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ORIGINAL DATA

Prevalence of Undiagnosed Diabetes and Quality of Care in Diabetic Patients Followed at Primary and Tertiary Clinics in Abu Dhabi, United Arab Emirates

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■ Abstract

AIMS: To investigate the prevalence of undiagnosed type 2 diabetes (T2D) at primary health care (PHC) clinics, and to assess the quality of care of diabetic patients followed at a tertiary hospital diabetes center in Abu Dhabi, United Arab Emirates (UAE). **METHODS**: Between May 2009 and October 2010, adult patients attending two PHC clinics, and adult diabetic patients attending the diabetes center, were invited to participate in the study. After overnight fast, participants returned for interview and laboratory tests. Undiagnosed T2D was defined by FPG ≥ 7.0 mmol/l or HbA1c ≥ 6.5%. Quality of care was assessed by reported care practices and achievement of internationally recognized targets. **RESULTS**: Out of 239 patients at PHC clinics without history of T2D, 14.6% had undiagnosed T2D, and 31% had increased risk of diabetes (FPG 5.6-7.0 mmol/l or HbA1c 5.7-6.5%). The independent predictors of undiagnosed T2D were age (adjusted OR per year 1.07, 95% CI 1.04-1.11, p < 0.001) and BMI ≥ 25 (adjusted OR 4.2, 95% CI 0.91-19.7, p = 0.033). Amongst all 275 diagnosed T2D patients, including those attending PHC clinics and those followed at the diabetes center, it was found that 40.1% followed dietary recommendations, 12% reported visiting a diabetes educator, 28.2% walked for exercise, and 13.5% attained recognized targets of HbA1c < 7%, blood pressure < 130/80 mmHg, and LDL cholesterol < 2.6 mmol/l. **CONCLUSIONS**: Almost half of the adult patients attending PHC clinics had undiagnosed T2D, or increased diabetes risk. Care practices, and achievement of treatment targets, were suboptimal.

Keywords: type 2 diabetes · diabetes screening · quality of care · diabetes diagnosis · obesity · hypertension · albuminuria · questionnaire · OGTT · fasting plasma glucose

Introduction

In the United Arab Emirates (UAE), there are growing concerns about diabetes-associated health problems. The UAE has the second-highest diabetes prevalence in the world, particularly type 2 diabetes (T2D) [1, 2]. In 2004, the total annual direct treatment costs of uncomplicated diabetes were estimated at US$ 1,605 per patient, which was more than three times the per capita expenditure for health care in the UAE [3]. Treatment costs increase with age, diabetes duration, complications, and use of insulin [3]. Screening for undiagnosed T2D would be cost-effective

due to the greater opportunity to reduce cardiovascular disease complications, principally through the use of statins [4, 5]. Also, intensive multi-factorial intervention in people with screen-detected T2D in primary care should result in lower morbidity and mortality [6]. In view of the high T2D prevalence rate, and the increasing costs, in the UAE, national guidelines recommend screening of all adults aged 30 years and above.

Abbreviations:
ACR - albumin to creatinine ratio
ADA - American Diabetes Association
ANOVA - analysis of variance
BMI - body mass index
BP - blood pressure
CI - confidence interval
DBP - diastolic blood pressure
DECS - Diabetes Education Consultative Section
DNE - diabetic neuropathy examination
DNS - diabetic neuropathy symptom
DVP - digital volume pulse
FPG - fasting plasma glucose
HbA1c - glycated hemoglobin
HDL - high-density lipoprotein
HDL-C - high-density lipoprotein cholesterol
HPLC - high-performance liquid chromatography
IDF - International Diabetes Federation
LDL - low-density lipoprotein
LDL-C - low-density lipoprotein cholesterol
NA - not available
OGTT - oral glucose tolerance test
OGLD - oral glucose lowering drugs
OR - odds ratio
PHC - primary health care
PVD - peripheral vascular disease
SBP - systolic blood pressure
SD - standard deviation
SI - stiffness index
SKMC - Shaikh Khalifa Medical City
T2D - type 2 diabetes
TG - triglycerides
UAE - United Arab Emirates
WC - waist circumference

