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Diabetes Research and Clinical Practice xxx (2007) xxx–xxx
DIABETES RESEARCH AND CLINICAL PRACTICE
www.elsevier.com/locate/diabres

Prevalence of diabetes mellitus and its complications in a population-based sample in Al Ain, United Arab Emirates

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Received 26 February 2007; accepted 20 April 2007

Abstract

Aims: To determine the prevalence of diabetes mellitus (DM) and its complications in the adult population of the United Arab Emirates (UAE) and assess the degree of metabolic control in subjects with diagnosed DM.

Methods: A random sample of houses of Emirati citizens living in Al Ain, UAE was surveyed. Fasting blood glucose was determined by glucose meter and an oral glucose tolerance test (OGTT) was conducted if blood sugar was <7 mmol/l. DM was defined according to the WHO criteria. Pre-diabetes status was based on fasting venous blood glucose concentration of 5.6–6.9 mmol/l or 2 h post-OGTT venous blood glucose level of 7.8–11.0 mmol/l.

Results: There were 2455 adults (>18) living in the 452 surveyed houses of which 10.2% reported having the diagnosis of DM. A total of 373 men and non-pregnant women underwent testing, and after adjustment for factors affecting participation probability the prevalence of diagnosed DM, undiagnosed DM and pre-diabetes was 10.5, 6.6 and 20.2%, respectively. Age-standardized rates for DM (diagnosed and undiagnosed) and pre-diabetes among 30–64 years old were 29.0 and 24.2%, respectively. Logistic regression analysis showed that only age and body mass index (BMI) were significantly independently related to undiagnosed DM. In patients with diagnosed DM, the prevalence rates for retinopathy, neuropathy, nephropathy, peripheral vascular disease and coronary heart disease were 54.2, 34.7, 40.8, 11.1 and 10.5%, respectively. A significant proportion of subjects with undiagnosed DM and pre-diabetes also had micro- and macro-vascular complications. The proportion of subjects with diagnosed DM who achieved internationally recognized targets for HbA1c (<7%), LDL-C (<2.6 mmol/l) and blood pressure (<130/80 mmHg) was 33.3, 30.8 and 42.1%, respectively.

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0168-8227/$ – see front matter
doi:10.1016/j.diabres.2007.04.008

Conclusion: This study confirms the previously reported high prevalence of DM in the UAE. Diabetic complications were highly prevalent among subjects with diagnosed and undiagnosed DM. Metabolic control was suboptimal in most subjects with diagnosed DM. Greater efforts are urgently needed to screen early and effectively treat DM in the UAE in order to prevent long-term complications.

Keywords: Prevalence; Diabetes mellitus; Pre-diabetes; Complications; United Arab Emirates

1. Introduction

Health problems associated with diabetes mellitus (DM) are a growing source of concern in the United Arab Emirates (UAE). First established as a nation in 1971, the UAE has progressed rapidly from a subsistence agrarian economy emphasizing animal husbandry and date production to a diversified economy producing oil and oil based products, commerce and tourism. These rapid changes had an enormous impact on the UAE society such as improved education and rising affluence. This has been associated with decreased levels of activity and increasing consumption of calories leading to obesity and associated high rates of type 2 DM in this population [1–4]. A prevalence survey, performed in 1989–1990 on adults in the UAE [1] found an overall prevalence of DM of 6%. A more recent survey (1999–2000) suggests a much higher prevalence of over 20% [2] making the prevalence of DM in the UAE the second highest in the world after Narau [5].

We are not aware of any more recent surveys on the prevalence of DM in the UAE. Our objectives were to determine the current prevalence of DM in a sample of UAE citizens residing in the city of Al Ain and survey complications in subjects with diagnosed and undiagnosed DM. We also wanted to assess the degree of metabolic control in subjects with diagnosed DM. This study may provide important information for planning of services and determining the effectiveness of population-based interventions.

2. Methods

2.1. Sampling

The study was designed to enroll 100 subjects with DM (diagnosed and undiagnosed) in order to be able to estimate the prevalence of any complication that occurs in 50% of subjects with DM with accuracy (coefficient of variation) of 10%, i.e. with a standard error of 0.05. On the basis of previous studies, showing a prevalence rate of DM in the adult population of 25% [2], we estimated a required total sample size of 400 subjects.

