) or diabetes. Near to 3% of individuals had their diabetes undiagnosed and in more

Table 3 Crude and adjusted odds ratio for different predictors of diabetes mellitus, Community-Based Study (KERCADR – 1st Round: $n = 5895$), Kerman, Iran, 2010–2011

Subgroups	Crude OR	Adjusted OR
Sex		
Men	1	1
Women	1.3 (1.1, 1.5)	1.2 (0.9, 1.4)
Age groups		
15–24	1	1
25–34	2.3 (1.1, 4.7)	1.8 (0.8, 3.7)
35–44	7.3 (3.7, 14.3)	5.0 (2.5, 10.0)
45–54	17.1 (8.9, 32.7)	11.7 (6.0, 22.9)
55–64	29.4 (15.5, 56)	20.7 (10.6, 40.6)
65–75	26.6 (13.7, 51.7)	18.2 (9.0, 36.4)
Education		
Illiterate	1	1
Primary to high school	0.4 (0.3, 0.5)	0.8 (0.6, 1.0)
Above high school	0.4 (0.3, 0.5)	0.8 (0.6, 1.1)
Current cigarette smoker		
No	1	
Yes	0.9 (0.7, 1.2)	
Opium addiction		
No	1	1
Occasional user	1.4 (1.1, 1.9)	1.2 (0.9, 1.7)
Dependent user	1.2 (0.9, 1.5)	0.9 (0.7, 1.3)
Depression		
No	1	1
Yes	1.6 (1.4, 1.9)	1.2 (1.0, 1.4)
Anxiety		–
No	1	
Yes	1.1 (0.9, 1.3)	
BMI		
Normal	1	1
Overweight	2.3 (1.9, 2.7)	1.6 (1.3, 2.0)
Obese	2.5 (2.1, 3.2)	1.5 (1.2, 2.0)
Physical activity		
High	1	1
Moderate	2.1 (1.5, 3.0)	1.5 (1.0, 2.2)
Low	2.2 (1.5, 3.1)	1.4 (1.0, 2.1)
Family History DM		
No	1	1
Yes	2.1 (1.8, 2.5)	2.2 (1.8, 2.6)

OR, odds ratio; numbers are reported as odds ratio (OR) and (95% confidence interval).

than 60% of diagnosed diabetic patients, the treatment was not effective.

In comparison to an International Diabetes Federation (IDF) report 2011 on the global prevalence of diabetes (8.3%), we observed a slightly greater prevalence (9%) of diabetes in our study population. However, we found that 23.4% of men and 13.7% of women were at the pre-diabetes stage. This should be taken as an opportunity by health authorities to prevent more diabetic cases and burden of disease. It has been shown that by losing weight and increasing physical activity, individuals can prevent or delay pre-diabetes from progressing to diabetes.[9–12]

The prevalence of diabetes was almost comparable among men and women by the age of 40 years when it started to increase considerably in both sexes, particularly among women. In several studies, it has been reported that the prevalence of diabetes (diagnosed and undiagnosed), impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) increased by age[13–15] is not similar between men and women.[13] Such differential increase among women can be partly explained by the higher prevalence of obesity[16–18] and low physical activity for work and transportation, in recent published studies.[9–12] Hadaegh et al. found that the prevalence of IFG increased by age only among women.[13] The reduction in the prevalence of diabetes among individuals aged 65 or more found in the current study could be due to the higher mortality in diabetic patients in comparison to the rest of the population, since diabetes also has been reported as a trigger for other cardiovascular diseases such as acute myocardial infarction.[19]

Although we have measured and reported the prevalence of diabetes (not incidence), the observed trend of diabetes by age indicated both onset and mortality were occurring in Iran at earlier ages (less than 40 years and 65 years, respectively) in comparison to global and developed countries' trends.[2,3] The underlying factors need to be fully explored in future studies, but generally, increasing trend was also observed for unhealthy diet,[20,21] low physical activity,[22,23] and overweight and obesity[16–18] in the Iranian population.

