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Prevalence and associated risk factors of undiagnosed diabetes among adult Moroccan Sahraoui women

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Abstract

Objective: The goal of the present work was to examine the prevalence and associated risk factors of undiagnosed diabetes among urban Moroccan Sahraoui women.
Design and setting: Randomised sample of adult women living in the city of Laayoune in south Morocco who visited public health centres during an immunisation campaign. Body weight, height, waist and hip circumferences, blood pressure, fasting plasma glucose (FPG), triglycerides, dietary intake and physical activity were collected.
Subjects: Data were obtained on 249 urban women aged 15 years and older, who were not pregnant. Only subjects identified as of Sahraoui origin were eligible for this investigation.
Results: The prevalence of impaired fasting glucose (IFG) was 5.5% and that of undiagnosed diabetes 6.4%. Diabetes and IFG were more common among older and obese women as well as among women with hypertension or a family history of diabetes. In addition, sucrose intakes were higher in women with diabetes than in those with normal FPG. Also, physical activity estimated as the time spent in walking was negatively associated with FPG. Regression analyses showed an independent association of age, obesity, family history of diabetes and triglycerides with diabetes.
Conclusion: The high proportion of unknown diabetes suggests the need for increased diabetes awareness in this population. The data suggest also the involvement of obesity in diabetes and the potential importance of intervention strategies to reduce population adiposity for the prevention and management of cardiovascular risk factors.

Keywords
Morocco
Sahraoui ethnic group
Women
Undiagnosed diabetes

Diabetes is one of the most frequent metabolic diseases. Widely distributed in various populations, its prevalence appears to be increasing rapidly and it could affect more than 300 million people by 2025[1]. Type 2 diabetes, previously known as non-insulin-dependent diabetes, accounts for 90–95% of diagnosed cases. The demographic and social transition has been also associated with the emergence of diabetes during the last decade in Morocco, as in many Arab countries[2,3]. The last study conducted in 2000 on a Moroccan representative sample aged 20 years and over showed that the prevalence of diabetes was 6.6% and was similar for males and females[4]. The complications resulting from the disease are a significant cause of morbidity and mortality and are associated with the damage or failure of large and small blood vessels, as well as various organs such as the eyes, kidneys and nerves[5,6]. Early diagnosis is therefore of major importance, since normalisation of glycaemia may reduce the risk of these diabetes-related conditions[7]. Unfortunately, several studies in different countries have reported that up to half of all subjects with diabetes are undiagnosed[8,9]. No data for undiagnosed diabetes are available for the Moroccan population.

Urbanisation is producing lifestyle changes that adversely affect metabolism and are thereby causing a large increase in the number of diabetic patients[1,10]. This notion is supported by studies on the Native American tribe of Pima Indians who mostly live a sedentary lifestyle and more than half of whom become diabetic[11]. Research on other populations, such as nomadic and semi-nomadic people, shows similar findings[12]. Bedouin Arabs of southern Israel, who were more physically active and tended to eat more traditional diets, were always considered as having a healthy lifestyle. However, their rapid urbanisation contributed to the emergence of obesity and diabetes[12]. In the same way, the Sahraoui population that previously lived in the desert of southern Morocco had a nomadic lifestyle, in permanent movement with their herds. Because of progressive desertification and aridity and their effects on water sources, flora and fauna, the population has undergone a rapid process of urbanisation accompanied by lifestyle changes. Many of

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them now live in urban areas[13] and their prevalence of obesity is very high[14]. No information is available on the prevalence of diabetes and its associated factors among this Moroccan ethnic group.

The goal of the present work was therefore to examine the prevalence and determinants of undiagnosed diabetes among urban Moroccan Sahraoui women.

Population and methods

Study population

The survey was undertaken between October 2001 and April 2002 on a sample of 249 urban, non-pregnant women aged 15 years and older who lived in the city of Laayoune in south Morocco. The sample was randomly selected from women who visited public health centres during an immunisation campaign[14]. We identified several ethnic groups (Sahraoui, Arab and Berber) but only subjects of Sahraoui origin and without any previous systemic diseases were eligible for this investigation. Women who had diagnosed diabetes ($n = 43$) and those who were pregnant ($n = 15$) were excluded from the sample.