In order to draw a random sample from the population of UAE citizens from Al Ain, the electricity department was contacted. This department is able to identify households held by UAE citizens on the basis of the tariff structure. From their list of approximately 40,000 houses, we randomly selected 1600 using simple random sampling. This much larger number was chosen in order to adjust for a potentially high refusal rate, and a high percentage of unoccupied houses (many UAE citizens have houses in different places, e.g. Abu Dhabi as well as Al Ain), as we estimated in our worst case scenario that only approximately 20–30% of all households would actually provide consenting participants. The 1600 houses were randomly divided into 600 to be contacted in a first sampling wave, and 1000 to be contacted in case the first wave would yield insufficient participants. Of the 600 houses in the first sampling wave 575 houses were approached, 25 houses turned out to be in very remote areas which were, therefore, excluded from the sample.[1] All men and non-pregnant women aged 18 years and over who were UAE citizens residing in any of the contacted houses were eligible for this study. Participants arrived in the morning at the nearest primary health care center after an overnight fast (8–16 h) for interview, physical examination and laboratory tests. The study was approved by the Al Ain Medical District Human Research and Ethics Committee.

2.2. Questionnaire

Following informed consent, each participating subject was interviewed in Arabic by a trained nurse using an English questionnaire. Items covered included demographic data, reproductive history, physical activity, tobacco use, health status, diabetic neuropathy symptom (DNS) score [6], medication use and cardiovascular symptoms.

2.3. Physical examination and anthropometric measurements

Physical examination and measurements were performed by a trained nurse. Weight and height were measured by portable digital scale and a portable stadiometer. Waist and hip circumference were assessed using a flexible tape over loose clothing. Blood pressure (systolic and phase-V diastolic) recordings were made after the subjects had rested in the

[1] Actually, to avoid potential imbalances among districts, a maximum number of participants per district were set. However, this maximum was never reached.

sitting position for 10 min using a validated electronic sphygmomanometer (Omron Hem 907). Three separate determinations were made with the mean of the three recorded as the blood pressure. Peripheral neuropathy was ascertained by the diabetic neuropathy examination (DNES) score [7]. Peripheral vascular disease (PVD) was assessed by palpation of the dorsalis pedis and posterior tibial pulses on both feet. Body fat percent was estimated by bioelectric impedance using the Tanita Body Composition Analyzer, model TBF-410 (Tanita Corporation, Tokyo, Japan).

2.4. Laboratory measurements

Subjects reporting a history of DM and currently taking oral medications or insulin were considered to have DM. For those who reported having DM but were not taking medications, and in all other subjects, fasting blood glucose was determined by glucose meter and an oral glucose tolerance test (OGTT) was conducted only if blood sugar was <7 mmol/l. Fasting blood venous samples were collected from all participants for determination of serum glucose and chemistry, HbA1c and lipid profile. Spot urine was also collected for measurement of albumin and creatinine. For the OGTT, subjects were requested to drink, within the space of 5 min, 75 g anhydrous glucose dissolved in 250 ml water. Samples were processed within 30 min of collection and the above laboratory tests were measured on a Beckman Coulter DXC800 (Beckman Instruments, Inc., Fullerton, California) auto-analyzer at the central laboratory of Tawam hospital, a tertiary hospital in Al Ain. Twelve-lead electrocardiography (ECG) was recorded in the supine position using the clinics' available ECG machines which are used for the daily routine clinical practice. All these ECG machines were standardized by the clinics' technical departments.

2.5. Retinal photographs

Retinal photographs were performed using a Topcon digital fundus camera model TRC50IX (Diagnostic Instrument Group, FL, USA) to assess the presence and degree of retinopathy. The images were viewed by an ophthalmologist to determine if retinopathy was present. Classification for diabetic retinopathy was based on the international clinical diabetic retinopathy severity scales [8].