Despite well-established evidence that better diabetes care reduces complications [7-9], the prevalence of diabetic complications remains high worldwide, and particularly in the UAE. This underlines the fact that quality of care is still suboptimal [2, 10, 11]. Therefore, our objectives for the present study were to estimate the prevalence of undiagnosed T2D, and to evaluate the criteria for screening in patients attending primary health care (PHC) clinics. Also, we wanted to assess the quality of care in a sample of diabetic patients followed at both PHC clinics, and a tertiary hospital diabetes center in Abu Dhabi city, UAE. Our findings should help policy makers and care providers identify key actions towards improving prevention and management of diabetes.

Subjects, materials, and methods

Study population

The target population of the survey was adult Emirati patients residing in Abu Dhabi. We chose two groups of patients. One group included patients being treated for general medical problems, including diabetes, at the PHC clinics of Shaikh Khalifa Medical City (SKMC). The other included those who were being actively followed up for regular diabetes care at the diabetes center of SKMC. Health care provision in Abu Dhabi is almost equally divided between state-managed institutions and privately-owned facilities. SKMC is the major state-managed hospital in Abu Dhabi. The majority of patients attending SKMC are Emirati citizens, and their health care is funded by the government of Abu Dhabi. In addition to being a tertiary hospital, SKMC manages six PHC clinics.

Initially, recruitment was carried out at Al-Bateen, and later at Al-Khaleej PHC clinics. These two clinics were selected because they are designated by SKMC to serve Emirati citizens. These two clinics employ 12 family medicine consultants, 14 specialists, 30 nurses, and 2 part-time dietitians. They handle 9500 patient visits per month. The diabetes center at SKMC employs 4 endocrinology consultants, 2 specialists, 3 full-time diabetes educators, 1 podiatrist, 2 dietitians, 1 clinical pharmacist, and 1 part-time clinical psychologist. The diabetes center handles 1200-1400 patient visits per month. More than 90% of diabetic patients who attend the diabetes center are Emirati citizens. Diabetes patients are usually referred from PHC clinics to the diabetes center for diabetes education and specific treatment of diabetic complications. Patients from both PHC clinics and the diabetes center are referred to the ophthalmology department of SKMC for retinopathy screening.

Subject recruitment

All patients, diabetic and non-diabetic, attending the two PHC clinics for any reason between May 2009 and October 2010, were invited to participate. Patients learned about the study from the physicians they were visiting, and from other health care professionals, such as nurses and clerks, and through posters placed in the clinics.

Eligibility criteria were UAE citizenship, age 18 years and over, and no known pregnancy.

394 (84.7%) of the 465 eligible patients seen at PHC clinics, agreed to participate. Subsequently, 30 (7.6%) of the 394 patients were excluded due to failure to engage in fasting blood measurements, or not completing the questionnaire. Patients who agreed to participate were asked to return after fasting on an agreed date, for interview, physical examination, body fat estimation, and laboratory tests. The latter included oral glucose tolerance test (OGTT) in patients as yet undiagnosed of T2D. OGTT was performed in 121 patients. Most other patients refused OGTT after learning that their fasting blood glucose was normal.

During the study period, all adult diabetic patients attending the diabetes center were invited to participate. 161 (76.3%) of the 211 eligible diabetic patients seen at the diabetes center agreed to participate. Subsequently, 4 of the 161 patients were excluded due to failure to engage in fasting blood measurements, or not completing the questionnaire. One patient reported type 1 diabetes. Patients who agreed to participate were asked to return to the SKMC cardiac laboratory for further study, after fasting on an agreed date. The study was approved by SKMC Research Committee and the Al Ain Medical District Human Research and Ethics Committee.

Questionnaire

Following informed consent, each participant was interviewed in Arabic language by a trained nurse using an English questionnaire on demographic data, tobacco use, diet, physical activity, reproductive history, co-morbidities, medications use, and personal and family history of T2D in first-degree relatives. Information on disease onset, duration, and management were obtained from patients with known T2D diagnosis.

