



ORIGINAL ARTICLE

Novel approach to systematic random sampling in population surveys: Lessons from the United Arab Emirates National Diabetes Study (UAEDIAB)

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Abstract

Background: The prevalence of diabetes has risen rapidly in the Middle East, particularly in the Gulf Region. However, some prevalence estimates have not fully accounted for large migrant worker populations and have focused on minority indigenous populations. The objectives of the UAE National Diabetes and Lifestyle Study are to: (i) define the prevalence of, and risk factors for, T2DM; (ii) describe the distribution and determinants of T2DM risk factors; (iii) study health knowledge, attitudes, and (iv) identify gene–environment interactions; and (v) develop baseline data for evaluation of future intervention programs.

Methods: Given the high burden of diabetes in the region and the absence of accurate data on non-UAE nationals in the UAE, a representative sample of the non-UAE nationals was essential. We used an innovative methodology in which non-UAE nationals were sampled when attending the mandatory biannual health check that is required for visa renewal. Such an approach could also be used in other countries in the region.

Results: Complete data were available for 2719 eligible non-UAE nationals (25.9% Arabs, 70.7% Asian non-Arabs, 1.1% African non-Arabs, and 2.3% Westerners). Most were men < 65 years of age. The response rate was 68%, and the non-response was greater among women than men; 26.9% earned less than UAE Dirham (AED) 24 000 (US\$6500) and the most common areas of employment were as managers or professionals, in service and sales, and unskilled occupations. Most (37.4%) had completed high school and 4.1% had a postgraduate degree.

Conclusion: This novel methodology could provide insights for epidemiological studies in the UAE and other Gulf States, particularly for expatriates.

Keywords: diabetes, non-UAE nationals, novel systematic sampling, United Arab Emirates.

Significant findings of the study: In the absence of an updated national census, the present study investigated approaches to seek the best possible sampling frame for a rapidly changing expatriate population and thereby provides a novel methodology that is feasible, efficient, practical, and economical.

What this study adds: This study can be adopted for future population surveys conducted in the UAE and other Gulf Co-operative countries like Saudi Arabia and Bahrain, and replace the traditional recruitment approaches for the non-UAE national population in these countries.

Introduction

It is currently estimated that type 2 diabetes mellitus (T2DM) accounts for over 90% of the global diabetes burden¹ and the increase in prevalence has been well documented.² According to the International Diabetes Federation (IDF), the Middle East and North Africa (MENA) is the region with the highest prevalence of diabetes in adults (10.9%);³ 34.6 million people have diabetes in the MENA region and, by 2035, this figure is expected to rise to 67.9 million. In 2013, 368 000 deaths in the MENA region were caused by diabetes, and US\$12 billion was spent on treating diabetes in this region.¹ The greatest number of people diagnosed with diabetes are between 40 and 59 years of age.⁴

The United Arab Emirates (UAE) was reported in 2011 to have the 10th highest prevalence of diabetes in the world, estimated at 18.8%;⁵ it has been projected that by 2030 this figure will be 21.6%.⁵ In 1989–90, the prevalence of diabetes in the UAE Bedouin population was 6%.⁶ However, these estimates are based on studies that excluded many of the overseas-born residents who make up over 80% of the population. Another survey conducted in both UAE and non-UAE nationals between 1999 and 2000 suggested a higher prevalence of 20%.⁷ This was higher in UAE citizens (25%) than in expatriates (13%–19%, according to the country of origin).⁷ A more recent in Al Ain found that the age-standardized rates for diabetes and prediabetes were 29% and 24.2%, respectively.⁸ This means that over 50% of people over the age of 18 years have abnormal glucose tolerance. The most recent study conducted in the UAE, developed by the Weqaya Screening Program in Abu Dhabi (2008–10),⁹ indicated that age-standardized rates of diabetes and prediabetes (no history of diabetes requiring medication but HbA1c levels between 5.7% and 6.4%) were 25% and 30%, respectively, with a diabetes prevalence of 19% among UAE nationals. Risk factor rates were as follows: obesity, 35%; overweight, 32%; central obesity, 27%; dyslipidemia, 44%; and hypertension, 23.1%. Age-standardized rates of obesity and overweight were 41% and 34%.⁹ Worse still, the results also indicated a rapidly deteriorating situation as the population aged without urgent effective intervention.⁹ Given the rapid rise in the prevalence of diabetes, it is critical to assess this and its risk factors across the whole population. However, because overseas-born residents often only reside in the UAE for a few years, are not listed on electoral rolls, have long hours of work, and their homes may show significant geographic clustering by employment, the traditional sampling methods of house-to-house or electoral roll recruitment are unsatisfactory. Because all overseas-born residents have to attend designated Preventive Medicine Depart-