2.6. Data processing and analysis

DM was defined according to the WHO expert group [9], i.e. fasting venous blood glucose concentration ≥7.0 mmol/l and/or 2 h post-OGTT venous blood glucose concentration ≥11.1 mmol/l. Pre-diabetes status was based on the presence of impaired fasting glucose (venous blood glucose concentration of 5.6–6.9 mmol/l) or impaired glucose tolerance (2 h post-OGTT venous blood glucose level of 7.8–11.0 mmol/l). Body mass index (BMI) was defined as weight (kg) divided by the square of height (m) and obesity was defined as a BMI of 30 kg/m^2 or more. Waist circumference ≥94 cm for males and ≥80 cm for females was considered as a risk factor for DM [10]. Obesity based on bioelectric impedance was defined as over 35% body fat [11]. Hypertension was defined as a systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg or being on antihypertensive medications. Glomerular filtration rate (GFR) was estimated using the Cockroft–Gault formula [12]. Nephropathy was defined as an estimated GFR <60 ml/min and/or a urinary albumin to creatinine ratio (ACR) ≥2.5 mg/mmol in males or ≥3.5 in females [13,14]. Peripheral neuropathy was considered to be present if the DNS score was >0 or the DNES score was >3. PVD was diagnosed when there was history of intermittent claudication in the presence of two or fewer (out of four) pedal pulses. In addition, patients reporting a history of PVD, gangrene or non-traumatic amputation were labeled as having PVD. Coronary heart disease (CHD) was identified by a history of angina, myocardial infarction, angioplasty or coronary bypass surgery or electrocardiographic findings consistent with ischemia or old myocardial infarction.

Data were analyzed using SPSS version 15 (SPSS Inc., Chicago, IL). Standard descriptive statistics were used. Logistic regression analysis was used for multivariate analysis of the probability of participation, and for the probability of having DM. To analyze whom to screen for DM in the UAE population, we selected all cases without a diagnosis of DM. We then carried out stepwise (forward selection) logistic regression with all demographic, socio-economic, behavioral and anthropometric variables that can be obtained through simple non-invasive means or by asking a simple question. Differences among groups were analyzed using analysis of variance (ANOVA) with Tukey's method for post hoc pair-wise comparisons for continuous variables, and Chi-square tests and Bonferoni adjusted pair-wise comparisons for categorical variables. For age-standardization the Segi world population was used [15].

3. Results

3.1. Prevalence of diabetes

Of the 575 houses surveyed between December 2005 and November 2006, 452 were occupied and household heads provided information. There were 2455 adults living in these houses and DM status was available on 2396 (1176 men and 1220 women), out of which 245 (10.2%) subjects (9.4% of men and 11.1% of women) were reported to have DM (Table 1). Using the 30–64 years olds only, as suggested by King and Rewers [16], we obtained Segi standardized prevalence rate of reported diabetes of 20.6% (17.7% in men and 22.1% in women). Subjects with DM were more likely to be older, illiterate and unemployed ($p < 0.01$ for all comparisons). DM was also more frequently reported in residents of urban compared to suburban areas (10.7% versus 6.8%; $p = 0.03$). Of these 452 houses, 71 household heads refused

Please cite this article in press as: H. Saadi et al., Prevalence of diabetes mellitus and its complications in a population-based sample in Al Ain, United Arab Emirates, Diab. Res. Clin. Pract. (2007), doi:10.1016/j.diabres.2007.04.008

Table 1
Prevalence of household-reported diabetes by age and sex in 2396 adults, Al Ain, UAE

Age (years)	Men		Women		Total	
	N	%	*N*	%	*N*	%
18–29	634	1.4	627	1.0	1261	1.2
30–39	207	3.4	240	6.7	447	5.1
40–49	108	12.0	161	23.0	269	18.6
50–59	99	35.4	114	31.6	213	33.3
60–69	77	41.6	47	53.2	124	46.0
≥70	51	27.5	31	48.4	82	35.4
All ages	1176	9.4	1220	11.1	2396	10.2

further participation, while 381 agreed. However, from only 194 houses, a total of 373 household members actually underwent testing. The range of the number of participating individuals per household was 1–9, median 2. These individuals were subsequently linked to the data base of all contacted households. Among these subjects, the elderly, females, unemployed, better educated and those known to have DM were overrepresented. The probability of inclusion (participating in the study) was estimated on the basis of these variables using logistic regression. The inverse probability, normalized to an average of one, was then used as a sampling weight to correct for non-randomness and thereby to estimate population prevalence.