For self-reported diabetic complications, retinopathy was considered to be present if the patient reported diabetic changes in the eye, laser treatment to the retina, or acquired blindness. Peripheral neuropathy was considered, if the diabetic neuropathy symptom (DNS) score was ≥1 [12]. Peripheral vascular disease (PVD) was considered, if circulatory problems or intermittent claudications were reported. Diabetic foot was considered, if patients had foot ulcers, gangrene, or non-traumatic amputation of lower extremities. Cardiac disease was considered, if patients reported angina, myocardial infarction, angioplasty, coronary bypass surgery, or heart failure. Cerbrovascular disease was considered in cases of stroke, or transient ischemic attacks.

Physical examination and anthropometric measurements

Physical examination and measurements were performed by the same trained nurses who carried out questionnaire interviews. Weight and height were measured by portable digital scales, and a portable stadiometer. Waist and hip circumference were measured using a flexible tape over loose clothing. Blood pressure (systolic and phase-V diastolic) recordings were made using a validated electronic sphygmomanometer (Omron Hem 907), after the participants had rested in sitting position for ten minutes. Two separate determinations were made. The mean of the two recorded values was taken as the blood pressure value.

Peripheral neuropathy was ascertained by DNS score and diabetic neuropathy examination (DNE) score [12, 13]. Body fat percent was estimated by bioelectric impedance using the Tanita Body Composition Analyzer, Model TBF-410 (Tanita Corporation, Tokyo, Japan).

Laboratory measurements

In patients with hitherto undiagnosed T2D, fasting blood glucose was determined by glucose meter using Roche Accucheck Inform meter, and OGTT was conducted if blood glucose was <7 mmol/l. Participants were requested to drink 75 g anhydrous glucose dissolved in 250 ml water within the space of five minutes, for the purpose of carrying out OGTT. Fasting venous blood samples were collected from all participants for determination of fasting plasma glucose (FPG), HbA1c, and lipid profile. Spot urine was collected for measurement of albumin and creatinine. All samples were processed within 30 minutes of collection, and the above laboratory tests were measured on a Beckman Coulter DXC800 (Beckman Instruments, Inc., Fullerton, California, USA) autoanalyzer at the central laboratory of SKMC.

Initially, HbA1c was measured by high-performance liquid chromatography (HPLC, Bio-Rad Variant II), and after February 1, 2010, by immunoassay (Cobas Roche Integra 400 plus). Large artery stiffness index (SI) derived from the digital volume pulse (DVP) was measured at the right index finger by a photoplethysmography (PulseTrace PCA2, Micro Medical Ltd., Rochester, UK). SI (m/s) was formulated automatically by computer as body height (m) divided by transition

Table 1. Baseline characteristics and risk factors of study participants by diabetes status and follow-up facility