A number of strict criteria were used to identify women belonging to the Sahraoui ethnic group: their communication skill in Hassani dialects, their popular traditional clothing and the history of their family's residence. Indeed Sahraoui ethnic groups, characterised by the Hassani dialect, have been a traditionally nomadic population undergoing a rapid process of urbanisation and, from the age of puberty, Sahraoui women are obliged to wear traditional clothing. All women were interviewed face-to-face by an interviewer who belonged to this Sahraoui ethnic group. Informed consent was obtained verbally from each participant before they were permitted to take part in the survey.

Measurements

All anthropometric measurements were made in accordance with World Health Organization (WHO) standards[15]. For participants wearing light clothing with no shoes, weight was measured using a portable scale and height by a metric tape adhered to a wall. Waist circumference (WC) and hip circumference, from which waist-to-hip ratio (WHR) was calculated, were measured respectively at the horizontal level of the umbilicus and the horizontal level of the maximal protrusion of the gluteal muscles. Body mass index (BMI) was calculated as weight divided by the square of height ($kg\,m^{-2}$). WHO categories of underweight, normal weight, overweight and obesity, defined respectively as BMI $<18.5\,kg\,m^{-2}$, BMI $= 18.5–24.9\,kg\,m^{-2}$, BMI $= 25.0–29.9\,kg\,m^{-2}$ and BMI $\geq 30\,kg\,m^{-2}$, were adopted; central obesity was defined as WC >88 cm or WHR >0.85[15,16].

Blood pressure was measured with women in sitting position after rest. Subjects with blood pressure equal to or greater than 130 (systolic)/85 (diastolic) mmHg were considered hypertensive[17]. Blood samples were collected from women after an overnight fast for 12 h; the plasma was separated by centrifugation and stored at -90°C until determinations. Plasma glucose was measured by the glucose oxidase method using a Beckman analyser (Palo Alto, CA, USA); plasma triglycerides were measured by an enzymatic method.

According to the American Diabetes Association (ADA) Expert Committee on the Diagnosis and Classification of Diabetes Mellitus[18], fasting plasma glucose (FPG) measurement should be used to diagnose diabetes. Based on the ADA criteria, FPG was categorised into normal fasting glucose (NFG) (FPG $<6.1\,mmol\,l^{-1}$), impaired fasting glucose (IFG) (FPG $= 6.1–6.9\,mmol\,l^{-1}$) and diabetes (FPG $\geq 7\,mmol\,l^{-1}$).

Data on sociodemographic characteristics, familial diabetes history, dietary intake and physical activity were collected using a questionnaire. Dietary intake estimates were based on 24-hour recall interviews. Mean daily dietary intake and composition were estimated by the Bilnut program (Nutrisoft, France) completed with some Moroccan dishes. Physical activity was assessed by asking subjects to complete a questionnaire indicating their activities over the past year. A list of types of activity was developed and detailed information about the frequency and duration of each activity was collected.

The protocol was approved by the Moroccan Ministry of Public Health.

Data analysis

Statistical analysis was undertaken using SPSS version 11 (SPSS Inc., Chicago, IL, USA). Categorical variables are expressed as percentages. Relationships among different groups and variables were analysed with the chi-square test. Associations between different variables were assessed by Spearman's correlation. Logistic regression analysis was performed to determine the association of independent risk factors with diabetes. A P-value <0.05 was considered statistically significant.