Of the 373 participants who underwent testing, 57 (15.3%) were known to have DM. Forty-two subjects had fasting blood glucose >7 mmol/l as determined by glucose meter, and were, therefore, excluded from OGTT (only 29, however, were later confirmed to have concentrations ≥7 mmol/l by venous sample and were, therefore, diagnosed with diabetes; the other 13 subject, all having fasting venous blood glucose ≥5.6 mmol/l, were considered to have impaired fasting glucose or pre-diabetes). The remaining 274 subjects underwent OGTT. The results were normal in 191 (51.2%) subjects. Eleven subjects had 2 h OGTT ≥11.1 mmol/l yielding a total of 40 (10.7%) subjects with undiagnosed DM. ~~Sixty~~ two subjects had impaired glucose tolerance and/or impaired fasting glucose yielding a total of 85 (22.8%) subjects with pre-diabetes (Table 2). After adjustment of the probability of inclusion in the study, the prevalence of diagnosed DM was reduced to 10.5%, undiagnosed DM to 6.6% and pre-diabetes to 20.2%. Age-standardized rates for DM and pre-diabetes among 30–64 years old were 29.0% (15.0% for diagnosed and 14.0% for undiagnosed) and 24.2%, respectively.

3.2. Prevalence of associated conditions and risk factors for undiagnosed diabetes

Overall, hypertension, hypercholesterolemia and a family history (first and second degree) of DM were reported in 16, 21 and 46% of subjects, respectively. Of the 178 women who were ever pregnant, 52 (29.2%) reported history of gestational DM. More than one-third (36.2%) of subjects were obese and only 34% reported that they have performed any form of exercise at least once in the previous 2 weeks. About 1 in 10 subjects (11.5%) was a current or past cigarette smoker. Subjects with diagnosed and undiagnosed DM were more likely to be older, have obesity, hypercholesterolemia, hypertension and nephropathy compared with normoglycemic subjects (Table 3). Stepwise logistic regression showed that only BMI and age were significantly independently related to undiagnosed DM. Gender, waist circumference, exercise, hypertension and the consumption of salads and various kinds of fruits were not significantly independently associated with undiagnosed DM. As the coefficients of these variables were 0.088 (BMI) and 0.059 (age), we created a new variable (risk score, RS) RS = 2 × age + 3 × BMI and grouped this into intervals of 25. No individual with a risk score <150 had undiagnosed DM.

3.3. Diabetes complications

Only 24 subjects with diagnosed DM had digital fundus camera examination and 13 (54.2%) had evidence of background retinopathy. None had proliferative retinopathy. Very few subjects with undiagnosed DM and pre-diabetes had digital fundus camera examination and,

Table 2
Prevalence (%) of diagnosed diabetes, undiagnosed diabetes and pre-diabetes by age category and sex in 373 subjects

Age (years)	Men (*n* = 122)			Women (*n* = 251)			Total (*n* = 373)		
	Diagnosed diabetes	Undiagnosed diabetes	Pre-diabetes	Diagnosed diabetes	Undiagnosed diabetes	Pre-diabetes	Diagnosed diabetes	Undiagnosed diabetes	Pre-diabetes
18–29	0	0	13.8	0	0	19.8	0	0	18.3
30–49	4.8	9.5	19.0	16.3	14.4	33.7	13.0	13.0	29.5
≥50	41.2	11.8	23.5	27.9	24.6	14.8	33.9	18.8	18.8
Total	18.9	8.2	19.7	13.5	12.0	24.3	15.3	10.7	22.8

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Table 3
Mean (±S.D.) and proportions (%) of selected factors in men and women with normal glucose tolerance, pre-diabetes and diabetes mellitus, Al Ain, UAE