Regarding the effect of cigarette smoking and opium consumption, the results of this study showed almost no statistically significant effects on control of diabetes or odds ratio of predictors of diabetes (Tables 2,3). However, based on the effect on some other risk factors such as the increase in basal mean arterial pressure and low-density lipoprotein/high-density lipoprotein (LDL/HDL) ratio,[24] increase in prevalence of high systolic blood pressure and reduction in HDL,[25] and more ECG abnormalities found in long term opium exposure,[26] the findings are in contrast to the belief of many opium consumers in Iran that opium may have an ameliorating effect on diabetes or other CVD risk factors.

It seems that basic preventive measures for such preventable risk factors are overlooked by health authorities and also the people themselves in urban areas. In rural areas, Iran has a well-developed primary health-care system, having Behvarz workers responsible for population-based prevention and control services. The effect of Behvarz workers in rural areas on better diabetes management (both diagnosis and treatment) has been acknowledged in a recent published paper.[5]

Table 4 Standardized prevalence of different co-morbidities in normal, pre-diabetes, undiagnosed and diagnosed diabetes, Community-Based Study (KERCADR – 1st Round: $n = 5895$), Kerman, Iran, 2010–2011

Co-morbidities	Normal	Pre-diabetes	Undiagnosed DM	Diagnosed DM
Hypertension	9.6 (8.7, 10.6)	9.4 (8.2, 10.8)	11.7 (9.1, 14.9)	17.1 (12.9, 22.4)
Hypercholesterolemia	26.7 (25.1, 28.4)	35.4 (31.3, 39.7)	54.3 (41.3, 66.7)	38.0 (28.0, 49.2)
Hypertriglyceridemia	10.7 (9.5, 12.0)	19.5 (16.2, 23.3)	27.7 (19.1, 38.4)	30.3 (21.3, 41.1)
Depression	35.2 (33.2, 37.3)	31.1 (26.9, 35.7)	29.2 (19.5, 41.2)	57.9 (46.4, 68.6)
Anxiety	77.2 (75.3, 79.0)	76.2 (72.1, 79.8)	73.2 (58.3, 84.2)	87.5 (82.5, 91.3)
Overweight and obesity	39.4 (37.5, 41.3)	50.5 (45.8, 55.1)	55.6 (39.3, 70.8)	47.1 (39.1, 55.2)

DM, diabetes mellitus; numbers are reported as % and (95% confidence interval).

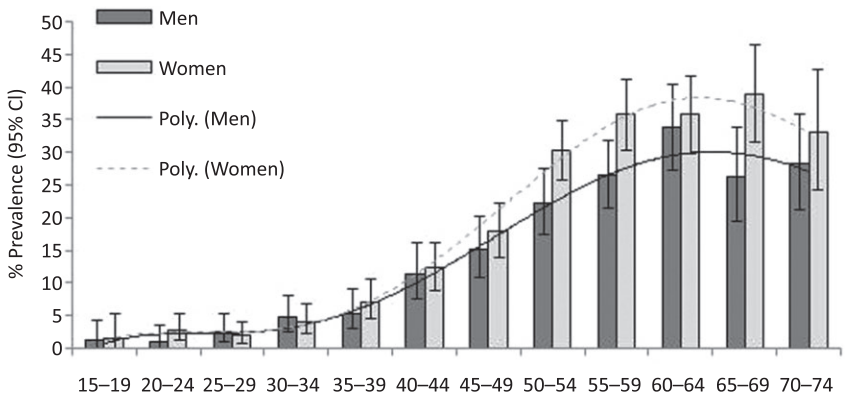

Figure 1 Prevalence of diabetes by age group and sex in Kerman, 2008 (Community-Based Cohort Study (KERCADR – 1st Round. $n = 5895$). Polynominal model (order 6) was used to fit the trend lines.