Results

Table 1 gives the basic sociodemographic and health characteristics of the sample. Of the 249 asymptomatic subjects, the combined prevalence of undiagnosed diabetes and IFG in the population was 11.9% (undiagnosed diabetes 6.4% and IFG 5.5%) and increased with age, obesity (particularly central fat distribution), hypertension, hypertriglyceridaemia and family history of diabetes (Table 2). Diabetes was more common among older (>35 years) than younger women (<25 years) (10.3 vs. 0%; $P = 0.007$), among obese compared with normal-weight women (9.0 vs. 2.1%; $P = 0.07$) and among women with central obesity (WHR > 0.85) compared with those with peripheral fat distribution (9.5 vs. 0%; $P = 0.002$)

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Table 1 Sociodemographic and health characteristics of the study sample

Variable	
Age (years), mean (SD)	36.79 (11.75)
BMI (kg m^{-2}), mean (SD)	29.63 (5.34)
Marital status (%)	
Single	20.1
Married	66.7
Divorced	7.6
Widow	5.6
Education (%)	
Never attended school	62.2
Primary school	18.9
Secondary school	18.9
BMI $>$30 kg m^{-2} (%)	49.0
WC $>$88 cm (%)	75.0
WHR $>$0.85 (%)	68.0
HyperTG (%)	22.4
IFG (%)	5.5
Diabetes (%)	6.4
Hypertension (%)	28.6
FHD (%)	9.6

SD – standard deviation; BMI – body mass index; WC – waist circumference; WHR – waist-to-hip ratio; HyperTG – hypertriglyceridemia; IFG – impaired fasting glucose; FHD – family history of diabetes.

(Table 2). Also, in this studied population, 28.6% had hypertension, 22.4% hypertriglyceridaemia and 9.6% a family history of diabetes. Women with these abnormalities had also a higher prevalence of diabetes compared with their counterparts.

Table 2 Prevalence (%) of undiagnosed abnormalities of carbohydrate metabolism across categories of age, BMI, WC, WHR, TG, BP and FHD in adult Moroccan Sahraoui women

		FPG category	
Category	*n*	IFG	Diabetes
Age (years)			
$<$ 25	42	0	0
25–34.9	71	1.4	2.8
$>$ 35	136	9.6	10.3
BMI			
Normal weight	48	2.1	2.1
Overweight	75	8.0	5.3
Obese	122	5.7	9.0
WC (cm)			
$<$ 88	60	0	1.7
$>$ 88	189	7.4	7.9
WHR			
$<$ 0.85	80	2.5	0
$>$ 0.85	169	7.1	9.5
TG			
Normal	193	5.7	5.1
HyperTG	56	7.1	10.7
BP			
Normal	177	3.4	3.4
Hypertension	71	11.4	12.7
FHD			
No	225	5.3	4.9
Yes	24	8.3	20.8

BMI – body mass index; WC – waist circumference; WHR – waist-to-hip ratio; TG – triglycerides; BP – blood pressure; FHD – family history of diabetes; *n* – number of subjects; FPG – fasting plasma glucose; IFG – impaired fasting glucose; HyperTG – hypertriglyceridaemia.

Table 3 presents the means and standard deviations of dietary energy and carbohydrates intake and physical activity estimated as the time spent in some lifestyle activities according to FPG category. Compared with the NFG group, the diabetic group tended to have higher mean intakes of sucrose, energy derived from sucrose, time spent in tea consumption, time spent in afternoon sleeping and a lesser time spent in walking.

Using Spearman correlation coefficients (Table 4), age ($P = 0.0001$), BMI ($P = 0.0001$), WC ($P = 0.0001$), WHR ($P = 0.0001$), triglycerides ($P = 0.001$), diastolic blood pressure ($P = 0.0001$), systolic blood pressure ($P = 0.001$) and family history of diabetes ($P = 0.006$) were found to be positively correlated with FPG, whereas time spent in walking activity ($P = 0.003$) was negatively correlated with FPG.

Using logistic regression analyses, age ($P < 0.05$), BMI ($P < 0.001$), family history of diabetes ($P < 0.05$) and triglycerides ($P < 0.001$) were independently associated with diabetes.