Variable	Normal glucose tolerance	Pre-diabetes	Diabetes mellitus (undiagnosed)	Diabetes mellitus (diagnosed)	*P*-value (ANOVA/Chi-square)
Number of persons	191	85	40	57	–
Female (%)	66.0	71.8	75.0	59.6	NS
Age (years)	34.6 ± 13.7^{a}	41.4 ± 14.3^{b}	49.9 ± 11.8^{c}	56.0 ± 11.6^{d}	<0.001
BMI (kg/m^2)	27.3 ± 6.0^{a}	$29.9 \pm 6.8^{a,b}$	30.8 ± 5.6^{b}	30.3 ± 5.9^{b}	<0.001
BMI ≥30 (%)	28.8^{a}	$41.7^{a,b}$	55.0^{b}	$40.0^{a,b}$	<0.01
Body fat (%)	30.4 ± 10.2^{a}	34.9 ± 9.6^{b}	37.5 ± 8.5^{b}	35.6 ± 8.3^{b}	<0.001
Body fat >35% (%)	37.8^{a}	58.0^{b}	67.5^{b}	56.4^{b}	<0.001
Waist circumference (cm)	84.5 ± 13.8^{a}	$90.2 \pm 13.5^{a,b}$	93.9 ± 12.8^{b}	95.4 ± 10.9^{b}	<0.001
Waist circumference ≥94 cm for males, ≥80 cm for females (%)	50.8^{a}	71.8^{b}	80.0^{b}	81.5^{b}	<0.001
Systolic BP (mmHg)	116.5 ± 14.9^{a}	$121.1 \pm 16.2^{a,b}$	125.9 ± 19.9^{b}	134.2 ± 20.1^{c}	<0.001
Diastolic BP (mmHg)	70.6 ± 9.7^{a}	$71.9 \pm 10.2^{a,b}$	$75.5 \pm 11.9^{b,c}$	77.1 ± 11.6^{c}	<0.001
Hypertension (%)	10.5^{a}	$17.9^{a,b}$	$30.0^{b,c}$	39.3^{c}	<0.001
Fasting serum glucose (mmol/l)	5.0 ± 0.7^{a}	5.6 ± 0.7^{a}	7.1 ± 1.3^{b}	9.3 ± 3.2^{c}	<0.001
HbA1c (%)	5.5 ± 0.6^{a}	5.7 ± 0.6^{a}	6.7 ± 0.9^{b}	8.3 ± 2.5^{c}	<0.001
Estimated GFR (ml/min)	127.6 ± 35.8	125.9 ± 47.0	119.4 ± 37.4	111.8 ± 45.9	0.07
Estimated GFR <60 (%)	1.6^{a}	$4.8^{a,b}$	$7.5^{a,b}$	15.1^{b}	0.001
Albumin excretion rate (mg/mmol)	1.9 ± 6.8^{a}	3.1 ± 11.8^{a}	$1.9 \pm 2.8^{a,b}$	10.6 ± 43.1^{b}	0.03
Albumin excretion rate ≥2.5 for males and ≥3.5 for females (%)	8.7^{a}	15.0^{a}	10.3^{a}	34.8^{b}	<0.001
Cholesterol (mmol/l)	4.9 ± 1.0^{a}	5.3 ± 1.0^{a}	$5.5 \pm 1.4^{a,b}$	5.0 ± 1.1^{b}	<0.001
LDL-C (mmol/l)	3.4 ± 0.9^{a}	$3.7 \pm 0.9^{a,b}$	$3.9 \pm 1.3^{b,c}$	3.2 ± 1.0^{c}	<0.001
HDL-C (mmol/l)	1.1 ± 0.2	1.1 ± 0.3	1.1 ± 0.2	1.0 ± 0.2	NS
Triglycerides (mmol/l)	0.9 ± 0.6^{a}	1.1 ± 0.6^{a}	1.2 ± 0.6^{a}	1.6 ± 0.9^{b}	<0.001

P-values (ANOVA/Chi-square) are for tests of heterogeneity, i.e. any differences among groups. Categories sharing the same superscripts (a–d) form homogeneous subsets and are not statistically significantly different from each other by Tukey's test for continuous variables and Bonferoni adjusted pair-wise comparison for categorical variables. All other comparisons, as indicated by different superscript letters, are statistically significantly different.
BMI: body mass index; BP: blood pressure. Hypertension: systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg or antihypertensive medication.