ments (PMDs) every 2–3 years for periodic medical examinations in order to renew their visas, these visits provide a novel and ideal method of obtaining a random sample of this component of the population.

To address the urgent need for more definitive data on the prevalence of diabetes and its associated risk factors in both the local Emiratis and the overseas-born component of the UAE population, the UAE National Diabetes and Lifestyle Survey was undertaken. The first phase of the survey, a population-based cross-sectional study involving estimation of fasting blood glucose, HbA1c, and lipid profiles in expatriates, and was conducted using standard tests between December 2012 and December 2013 in Dubai and The Northern Emirates of the UAE. The second phase involved the Emirati population and was a general random household sample stratified by emirates and identified by the UAE Bureau of Statistics. The sample will be proportional to the distribution of UAE citizens in each emirate and data collection is currently underway. The data collection procedures in Phase 2 are the same as in Phase 1, but different recruitment strategies have been used. This paper provides a detailed description of the approach we adopted for the first phase of the study, including design, sampling techniques, and survey protocols, to address and suit local and unusual circumstances.

The aim of the UAE National Diabetes and Lifestyle Study was to determine the prevalence of diabetes and its risk factors in a representative sample of local Emiratis and non-UAE nationals aged 18 years and over, from Dubai and the Northern Emirates of the UAE. Only Abu Dhabi, the largest emirate, is not participating in this survey because a comprehensive population-based screening is already underway as a prerequisite for compulsory insurance.

The objectives for both phases of the study are to describe the following for the UAE: (i) the prevalence of, and risk factors for, T2DM; (ii) the distribution of risk factors for T2DM (including obesity, hypertension, physical activity, age, diet, smoking, serum lipids); (iii) health knowledge, attitudes, and behaviors, as well as patterns of health services utilization; (iv) gene-environment interactions in our multiethnic community; (v) baseline data for evaluation of future intervention programs; and (vi) differences between the Emirati and other major ethnic groups in terms of diabetes prevalence and its risk factors.

Methods

The Ethics Committee of Sharjah University and the Ministry of Health Research Ethics Committee approved this study.

Target population and eligibility requirements

The target population for the first phase of the survey was all non-UAE national non-institutionalized adults aged 18 years and older residing in Dubai and the Northern Emirates of the UAE attending their second or subsequent visa renewal (i.e. resident for at least 4 years). People with serious physical disabilities, learning disorders, severe communication barriers, and pregnant women were excluded from the survey. The second phase of the study involving local Emirati nationals will use similar eligibility requirements, but will not take the number of years of stay in the country into consideration.

Sampling frame

A novel approach was adopted to obtain a representative sample of the non-UAE national population living in the UAE. Non-UAE nationals visit PMDs every 2–3 years for periodic medical examinations, which are required for the renewal of their residence. Acquiring a health certificate through blood tests from authorized health centers is a mandatory step for non-UAE nationals living in the UAE. The PMDs provided an opportunity to obtain a representative sample of non-UAE nationals. Systematic random sampling was done at the PMDs and every 10th person was invited to take part in the study after determining suitability according to the inclusion criteria.