Variable	PHC clincs					Diabetes center	
	Low risk (n = 130)	Increased risk (n = 74)	Undiagnosed T2D (n = 35)	Diagnosed T2D (n = 118)	p	Diagnosed T2D (n = 157)	p
Women (%)	86.9	78.4	80.0	76.3	NS	52.2	< 0.001
Age (yr)	38.0 ± 12.0	46.7 ± 12.2	52.8 ± 12.0	51.9 ± 11.9	< 0.001	54.2 ± 10.2	0.09
BMI (kg/m^2)	29.6 ± 6.8	32.4 ± 6.0	31.9 ± 5.9	32.8 ± 6.5	< 0.001	32.9 ± 7.2	NS
Body fat (%)	32.5 ± 11.7	36.0 ± 7.0	34.7 ± 8.8	37.5 ± 10.0	NS	NA	NA
Waist (cm)	99.0 ± 13.8	107.1 ± 11.3	106.6 ± 12.7	106.9 ± 12.4	< 0.001	109.3 ± 15.9	NS
SBP (mmHg)	115.3 ± 12.7	120.8 ± 15.5	129.9 ± 16.6	123.9 ± 16.7	< 0.001	127.0 ± 18.0	NS
DBP (mmHg)	72.0 ± 8.8	76.7 ± 10.1	78.3 ± 11.7	76.0 ± 12.1	< 0.001	72.0 ± 10.0	< 0.001
FPG (mmol/l)	4.9 ± 0.3	5.4 ± 0.5	6.3 ± 1.3	8.0 ± 3.3	< 0.001	8.7 ± 3.4	0.09
HbA1c (%)	5.5 ± 0.3	6.0 ± 0.3	6.9 ± 0.6	7.8 ± 1.9	< 0.001	8.1 ± 1.9	NS
T-chol (mmol/l)	4.7 ± 0.9	4.7 ± 1.0	5.1 ± 1.1	4.3 ± 1.1	< 0.001	3.9 ± 0.9	< 0.001
LDL-C (mmol/l)	3.1 ± 0.8	3.1 ± 0.9	3.4 ± 1.0	2.6 ± 0.9	0.006	2.2 ± 0.8	0.001
HDL-C (mmol/l)	1.2 ± 0.3	1.1 ± 0.4	1.2 ± 0.3	1.1 ± 0.3	0.03	1.1 ± 0.3	NS
TG (mmol/l)	0.9 ± 0.5	1.1 ± 0.5	1.2 ± 0.4	1.4 ± 0.8	< 0.001	1.3 ± 0.7	NS
Albuminuria (mg/mmol)*	6.1 ± 9.0	7.0 ± 10.1	10.9 ± 16.8	12.8 ± 29.8	0.04	18.3 ± 49.5	NS
SI (m/s)	7.9 ± 1.8	8.5 ± 1.9	10.3 ± 7.8	8.5 ± 2.1	0.02	8.6 ± 2.2	NS
Gestational diabetes (%)	10.8	10.0	21.7	33.7	< 0.001	47.2	0.09
Family history of T2D (%)	52.8	65.8	41.2	61.2	NS	63.5	NS

Legend: Data are mean ± SD, or percentage. P-values (ANOVA/Chi-square) are for tests of heterogeneity, i.e. any differences among groups. BMI: body mass index. SBP: systolic blood pressure. DBP: diastolic blood pressure. FPG: fasting plasma glucose. LDL-C: low-density lipoprotein cholesterol. HDL-C: high-density lipoprotein cholesterol. TG: triglycerides. SI: stiffness index. T2D type 2 diabetes. PHC: primary health care. NS: not significant. NA: not available. *Albuminuria is defined as urine albumin/creatinine.

time (s) from the first systolic peak to the inflection point of reflection waveform (peak-to-peak time) [14]. All measurements were made according to the manufacturer operating manual (Drg no. 117-24; Revision 1.0; November 2006).

Data processing and analysis

Participants reporting history of T2D other than gestational diabetes were regarded as T2D-positive. As some participants did not undergo OGTT, undiagnosed T2D was defined as FPG ≥ 7.0 mmol/l or HbA1c ≥ 6.5% [15]. Determination of increased T2D risk was based on the presence of impaired FPG (5.6 to <7.0 mmol/l), or HbA1c of 5.7% to <6.5%. Low diabetes risk was defined as FPG < 5.6 mmol/l and HbA1c < 5.7% [15]. Obesity was defined as body mass index (BMI) ≥ 30 kg/m^2. Obesity based on bioelectric impedance was defined by >35% body fat [16]. Urinary albumin to creatinine ratio (ACR) ≥ 2.5 mg/mmol in males, or ≥3.5 in females, was considered abnormal [17]. DNS score ≥ 1 and DNE score > 3 were considered abnormal [12, 13].

Statistical analysis

Data were analyzed using SPSS version 18 (SPSS Inc., Chicago, IL, USA). Standard descriptive statistics were used. Linear and logistic regression analysis was used for multivariate analysis with continuous and binary dependent variables, respectively. Analysis of criteria for T2D screening was carried out by selecting all cases without prior diagnosis, and performing stepwise (forward selection) logistic regression with undiagnosed diabetes as the dependent variable. All demographic, socio-economic, behavioral, and anthropometric variables that were obtained through simple non-invasive means, e.g. by asking a simple question, were taken as independent variables.