therefore, their results are not reported. The prevalence rates of nephropathy and peripheral neuropathy in subjects with diagnosed diabetes were ~~37.8 and 33.1~~%, respectively (Table 4). These rates were significantly higher than those observed in subjects with pre-diabetes ($p < 0.05$). The prevalence rates for PVD and CHD were also higher in subjects with diagnosed DM compared to subjects with pre-diabetes, but this did not reach statistical significance. Compared to subjects with normoglycemia, however, both conditions were significantly more prevalent in subjects with diagnosed DM (10.5% versus 0.5% and 11.1% versus 1.6%; $p = 0.004$, respectively). The prevalence of cerebrovascular disease was too low to make a meaningful comparison.

Table 4
Prevalence of diabetic complications among subjects with diagnosed, undiagnosed diabetes and pre-diabetes

Complication	Pre-diabetes ($n = 85$)			Undiagnosed diabetes ($n = 40$)			Diagnosed Diabetes ($n = 57$)		
	Men (%)	Women (%)	Total (%)	Men (%)	Women (%)	Total (%)	Men (%)	Women (%)	Total (%)
Retinopathy[a]	–	–	–	–	–	–	72.7	38.5	54.2
Nephropathy	29.2	14.3	18.8^{a}	30.0	13.3	$17.5^{a,b}$	44.4	38.7	40.8^{b}
Peripheral neuropathy	13.0	10.9	11.5^{a}	22.2	14.3	$16.2^{a,b}$	36.8	33.3	34.7^{b}
Peripheral vascular disease	4.2	3.3	3.6^{a}	0.0	6.7	5.0^{a}	9.1	12.5	11.1^{a}
Coronary heart disease	8.3	3.3	4.7^{a}	10.0	3.3	5.0^{a}	13.0	8.8	10.5^{a}

Categories sharing the same superscript (a and b) are not statistically significantly different from each other by Mantel–Haenszel test Bonferoni corrected pair-wise comparisons (only gender adjusted totals are compared).
[a] Only 24 subjects with diagnosed diabetes had digital fundus camera examination.

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Table 5
Metabolic control in subjects with diagnosed diabetes according to type of care received

Variable	Target	Achieving target (total) (%)	Achieving target (primary care) (%)	Achieving target (specialty care) (%)	*P*-value[a]
Fasting serum glucose	≤7.2 (mmol/l)	26.4	12.0	35.7	0.059
HbA1c	<7%	33.3	29.2	40.7	NS
LDL-C	<2.6 (mmol/l)	30.8	12.0	50.0	0.004
HDL-C	>1 (mmol/l)	54.7	68.0	50.0	NS
Triglycerides	<1.7 (mmol/l)	64.2	57.1	68.0	NS
Blood pressure	<130/80 mmHg	42.1	36.0	55.2	NS

[a] *P*-value obtained by Fischer's exact test.

3.4. Patterns of care and metabolic control of subjects with diagnosed diabetes

A total of 57 subjects had diagnosed DM (23 males and 34 females, median age 55 years, range 35–79). The median duration of diabetes was 3 years (range 1 month to 40 years). Only three subjects had type 1 DM. Most subjects were on oral hypoglycemic agents (77.2%), and few were on diet (8.8%) or insulin (14.0%). Almost half received their care from a general practitioner and the others were usually seen by a specialist. Among women who had ever been pregnant, 40.6% reported a previous history of gestational DM. Only 44% of subjects reported seeing a dietitian and 26.8% reported that they did not follow any diet. Less than one-third (30%) reported having ever been seen by a diabetes educator, and 59% did self home glucose monitoring. Few subjects smoked cigarettes (7.4%) and less than a third (31.5%) reported that they had performed any form of exercise at least once in the previous 2 weeks. The frequency of having had an eye examination, HbA1c and cholesterol measurement, and urine analysis in the preceding year was 68, 91, 93 and 70%, respectively. Table 5 shows the metabolic control in these subjects with diagnosed DM. The proportion of subjects who achieved internationally recognized targets [13] for HbA1c (<7%), LDL-C (<2.6 mmol/l) and blood pressure (<130/80 mmHg) were 33.3, 30.8 and 42.1%, respectively. These rates were generally worse for subjects receiving their care from general practitioner in comparison to specialty care, but the differences were statistically significant only for LDL-C (12.0% versus 50.0%; $p = 0.004$).