Sample size determination

The number of individuals (n) to be included in the sample was derived using the following formula:

$$n = [1.96^2 \times r \times (1-r) \times deff \times (1+m)] / (e \times r)^2$$

where r is the estimated prevalence of 0.2, $deff$ is the design effect (estimated to be 1.5), m is the non-response (expected to be 10%) and e is the relative margin of error. The level of confidence was set at 95%, and the margin of error at 8%. Sample size calculation was done separately for non-UAE and UAE nationals because the sampling techniques used for both groups were different: cluster sampling for UAE nationals for Phase 1 of the survey and stratified for non-UAE national expatriates for Phase 1. For non-UAE nationals, 20% was used as the expected prevalence of diabetes and the non-response rate (m) was 20%, a value that was set much higher than non-response rates achieved in previous surveys conducted among the same population because of the length of the constructed questionnaire, the sensitivity of some of its questions, and the difficulty in convincing participants to come fasting the next day for blood collection.

The value for $deff$ used in the formula was 1 because a non-cluster sampling method was used for the non-UAE national population, which comprises approximately 82% of the total UAE population. Therefore, a total of 2000 individuals was the minimum number of expatriates needed in this study.

Phase 2 will involve the study of 3000 local Emirati adults living in Dubai and the Northern Emirates. These people will be recruited as a household survey of non-institutionalized adults, following a random selection of districts, and stratified by emirate. The household sample will be drawn by the National Bureau of Statistics in Abudhabi (NBS) based on the most recent census data, and will define an Emirati household as one in which the head of the family is an Emirati national. Phase 2 data will be reported separately, because recruitment is on-going. Sample sizes in each emirate for both components of the study are proportional to population size within each emirate.

Sample selection

Each of the five Northern Emirates has one main PMD and two to three peripheral PMDs, all under the authority of the Ministry of Health. The NBS investigated the demographics of every PMD in each Emirate and identified the main PMD in that Emirate accordingly. The selection was based on the PMD whose population was the closest to the population of non-UAE nationals in that emirate in terms of age, gender, ethnicity, and socioeconomic status. The data were provided by Global Information Technology Company (Dubai, UAE), which is the company responsible for gathering all data under the Ministry of Health on the actual distribution of non-UAE nationals attending all PMDs during 2011 and 2012.

Survey protocol and procedures

The UAE Diabetes and Lifestyle survey began with a week of pilot studies at three randomly selected PMDs (Dubai, Sharjah, and Ajman) in the first week of December 2012. The actual study period lasted from December 2012 until the end of May 2013 for this phase of the study.

Interviews at the PMDs

Data collection was performed through pretested, validated, and modified questionnaires following pilot study results. Interviews were held daily on weekdays at PMDs from 0800 to 1300 hours. Approximately six to eight participants were interviewed each day. Participants, data collectors, and one witness signed written informed

consent forms. Information was gathered through face-to-face interviews using structured questionnaires comprising demographic data, personal and family history of chronic diseases, tobacco use, physical activity, socio-economic status, women's obstetric and gynecological health, knowledge of diabetes and nutrition, health service utilization, quality of life, and sleep apnea using the Berlin questionnaire.¹⁰

Prompt cards were prepared for multiple responses and were translated into multiple languages as identified by the PMD population requirements. The presence of both male and female data collectors at the study center helped overcome gender barriers and cultural differences. Completed questionnaires were reviewed at the end of each interview for missing data and updated at the earliest opportunity when required.

Anthropometric and blood pressure measurements

Separate enclosed areas were provided for male and female participants during anthropometric measurements. Hip, waist, and neck circumference, as well as height, weight, and blood pressure were measured three times and recorded. Neck circumference was considered a marker for upper body adipose tissue distribution and therefore obesity, which is a risk factor for T2DM.¹¹ Evidence also suggests that there is a direct relationship between neck circumference and sleep apnea,¹² which is associated with a risk of insulin resistance and diabetes independent of obesity and is considered a novel and a modifiable risk factor for diabetes and prediabetes.¹³ The average of all three measurements was considered the most accurate and recorded. Blood pressure was measured at 10-min intervals.

Blood collection

Fasting blood samples were collected for blood glucose levels and lipid profiles, as well as HbA1c and genetic analysis. Blood samples were stored in a refrigerator or insulated ice box to avoid exposure to fluctuating temperatures. All blood samples were centrifuged within approximately 4 h of collection before being transported in an insulated ice box lined with dry ice pallets or sheets to the reference laboratory (Rashid Centre for Diabetes and Research, Ajman, UAE). All blood samples were stored at -20°C .