Discussion

This study addressed the prevalence of undiagnosed diabetes and IFG in a Moroccan ethnic group. Using FPG, which is considered equally predictive of future diabetes as blood glucose 2 h after an oral glucose tolerance test[18], the estimated prevalence of undiagnosed diabetes was 6.4% and IFG was 5.5% among the population of Sahraoui women. The prevalence of these glucose abnormalities increased with age and obesity.

Undiagnosed diabetes and IFG increase the risk of cardiovascular disease[5,19]. Part of this increase is due to the frequency of associated cardiovascular risk factors such as dyslipidaemia and hypertension[20,21]. The most commonly recognised lipid abnormality in diabetics is hypertriglyceridaemia, known to be an independent risk factor for coronary heart disease[22]. Also, people with both diabetes and hypertension have a higher risk of cardiovascular disease, retinopathy and nephropathy[21,23]. In this population, hypertriglyceridaemia and hypertension were more common in diabetics and patients with IFG and, in accordance with the results of other studies[24], the increased levels of triglycerides and hypertension were independent cardiovascular risks. These results highlight again the necessity to normalise increased blood pressure and lipid level as quickly as possible, as recommended by the ADA[21], to decrease the possibility of coronary artery disease in these women.

As reported in previously[24,25], our investigation showed a clear relationship between age, obesity and diabetes. Also, the prevalence of the disease clearly began to increase considerably after the age of 25 years and markedly in women with android fat distribution. A number of prospective and cross-sectional studies have shown that obesity and central fat are principal causes of

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Table 3 Mean (SD) of dietary intake (total energy, carbohydrate and sucrose) and lifestyle activity (walking, tea consumption, afternoon sleeping) according to the FPG status of adult Moroccan Sahraoui women

	Dietary intake					Lifestyle activity		
FPG category	Total energy (kcal day^{-1})	Carbohydrate (g day^{-1})	Carbohydrate (% of total energy)	Sucrose (g day^{-1})	Sucrose (% of total energy)	Walking (h week^{-1})	Tea consumption (h day^{-1})	Afternoon sleeping (h day^{-1})
NFG	1828.9 (427.8)	266.2 (72.5)	58.5 (7.8)	46.1 (34.4)	9.9 (6.0)	3.9 (3.2)	3.2 (1.8)	1.4 (1.1)
IFG	1710.8 (436.2)	298.1 (66.8)	59.5 (5.8)	55.6 (38.5)	12.1 (7.1)	2.2 (2.5)	3.8 (1.6)	1.4 (1.1)
Diabetes	1766.4 (429.6)	254.4 (66.1)	61.9 (6.5)	59.2 (41.1)	12.9 (7.0)	2.6 (1.9)	3.6 (2.3)	1.6 (1.1)
All	1818.7 (427.6)	267.1 (72.0)	58.8 (7.7)	47.4 (35.1)	10.2 (6.2)	3.8 (3.2)	3.3 (1.8)	1.4 (1.1)

SD – standard deviation; FPG – fasting plasma glucose; NFG – normal fasting glucose; IFG – impaired fasting glucose.

increased diabetes prevalence[26–29]. Boyko *et al.*[28] have reported that greater visceral adiposity precedes the development of type 2 diabetes in Japanese Americans. Consequently, the finding in our survey that obesity was highly associated with both undiagnosed diabetes and IFG has alarming implications for this population's health.

In concordance with other studies[9,25], our data confirm also the important role of heredity in the problem of diabetes, as diabetes and IFG rates in this population were higher among women with a family history of diabetes than in those without. Therefore, the presence of family history of diabetes and obesity in IFG and even NFG women suggests that these women are at elevated risk for diabetes. The results show that public health programmes should target obesity, with a focus especially and urgently on high-risk women with positive heredity for diabetes.