Results

Prevalence of undiagnosed diabetes and diabetes risk factors in patients from PHC clinics

118 (32.4%) of the 364 patients had known diagnosed T2D. OGTT was performed in 121 pa-

Table 2. Clinical profile and care practices of diabetic patients followed at primary health care clinics and diabetes center

Variable	All patients (n = 275)	PHC clinics (n = 118)	Diabetes center (n = 157)	p
Time since diagnosis (yr)	9.5 ± 7.5	6.3 ± 7.0	11.7 ± 7.1	< 0.001
Way of diagnosis				
Screening	23.6	27.7	20.6	NS
Incidental	51.7	50.0	52.9	NS
Symptoms	24.7	22.3	26.5	NS
Treatment				
Lifestyle only	5.1	9.6	1.9	0.01
OGLD only	65.1	79.1	54.8	< 0.001
Insulin + OGLD	29.8	11.3	43.3	< 0.001
Anti-lipid medication	73.6	67.2	78.4	0.03
Hypertension medication	55.7	54.4	56.7	NS
Microvascular compl.	20.3	13.6	25.5	0.01
Macrovascular compl.	28.4	22.0	33.1	0.06
Abnormal DNS score	25.1	20.3	28.7	NS
Abnormal DNE score	8.5	6.8	9.7	NS
Care practices				
≥3 physician visits/year	87.6	80.5	92.4	0.01
Retinopathy screening	60.7	50.9	67.7	0.01
Diabetes educator visit	12.0	8.9	14.3	NS
Dietitian visit	61.3	43.4	74.4	< 0.001
Self-management and habits				
Regular self-monitor BG	79.5	61.4	92.3	< 0.001
Follows diet most times	40.1	29.2	48.1	0.005
Walking in last 2 wk	28.2	23.9	31.4	NS
Smoking	6.7	4.4	8.4	NS

Legend: Data are mean ± SD, or percentage. P-values by chi-square test. DNE: diabetes neuropathy examination. DNS: diabetes neuropathy symptom. OGLD: oral glucose lowering drugs. PHC: primary health care. NS: not significant.

tients. Based on 2-hr OGTT (≥11.1 mmol/l), only 3 (2.5%) patients without diabetes history were diagnosed as T2D-positve. The 3 identified patients had FPG ≥ 7 mmol/l, or HbA1c ≥ 6.5%. Based on FPG and HbA1c, 239 of the 246 patients without history of T2D were classified as follows (Table 1):

- Undiagnosed diabetes (35 patients; 14.6%)
- Low risk for T2D (130 patients; 54.4%)
- Increased risk for T2D (74 patients; 31%).

Seven patients could not be classified as their HbA1c results were not available. Where T2D had been identified by either FPG, or HbA1c (n = 35), 11.4% were identified only by FPG, 68.6% only by HbA1c, and 20% by both criteria. Among the patients with increased risk for T2D, 13.9% were identified only by FPG, 52.8% only by HbA1c, and 33.3% by both tests.

Compared with other patients, those with diagnosed and undiagnosed T2D were more likely to be older, to have obesity, dyslipidemia, hypertension, albuminuria, history of gestational diabetes, and increased stiffness index. All patients identified as undiagnosed diabetics were ≥45 years and/or had BMI ≥ 25 kg/m^2. The only independent predictors of undiagnosed T2D were age (adjusted OR per year 1.07, 95% CI 1.04-1.11, one tailed p-value < 0.001) and BMI ≥ 25 (adjusted OR 4.2, 95% CI 0.91-19.7, one tailed p-value = 0.033).