Blood results were linked with barcodes to maintain confidentiality and were communicated electronically on a daily basis to nominated data collectors and authorities at the PMDs to expedite and fast track the residency visa approval.

Results

This report provides data on the recruitment of non-UAE nationals, because recruitment of Emiratis is on-going. Although over 3000 blood samples were collected, only 2719 of those samples had full, accurately completed records for all parts of the questionnaire and anthropometric and blood pressure measurements. However, 2933 of those 3000, had the first part of the questionnaire complete, which included questions on demographics (age, gender, ethnicity, occupation, and education). The age and gender distribution were as expected for expatriates. The great majority were men under 65 years of age (Table 1). As for their educational achievements (Table 2), 14.2% had a primary school certificate or below, 37.4% had completed high school, and

Table 1 Age and gender distribution of study population across the Emirates

Age group (years)	Sharjah	Dubai	Fujairah	Ras Al Khaima	Ajman	Um Al Quwein	Total
18–34							
Male	219 (80.8%)	470 (87.4%)	53 (82.8%)	77 (62.1%)	106 (74.6%)	28 (70%)	953 (80.8%)
Female	52 (19.2%)	68 (12.6%)	11 (17.2%)	47 (37.9%)	36 (25.4%)	12 (30%)	226 (19.2%)
35–64							
Male	263 (78.3%)	579 (90.2%)	78 (87.6%)	117 (65%)	153 (75.4%)	38 (76%)	1228 (81.9%)
Female	73 (21.7%)	63 (9.8%)	11 (12.4%)	63 (35%)	50 (24.6%)	12 (24%)	272 (18%)
>65							
Male	11 (57.9%)	4 (50%)	1 (50%)	2 (66.7%)	4 (66.7%)	1 (50%)	23 (57.5%)
Female	8 (42.1%)	4 (50%)	1 (50%)	1 (33.3%)	2 (33.3%)	1 (50%)	17 (42.5%)
Total							
Male	493 (78.8%)	1053 (88.6%)	132 (85.2%)	196 (63.8%)	263 (74.9%)	67 (72.8%)	2204 (81.1%)
Female	133 (21.2%)	135 (11.4%)	23 (14.8%)	111 (36.2%)	88 (25.1%)	25 (27.2%)	515 (18.9%)
Total	626 (100%)	1188 (100%)	155 (100%)	307 (100%)	351 (100%)	92 (100%)	2719 (100%)

Data show the number of subjects in each group, with column percentages in parentheses.

Table 2 Highest educational achievements of study population across the Emirates

Highest level of education	Sharjah	Dubai	Fujairah	Ras Al Khaima	Ajman	Um Al Quwein	Total
Never attended school	24(3.8%)	12(1%)	20(12.9%)	23(7.5%)	12(3.4%)	1(1.1%)	92(3.4%)
Primary school	42(6.7%)	158(13.3%)	36(23.2%)	23(7.5%)	18(5.1%)	17(18.5%)	294(10.8%)
Some high school/secondary school	230(36.7%)	484(40.6%)	42(27.1%)	131(42.5%)	99(28.2%)	33(35.9%)	1019(37.4%)
Diplomas	102(16.3%)	133(11.2%)	26(16.8%)	22(7.1%)	47(13.4%)	12(13%)	342(12.6%)
University bachelor degree	175(28%)	299(25.1%)	22(14.2%)	95(30.8%)	140(39.9%)	25(27.2%)	756(27.8%)
Postgraduate diploma	28(4.5%)	52(4.4%)	4(2.6%)	8(2.6%)	14(4%)	2(2.2%)	108(4%)
Masters degree/doctorate	25(4%)	53(4.5%)	5(3.2%)	6(1.9%)	21(6%)	2(2.2%)	112(4.1%)
Total	626	1191	155	308	351	92	2723

Data show the number of subjects in each group, with column percentages in parentheses.