However, in urban areas, patients' compliance with medication and regular visits to physicians depends on the patients themselves. To cover this gap in primary health-care in urban settings, the family physician program has been piloted in a few cities and now expanded to many urban areas in Iran.[27,28] However, at the time of the study, such services were not available to the population. Our findings provided the baseline status of diabetes treatment/management while the effect of such interventions should be monitored over time by the next phase of the KERCADRs study or other population-based surveys.

We should acknowledge the limitations of our study. The main limitation of our analysis to assess the effectiveness of diabetes management was the use of prevalence data. Like other cross-sectional studies, our findings are prone to be distorted by surveillance bias and reverse causality. We also were not able to distinguish type I from II diabetes as we did not review individual's medical records. Near to 200 patients with impaired FPG level did not return for HbA1c test. On average, they had lower FPG (–1.98 mmol/L) in comparison to those who returned and tested for HbA1c. Although they were small in size, compared to the total recruited people, the prevalence of uncontrolled diabetes might be partly overestimated due to such selection bias.

In conclusion, we found that diabetes and susceptibility in to diabetes was very common in Kerman. The prevalence increased by age, particularly after 40 years. A considerable number of people had their diabetes undiagnosed, while in those who have been diagnosed with diabetes, the treatment was not effective and more than 60% presented with impaired HbA1c test results. Like rural areas, more feasible interventions at the primary health-care in urban areas for early diagnosis and better management of diabetic cases is needed to prevent further morbidity and mortality of diabetes in Iran.

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Disclosure

KE participated in the planning and implementation of the non-communicable diseases management in Ministry of Health program. All other authors have no conflicts of interest to be declared.

References

1. Wild S, Roglic G, Green A et al. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care*. 2004; **27**: 1047–53.
2. Boutayeb A, Boutayeb S. The burden of non communicable diseases in developing countries. *Int J Equity Health*. 2005; **4**: 2.
3. Esteghamati A, Meysamie A, Khalilzadeh O, Rashidi A, Haghazali M, Asgari F. Third national surveillance of risk factors of non-communicable diseases (SuRFNCD-2007) in Iran: Methods and results on prevalence of diabetes, hypertension, obesity, central obesity, and dyslipidemia. *BMC Public Health*. 2009; **9**: 1–10.
4. Haghdoost AA, Rezazadeh-Kermani M, Sadghirad B, Baradaran HR. Prevalence of type 2 diabetes in the Islamic Republic of Iran: Systematic review and meta-analysis. *East Mediterr Health J*. 2009; **15**: 591–9.
5. Farzadfar F, Murray CJL, Gakidou E, Bossert T, Namdaritabar H, Alikhani S. Effectiveness of diabetes and hypertension management by rural primary healthcare workers (Behvarz workers) in Iran: A nationally representative observational study. *Lancet*. 2012; **379**: 47–54.
6. Mirzazadeh A, Baradaran HR, Haghdoost AA, Salari P. Related factors to disparity of diabetes care in Iran. *Med Sci Monit*. 2009; **15**: PH32–6.
7. Najafipour H, Mirzazadeh A, Haghdoost AA et al. Coronary artery disease risk factors in an urban and peri-urban setting, Kerman, Southeastern Iran (KERCADR Study): Methodology and preliminary report. *Iranian J Publ Health*. 2012; **41**: 86–92.
8. American Diabetes Association. Standards of medical care in diabetes – 2012. *Diabetes Care*. 2012.
9. Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med*. 2002; **346**: 393–403.
10. Burr JF, Rowan CP, Jamnik VK, Riddell MC. The role of physical activity in type 2 diabetes prevention: Physiological and practical perspectives. *Phys Sportsmed*. 2012; **38**: 72–82.
11. Jeon CY, Lokken RP, Hu FB, van Dam RM. Physical activity of moderate intensity and risk of type 2 diabetes: A systematic review. *Diabetes Care*. 2007; **30**: 744–52.
12. Riddell MC, Burr J. Evidence-based risk assessment and recommendations for physical activity clearance: Diabetes mellitus and related comorbidities. *Appl Physiol Nutr Metab*. 2011; **36** (Suppl. 1): S154–89.
13. Hadaegh F, Bozorgmanesh MR, Ghasemi A, Harati H, Saadat N, Azizi F. High prevalence of undiagnosed diabetes and abnormal glucose tolerance in the Iranian urban population: Tehran Lipid and Glucose Study. *BMC Public Health*. 2008; **8**: 1–7.
14. Ozdemir L, Topcu S, Nadir I, Nur N, Arslan S, Sumer H. The prevalence of diabetes and impaired glucose tolerance in Sivas, Central Anatolia, Turkey. *Diabetes Care*. 2005; **28**: 795–8.
15. Ramachandran A, Snehalatha C, Satyavani K, Vijay V. Impaired fasting glucose and impaired glucose tolerance in urban population in India. *Diabet Med*. 2003; **20**: 220–4.
16. Navadeh S, Sajadi L, Mirzazadeh A, Asgari F, Haghazali M. Housewives' obesity determinant factors in Iran; National Survey – Stepwise approach to surveillance. *Iranian J Publ Health*. 2011; **40**: 87–95.
17. Azizi F, Azadbakht L, Mirmiran P. Trends in overweight, obesity and central fat accumulation among Tehranian adults between 1998–1999 and 2001–2002: Tehran lipid and glucose study. *Ann Nutr Metab*. 2005; **49**: 3–8.
18. Janghorbani M, Amini M, Willett WC et al. First nationwide survey of prevalence of overweight, underweight, and abdominal obesity in Iranian adults. *Obesity*. 2007; **15**: 2797–8.
19. Henderson SO, Haiman CA, Wilkens LR, Kolonel LN, Wan P, Pike MC. Established risk factors account for most of the racial differences in cardiovascular disease mortality. *PLoS ONE*. 2007; **2**: e377.
20. Ghassemi H, Harrison G, Mohammad K. An accelerated nutrition transition in Iran. *Public Health Nutr*. 2002; **5**: 149–55.
21. Kelishadi R, Ardalan G, Gheiratmand R et al. Association of physical activity and dietary behaviors in relation to the body mass index in a national sample of Iranian children and adolescents: CASPIAN Study. *Bull World Health Organ*. 2007; **85**: 19–26.
22. Azadbakht L, Mirmiran P, Shiva N, Azizi F. General obesity and central adiposity in a representative sample of Tehranian adults: prevalence and determinants. *Int J Vitam Nutr Res*. 2005 Jul; **75**(4): 297–304.