As the coexistence of hyperglycaemia, obesity, hypertriglyceridaemia and hypertension in the same individual greatly increases cardiovascular risk[30], the high risk for cardiovascular disease among Sahraoui women may be reduced by weight reduction. Weight loss could reduce blood pressure and improve blood glucose and lipid levels[31]. In fact, excess weight as well as unhealthy dietary intake and physical inactivity resulting from urbanisation have resulted in large increases in diabetes frequency and coronary heart disease in traditional societies that have adopted a 'Western' lifestyle[10,11]. In this urban Sahraoui population, women with IFG or undiagnosed diabetes appeared to have impaired quality of life compared with women having NFG. Indeed, women with IFG and diabetes tended to consume more energy derived from sucrose taken as beverages (12.1% in IFG and 12.9% in diabetes), values which are higher than recommended (<10%)[32]. However, it is important to signal that the role played by sucrose intake in the occurrence of obesity, diabetes and cardiovascular diseases is still a matter of debate[32,33]. Previous data suggest that a high intake of rapidly absorbed carbohydrates, characterised by a high glycaemic load, may increase the risk of coronary heart disease by aggravating glucose intolerance and dyslipidaemia[34]. These data suggest also that women with IFG and diabetes are particularly prone to the adverse effects of a high dietary glycaemic load. Reducing the intake of high-glycaemic-load beverages may offer a simple strategy for reducing the incidence of coronary heart disease[33].

Lack of physical activity was also an associated risk factor for diabetes in this study. Indeed, most Sahraoui women tended to be involved in the traditional sedentary occupations of drinking tea and sleeping in the afternoon. These sedentary habits occupied a considerable part of the day as indicated by the time spent on them, which tended to be higher among diabetic women. Also, compared with women with normal glycaemia, women with IFG and diabetes tended to expend less energy evaluated by the time spent walking. Therefore, increasing physical activity may be a therapeutic tool in this female population with or at risk of diabetes. Previous clinical trials demonstrated that physical activity as part of an intervention strategy decreased diabetes development at follow-up in adult Swedish men and Chinese and Finnish men and women with impaired glucose intolerance at baseline[35,36].

Table 4 Spearman correlation between FPG and anthropometric indices, triglycerides, BP, dietary intakes and physical activity among adult Moroccan Sahraoui women

	FPG	
	r	*P*-value*
Age	0.342	0.0001
BMI	0.27	0.003
WC	0.378	0.0001
WHR	0.294	0.0001
HyperTG	0.245	0.001
Systolic BP	0.264	0.001
Diastolic BP	0.312	0.0001
FHD	0.188	0.006
Dietary intakes		
Energy	−0.137	0.048
Carbohydrates	0.073	0.29
% Carbohydrate	0.095	0.17
Sucrose	0.036	0.6
% Sucrose	0.08	0.22
Physical activity		
Walking	−0.227	0.003
Tea consumption	0.09	0.216
Afternoon sleeping	0.092	0.257

FPG – fasting plasma glucose; BP – blood pressure; *r* – Spearman correlation coefficient; BMI – body mass index; WC – waist circumference; WHR – waist-to-hip ratio; HyperTG – hypertriglyceridaemia; FHD – family history of diabetes.
*Statistical significance was set at $P < 0.05$.

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Also people with a family history of diabetes or with IFG may be able to avoid the disease if they adopt healthy lifestyles and maintain a healthy weight[37]. In addition, a marked improvement in carbohydrate and lipid metabolism in diabetic Australian aborigines after temporary reversion to traditional lifestyle has been reported[38].

In conclusion, although a limitation of our analyses, as for almost all published studies[18], is that we defined hyperglycaemia based on a single measurement rather than using the repeated measurements necessary for a clinical diagnosis, this study has clearly demonstrated that undiagnosed diabetes and IFG are very common in Sahraoui adult women, associated with adverse levels of cardiovascular risk factors. The results reflect the general lack of community awareness of diabetes. Strategies and programmes to increase diabetes awareness in this population should be considered a priority so that early intervention can prevent, reverse, halt or slow the progression of complications. Preventing obesity early in life through lifestyle modification, including healthy diet and increased physical activity, may considerably reduce diabetes incidence and its future complications in this population.

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