Clinical profile of diabetic patients seen at PHC clinics and the diabetes center

Baseline characteristics of the participants by their diabetes status are shown in Table 1. More female patients were treated at PHC clinics. Amongst all 275 diagnosed T2D patients, including those attending PHC clinics and those followed at the diabetes center, it was found that obesity occurred in 46.6% of men, and 73.5% of women. 26% of all women reported history of gestational diabetes. More than half of the latter were treated with insulin.

Diabetic patients followed at the diabetes center had longer duration of diabetes, and were more likely to be using insulin, and taking lipid lowering medications (Table 2). Hypertension and lipid abnormalities were common (reported in 55.7% and 73.6% of all patients, respectively). Whereas, micro- and macrovascular complications were less prevalent (20.3 and 28.4%, respectively). Abnormal DNS score was found in one-quarter of patients, but abnormal DNE scores were rare. Abnormal ACR was found in approximately half of

the studied patients. Few patients had been hospitalized in the preceding twelve months.

Care practices of diabetic patients at PHC clinics and the diabetes center

Most patients (87.6%) visited their physicians 3 times or more often per year. 60.7% reported that they had been screened for retinopathy in the past, and 79.5% did self-glucose monitoring (Table 2). Only few patients (12%) had ever visited a diabetes educator. 61.3% of patients reported having visited a dietitian, but only 40.1% followed dietary recommendations. Only few patients smoked cigarettes (6.7%), and less than a third (28.2%) reported that they had walked for the purpose of exercise in the previous two weeks. More than 90% reported having had HbA1c, cholesterol, and urine albumin measurements in the preceding year (data not shown).

Metabolic profile and achievement of targets

Patients followed at the diabetes center had significantly lower cholesterol, LDL-C, and diastolic blood pressure compared with patients followed at PHC clinics (Table 1). The proportion of patients who achieved recognized targets are shown in Table 3. Except for lipid control, all targets were achieved in less than half of the patients, and only 13.5% attained all 3 internationally recognized targets of HbA1c < 7%, blood pressure < 130/80 mmHg, and LDL-C < 2.6 mmol/l. Only one-third of patients were at the HbA1c goal. Logistic regression analysis showed that diabetes duration was the only independent factor of HbA1c target achievement (adjusted OR per year 0.93, 95% CI 0.89-0.98, p < 0.01). No significant differences were found in the achievement of these targets between PHC and diabetes center patients except for LDL-C target, which was better achieved at the diabetes center (p = 0.04). Similar findings were made when adjusting for age, gender, and diabetes duration, and using stepwise (forward selection) logistic regression.

Table 3. Metabolic control of diabetic patients followed at primary health care clinics and diabetes center according to internationally recommended targets

Target	All patients (n = 275)	PHC clinics (n = 118)	Diabetes center (n = 157)	p
FPG ≤ 7.2 mmol/l	44.8	50.0	40.6	0.08
HbA1c < 7%	32.7	37.2	29.0	NS
BP < 130/80 mmHg	48.7	47.8	49.3	NS
TG < 1.7 mmol/l	78.9	76.3	81.0	NS
LDL-C < 2.6 mmol/l	68.4	61.4	73.9	0.04
HDL-C >1 mmol/l (men), >1.3 mmol/l (women)	61.1	61.7	60.6	NS
HbA1c < 7%, BP < 130/80 mmHg, LDL-C < 2.6 mmol/l	13.5	13.4	13.7	NS

Legend: Data are presented as percentage. P-values by chi-square test. BP: Blood pressure. FPG: fasting plasma glucose. LDL-C: low-density lipoprotein cholesterol. HDL-C: high-density lipoprotein cholesterol. TG: triglycerides. PHC: primary health care. NS: not significant.