4. Discussion

We found that the prevalence of known DM in this random sample of UAE citizens living in Al Ain was 10.2%. This rate is very similar to the rate of 10.4% reported by a survey of health status conducted in the Emirate of Abu Dhabi in 2001 [3]. We also found that almost one-third of parous women had history of gestational DM, consistent with previous finding [17]. In subjects who underwent testing, the age-standardized rates for DM (diagnosed and undiagnosed) and pre-diabetes were 29.0 and 24.2%, respectively. Our results confirm the high prevalence of DM in the UAE previously reported by a national study conducted in 1998–2000 [2]. A total of 2360 adult UAE citizens participated in that study and 24.5% were found to have diabetes (14.5% diagnosed, 10.0% undiagnosed), while 18.5% had impaired glucose tolerance. Although earlier studies from the Gulf region [5] have indicated lower rates of DM compared with the UAE, more recent studies show very similar results [18]. Many explanations exist for the high rate of DM in the UAE and other Gulf countries. The most consistent explanations relate to high rates of obesity [1–4,19], which appears to have increased over the last few decades. For example, in a cross-sectional study of 535 community dwelling adult women living in Al Ain [4], 35% of subjects were obese, while this prevalence 11 years earlier was only 27% [1].

The development of a methodology to prevent diabetes on a population-wide basis is in its infancy throughout the world at the present time [5,20]. Although much work needs to be done in this area in the UAE, there are encouraging advances being made. For example, the National Diabetes Control Committee (NDCC) was established by the Ministry of Health in 2001. The NDCC and the Emirates Diabetes Society have been very active in increasing public awareness of diabetes, improving the understanding of diabetes and its control by encouraging research in this area, improving health care providers' understanding of diabetes by organizing continuous medical education programs, and promoting health care policies that improve access to and quality of diabetes care. Lifestyle changes aiming at the reduction of the risks for obesity and diabetes will likely be the greatest challenge to UAE health care leaders and community partners as that will require close collaboration between

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the public and private sectors including within the schools where exercise habits are developed.

The appropriate screening strategy for DM in this high-risk population remains to be established. We agree with the current international recommendations [13] that screening should be carried out within the health care setting rather than in the community. However, the criteria for screening adults in our population could be simplified given our findings that only age and BMI were significantly independently related to undiagnosed DM. Using the risk score equation of RS = 2 × age + 3 × BMI, we observed that no subject with a score <150 had undiagnosed DM. One may, thus, use BMI and age as a first selection criterion. If we maximize specificity of this criterion while keeping its sensitivity at 100% we find that only individuals with a risk score >150 need to undergo further testing. An even simpler selection rule can be created by categorizing both age and BMI into easily recognized groups as follows:

BMI ≤20 (slender): screen from age 45.
BMI >20 and <25 (normal BMI): screen from age 40.
BMI ≥25 and <30 (overweight): screen from age 35.
BMI ≥30 (obese): screen from age 30.

Micro- and macro-vascular complications were highly prevalent among our patients with diagnosed DM and were also detected in a significant proportion of subjects with undiagnosed DM and pre-diabetes. These complications are most likely caused by the hyperglycemia and associated conditions, especially, hypertension. Although methodological differences preclude accurate comparisons, our results are very similar to those published from other Arab countries, except for nephropathy. In a study of 648 patients with type 1 and type 2 DM (age range 5–90 years) assessed at the Diabetes Center, King Abdulaziz University Hospital in Riyadh [21], the prevalence rates for retinopathy, neuropathy, nephropathy, PVD and CHD were 31.8, 34.9, 9.0, 1.9 and 4.3%, respectively. In another study involving 413 Sudanese patients with type 2 DM [22], the prevalence rates were 17.4, 31.5, 9.2, 3.4 and 5.1%, respectively. The higher rate of nephropathy observed in our study is likely related to our measurement of albumin excretion rate which is more sensitive than commercial urine dipsticks used in the other studies for detection of proteinuria, and our use of the new criteria set forth by the National Kidney Foundation [13,14] that also take into consideration the estimated GFR. Our results are in line with a recent audit performed on patients requiring chronic hemodialysis at Tawam hospital, showing that DM as the cause of end-stage renal disease has increased from 43% in 2003 to 63% in 2006 (Bernieh B, personal communication). Although the rates for PVD and CHD were relatively low, cardiovascular risk factors such as hypertension, dyslipidemia, obesity and sedentary lifestyle were highly prevalent in our subjects with and without DM, necessitating urgent attention.