23. Hajian-Tilaki KO, Heidari B. Prevalence of obesity, central obesity and the associated factors in urban population aged 20–70 years, in the north of Iran: A population-based study and regression approach. *Obes Rev*. 2007; **8**: 3–10.
24. Najafipour H, Joukar S, Malekpour-Afshar R, Mirzaeipour F, Nasri HR. Passive opium smoking does not have beneficial effect on plasma lipids and cardiovascular indices in hypercholesterolemic rabbits with ischemic and non-ischemic hearts. *J Ethnopharmacol*. 2010; **127**: 257–63.
25. Rahimi N, Gozashti MH, Najafipour H, Shokoohi M, Marefati H. Potential effect of opium consumption on controlling diabetes and some cardiovascular risk factors in diabetic patients. *Addict Health*. 2013; **5**: 1–6.
26. Joukar S, Najafipour H, Malekpour-Afshar R, Mirzaeipour F, Nasri HR. The effect of passive opium smoking on cardiovascular indices of rabbits with normal and ischemic hearts. *Open Cardiovasc Med J*. 2010; **4**: 1–6.
27. Shalileh K, Mahdanian A. Family physicians' satisfaction in Iran: A long path ahead. *Lancet*. 2010; **14**: 376(9740): 515.
28. Reiesian S, Eslamian M, Azmal M, Bastani P, Kalhor R. Assessment of urban family physician program in pilot centers covered by Ahvaz Jundishapur University of Medical Sciences. *Payavard*. 2013; **7**: 11–20 (In Persian).