Discussion

Screening for undiagnosed T2D

We found a prevalence of undiagnosed diabetes of 14.6% among adult patients attending PHC clinics. As expected, this rate is higher than our previous result of 10.1% found in a population-based sample of Emirati adults using HbA1c [18]. Individuals who attend PHC for routine care for other reasons than diabetes are usually less healthy, and older than the rest of the population, and may be at a higher risk for T2D. We also found a considerable discordance between FPG- and HbA1c-based diagnosis of diabetes and increased risk for diabetes, with more patients identified by HbA1c. This discordance may be attributed to the greater amount of women than men in the sample studied (as women are more likely to be identified by HbA1c than FPG), and possibly other factors that are relatively common in Emirati citizens such as hemoglobinopathies and iron deficiency anemia. UAE national screening guidelines are similar to the American Diabetes Association (ADA) guidelines [15] except for a lower age cut-off (≥30 years). All patients identified in our study as undiagnosed diabetics were ≥45 years, or had BMI ≥ 25 kg/m^2. These patients would have been identified by following the ADA recommendations for screening, since they have an additional risk factor (high-risk ethnic population). Lowering the age of screening in the UAE to ≥30 years would likely identify only few more cases, and therefore would not be a cost-effective strategy.

We did not examine whether community screening would be a recommendable strategy in the UAE. Given the data retrieved, we were unable to assess whether screening should be carried out within the health care setting only for targeting high-risk individuals, as recommended by international organizations [15, 19]. People identified with positive tests by community screening may not seek, or may not have access to, appropriate follow-up testing and care. On the one hand, screening tests at health care centers and clinics showed that high-risk individuals can be successfully introduced to lifestyle counseling [20]. Whereas, tests carried out in public campaigns outside health care centers rarely led to such beneficial contacts. Community screening in the UAE would be preferable, if a substantial percentage of individuals with undiagnosed diabetes otherwise rarely visit PHC clinics. Provided that when diagnosed through screening, the individuals would comply with treatment, and the medical infrastructure can cope with the extra workload without loss of quality of care. However, it is questionable whether the ideal responses can be achieved in the UAE. PHC clinics and diabetes centers in the UAE are already under pressure, and would need extra resources to cope with the increase in work load.

Prevention of type 2 diabetes

We found that 31% of patients attending PHC clinics are at increased risk for T2D. Studies have shown that T2D can be effectively prevented in high-risk individuals by lifestyle changes, which include increased physical activity and reduced intake of dietary fat [21-23]. Lifestyle intervention can also reduce the risk of cardiovascular disease and mortality [5, 24]. Programs addressing lifestyle intervention strategies in the PHC setting have been successful in reducing the progression of T2D in individuals at high risk [20]. Long follow-up periods are needed to see whether this effect will last over time. Also, community-wide prevention programs that raise public awareness of the importance of lifestyle behaviors are needed [25]. Prevention programs were implemented in some countries, and hey have been successful in reducing coronary heart disease, and stroke mortality [26]. Recently, the "Weqaya" cardiovascular screening program was introduced by the Health Authority in Abu Dhabi. In the first 2 years, this program has obtained a Framingham Risk Score for almost every adult Emirati [27]. Also, it addresses a spectrum of behavioral change interventions, which are aimed at the individual, group, and population level [27].

Management of type 2 diabetes

Although micro- and macrovascular complications were not commonly reported among our diabetic patients, cardiovascular risk factors such as hypertension, dyslipidemia, vascular stiffness, obesity, and sedentary lifestyle were highly prevalent. Fortunately, smoking was not common (6.7%). Recent long-term clinical trials, aimed at controlling hyperglycemia and lowering known risk factors for cardiovascular disease, have demonstrated benefits of early intervention by reducing micro- and macrovascular diabetes complications [9, 28].

Only 40% of our studied patients followed dietary recommendations, and very few reported that they have ever visited a diabetes educator. These results are in accordance with our previous findings [2, 29, 30]. Education of patients with T2D is considered a fundamental aspect of diabetes care. It is important to recognize that all contacts between patients and practitioners can be opportunities for education [31]. Because patients are responsible for the day-to-day control of their diabetes, it is critical that patients understand the disease, and how to treat it [32]. Education can be carried out on a one-to-one basis, in groups, or both. However, it is not yet clear which education strategy is the most effective one regarding behavioral change, self-management, and physical and psychological outcomes [33].