Table 3 Distribution of the study population across the Emirates according to household income

Total household income (AED per year)	Sharjah	Dubai	Fujairah	Ras Al Khaima	Ajman	Um Al Quwein	Total
≥420 000	23 (3.7%)	25 (2.1%)	0 (0.0%)	9 (2.9%)	0 (0.0%)	0 (0.0%)	57 (2.1%)
300 000–419 999	11 (1.8%)	60 (5%)	1 (0.6%)	2 (0.6%)	6 (1.7%)	1 (1.1%)	81 (3%)
240 000–299 999	26 (4.2%)	35 (2.9%)	0 (0.0%)	9 (2.9%)	9 (2.6%)	3 (3.3%)	82 (3%)
132 000–239 999	74 (11.8%)	162 (13.6%)	7 (4.5%)	27 (8.8%)	39 (11.1%)	5 (5.4%)	314 (11.5%)
60 000–131 999	162 (25.8%)	208 (17.5%)	19 (12.3%)	59 (19.1%)	118 (33.6%)	22 (23.9%)	588 (21.6%)
24 000–59 999	195 (31.1%)	266 (22.3%)	40 (25.8%)	99 (32.1%)	85 (24.2%)	31 (33.7%)	716 (26.3%)
<24 000	130 (20.7%)	352 (29.5%)	83 (53.5%)	100 (32.4%)	40 (11.4%)	29 (31.5%)	734 (26.9%)
Refused to answer	5 (0.8%)	83 (7%)	5 (3.2%)	3 (1%)	54 (15.4%)	1 (1.1%)	151 (5.5%)
Total	626	1191	155	308	351	92	2723

Data show the number of subjects in each group, with column percentages in parentheses.

4.1% had a masters degree or doctorate. The annual household income indicated that 26.9% earned less than United Arab Emirates Dirham (AED) 24 000 (US\$6534.35) and only 2.1% earned AED ≥420 000 (US\$114 347.95; Table 3). Table 4 shows that the most common areas of employment were as managers or professionals, in service and unskilled occupations. The ethnic backgrounds of participants were grouped into four categories (Fig. 1): (i) Asian non-Arabs (70.7%), including Indians, Pakistanis, Bangladeshis, and Filipinos; (ii) Arabs (25.9%), including Egyptians, Iraqis, Syrians, Sudanese, and Palestinians; (iii) Western (2.3%), including Europeans, Americans, and Australians; and (iv) Africans (1.1%).

The response rate was 68%. The response rate was slightly lower in the Sharjah Emirate due to language barriers, which were later resolved by including data collectors who were fluent in Hindi. The age and gender distribution of the sample compared with the non-UAE national population who attended the PMD for visa renewal in 2012 is shown in Fig. 2 and indicates that women were under-represented in the study sample compared with the total visa renewal population for 2012 (19% vs 33%, respectively).

Discussion

In the wake of the rising global burden of chronic non-communicable diseases, especially T2DM, various studies have been conducted in the UAE to determine the prevalence of diabetes and other categories of glucose intolerance. Epidemiological investigations have been undertaken to study the risk factors and their association with the disease.^{6,7} However, diabetes prevalence studies in the UAE specifically targeted the National Emirati population in one emirate only⁸ or over-sampled UAE citizens compared with non-UAE nationals because they were more likely to be long-term residents and long-term users of the healthcare system.⁷

Because the UAE is characterized by multinationality and diversity, it is essential to cover all the significant subgroups of the population in any epidemiological study. Hence, the present study was designed to include both the large expatriate community and the indigenous population of Emiratis to ascertain the prevalence of diabetes and its precursors in the UAE population as a whole.

The UAE Diabetes and Lifestyle survey was designed to provide a snapshot of the magnitude of the diabetes