The management of DM is a major challenge to primary care systems worldwide. Despite advances in our knowledge regarding the optimal management of DM, studies using standardized measures from the United States [20,23] and other countries to assess DM quality of care, indicate that management of patients with DM usually falls short of that advocated by current guidelines worldwide. The proportion of subjects achieving internationally recognized targets in our study was generally low albeit very similar to other international population-based studies [24]. This was, especially, so for those subjects receiving their care from general practitioners in comparison to specialty care. As the site of care for the majority of patients with DM is in primary health care, interventions to improve DM management in this sector are of great importance [25]. The current system of primary medical care in Al Ain is not based on continuity of care and accountability but rather on rapid access without appointment to any physician available. Chronic diseases clinics that have been recently implemented may have any impact on quality of care. In a previous preliminary study in Al Ain [26], an intervention was developed and implemented which centered on the development of chronic care/mini-clinics at three primary health care centers. These clinics used structured care protocols, patient-education and a common paper-based system for recording of critical clinical data. Adherence to a set of clinical guidelines using a common data collection form adapted from the Diabetes Quality Improvement Project (DQIP) measurement set [23] was used as the primary quality measure. Significant improvements in the adherence to nearly all guidelines were documented. Similarly, a systematic review of 41 studies based in primary care concluded that complex interventions incorporating organizational changes and interventions aimed at professionals had a potential to lead to improvements in process of care and intermediate outcome measures [25].

4.1. Limitations

The reported rate of diagnosed DM (by individuals and proxy) of 10.2% could be an under- or over-estimation depending on whether Emirati citizens tend to report or not report their disease. In addition, the percentage of

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subjects out of all those in sampled households who underwent testing was small. Especially, the number of households that initially agreed to participate but actually provided household members to the study was somewhat disappointing. Perhaps, traveling to the clinic was considered too time consuming or too inconvenient by many potential participants. Although we adjusted for participation probability, the prevalence rates for diabetes may not be well representative of all eligible subjects in Al Ain. Additionally, data from subjects in Al Ain might not be typical for all regions in the UAE—especially, for those living in smaller rural communities, or those in the major cities (Dubai and Abu Dhabi especially) where the living styles are likely to be different. Despite these limitations, however, our results were very similar to those previously published for the UAE population. Another limitation relates to the methods used to ascertain diabetes complications, especially, retinopathy and PVD. Hence, it will be important to carry out a more comprehensive study of subjects from around the whole UAE. To increase participation rates, participation should be made easier and more attractive, e.g. by working with mobile units and by offering testing at more convenient times (e.g. during weekends).

5. Conclusion

Our results confirm the previously reported high prevalence of diabetes in the UAE. Micro- and macrovascular complications were highly prevalent among patients with diagnosed DM and a significant proportion of subjects had these complications at the time of first diagnosis. Metabolic control was suboptimal in most subjects with diagnosed DM. Greater efforts are urgently needed to properly screen and diagnose DM early in order to prevent long-term complications. Patient-education, dietitian-involvement and an effective referral system are some issues that need further attention in the primary care setting. Programs that both motivate patients to make the important but difficult lifestyle changes, and empower them to promote self-care, need to be initiated throughout the UAE.

Acknowledgments

We are grateful for Drs. Tariq Jabir and Latifa Al Ketbi from Primary Health Care for their support of this study, Mrs. Hala Shehouri for data collection, Mr. Awad Al Essa for data entry and Ms. Lina Sejaan and Mr. Javed Yasin for their technical assistance.

Supported by a research grant from UAE University and UAE Red Crescent.

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