Promotion of behavioral change among patients requires underlying patient-education programs that include and ensure appropriate training for health professionals. Priority should be given to programs that target patients at high risk of diabetes complications, and that make use of intensive contact and proactive follow-up. In contrast, programs targeting the whole population of diabetes patients, with a low frequency of contact, are likely to have a lower success rate, as high-risk individuals are more likely to slip through the net. Also, it could be beneficial if disease managers are able to start or modify medical treatment proactively [32, 34].

Education programs for educators have been developed internationally by several organizations. We have previously organized several diabetes education courses in collaboration with the Diabetes Education Consultative Section (DECS) of the International Diabetes Federation (IDF). These courses aimed at educating health care pro-

fessionals, such as dietitians, pharmacists, and nurses, who interact with patients suffering from diabetes. The courses were based on the IDF curriculum for Diabetes Health Professional Education, and were generally well attended and well received [35]. National policy initiatives are needed to support the role of diabetes educators and self-management education programs to improve the health of diabetic patients.

Diabetes control in patients from primary health care and diabetes clinics

In our study, only 13.5% of patients attained all three internationally recognized targets. This value is similar to that found by a recent study from the United States [36], but slightly better than that in developing countries [11]. The achievement of treatment goals was not significantly different between PHC clinics and the diabetes center except for the LDL-C target. This could be due to a more aggressive lipid lowering therapy in patients followed at the diabetes center.

Although the achievement of treatment goals has been shown to significantly reduce the risk of morbidity and mortality in T2D, health care practice in community and referral centers often falls short of these goals [10, 11, 36]. While numerous interventions to improve adherence to the recommended standards have been implemented, a major contributor to suboptimal care is a system poorly designed for the delivery of chronic care [15]. Implementation of structured and multifaceted intervention for disease management is needed to deliver effective care, This should include patient education, psychological intervention, dietary education, self-monitoring, telemedicine, and other components [34, 37]. In recent meta-analysis, the most effective components of such programs were a high frequency of patient contact, and an ability for disease managers to adjust treatment with, or without, prior physician approval [34, 38].

As the site of care for the majority of T2D patients is the primary health care clinic, it is important to improve diabetes management interventions in this environment [39]. A recent multicomponent intervention trial in community primary care practices showed that implementation of an electronic diabetes registry, visit reminders, patient-specific physician alerts, pre-visit planning, and monthly review of performance with a local physician, resulted in better target achievement in twelve months [40]. Also, it may be helpful to have target, or points-based, systems to remunerate successful practices [15].

Limitations

The prevalence rate of undiagnosed T2D may be affected by recruitment biases, and the use of HbA1c rather than the more sensitive OGTT. Also, patients were recruited from one large medical center in Abu Dhabi, which may not necessarily represent the overall adult Emirati diabetic population. Similarly, our quality of care results may not apply to Emirati patients attending privately-owned facilities. However, previous studies in the UAE accord with our findings regarding care practices, and achievement of treatment targets [2, 28]. Finally, our study was cross-sectional in nature. Undiagnosed T2D was not confirmed, and self-reported diabetes complications were not fully verified.

Conclusions

In our study, almost half of patients without diabetes history attending PHC clinics had undiagnosed T2D, or were at increased risk. This represents a high proportion of patients living without adequate diabetes intervention at early stages of the disease. Therefore, new prevention programs need to be implemented to identify diabetic patients and persons at risk, and to deliver the appropriate care for an effective prevention of diabetic complications. Lifestyle intervention strategies including increased physical activity and reduced intake of dietary fat can result in moderate weight loss and reduce risk. Community-wide prevention programs can raise public awareness of the importance of lifestyle behavior.

Only 40% patients with diagnosed T2D followed dietary recommendations, and very few reported visiting a diabetes educator, or performing regular exercise. Only 13.5% of all patients attained all three internationally acknowledged targets. Care practices and achievement of treatment targets in diabetic patients could be improved by structured multifaceted interventions. National policy initiatives, that support the role of diabetes educators and self-management education programs, are needed to improve the health of diabetic patients.

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