Table 4 Distribution of study population across Emirates by area of employment

Categories for area of employment	Sharjah	Dubai	Fujairah	Ras Al Khaima	Ajman	Um Al Quwein	Total
Managers	134 (21.4%)	92 (7.7%)	14 (9%)	19 (6.2%)	77 (21.9%)	10 (10.9%)	346 (12.7%)
Professionals	26 (4.2%)	183 (15.4%)	4 (2.6%)	34 (11%)	47 (13.4%)	6 (6.5%)	300 (11%)
Technicians and associate professionals	34 (5.4%)	59 (4.9%)	3 (1.9%)	24 (7.8%)	12 (3.4%)	4 (4.3%)	136 (5%)
Clerical support workers	40 (6.4%)	77 (6.5%)	7 (4.5%)	11 (3.6%)	26 (7.4%)	8 (8.7%)	169 (6.2%)
Service and sales workers	121 (19.3%)	161 (13.5%)	2 (1.3%)	21 (6.8%)	44 (12.5%)	11 (12%)	360 (13.2%)
Skilled agricultural, forestry and fishery workers	8 (1.3%)	15 (1.3%)	10 (6.5%)	3 (1%)	6 (1.7%)	0 (0%)	42 (1.5%)
Craft and related trades workers	16 (2.6%)	29 (2.4%)	20 (12.9%)	15 (4.9%)	13 (3.7%)	7 (7.6%)	100 (3.7%)
Plant machine operators and assemblers	30 (4.8%)	51 (4.3%)	10 (6.5%)	11 (3.6%)	15 (4.3%)	6 (6.5%)	123 (4.5%)
Unskilled workers	114 (18.2%)	74 (6.2%)	69 (44.5%)	94 (30.5%)	22 (6.3%)	15 (16.3%)	388 (14.2%)
Unemployed	44 (7%)	32 (2.7%)	6 (3.9%)	11 (3.6%)	25 (7.1%)	8 (8.7%)	126 (4.6%)
Not specified	59 (9.4%)	419 (35.2%)	10 (6.5%)	65 (21.1%)	64 (18.2%)	17 (18.5%)	634 (23.3%)
Total	626	1192	155	308	351	92	2724

Data show the number of subjects in each group, with column percentages in parentheses.

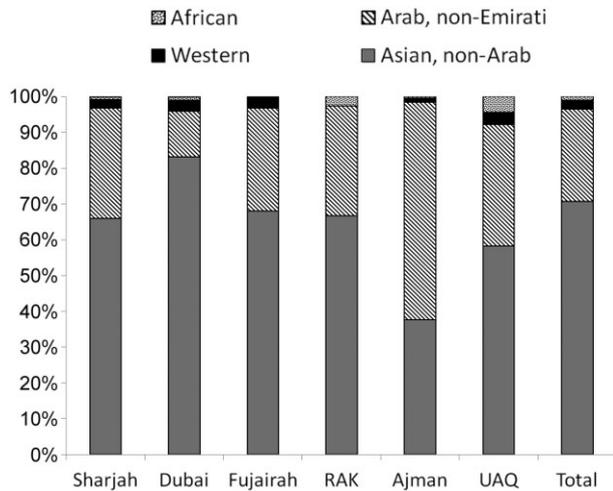


Figure 1 Distribution of ethnicity in each emirate. RAK, Ras Al Khaima; UAQ, Um Al Quwein.

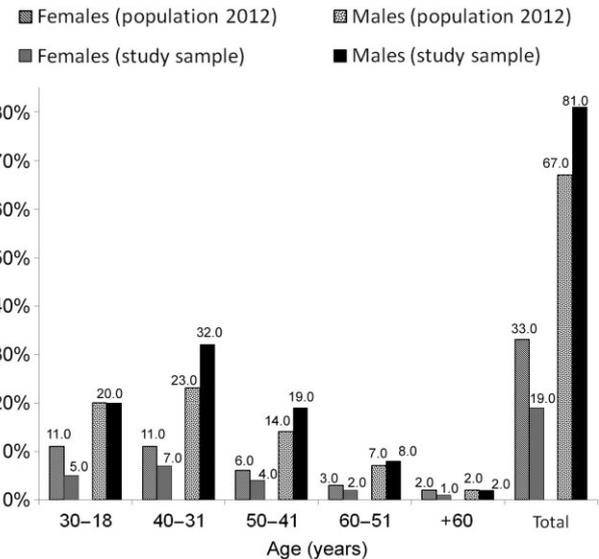


Figure 2 Age and sex distribution of the study population and the total expatriate population in 2012.

epidemic in the UAE. The present study will also be a valuable resource for healthcare planners in the UAE to organize and direct funds and resources to deal with this epidemic. In addition, it will serve as an important research tool for the study of genetic markers for diabetes and associated diseases on a longitudinal basis. Finally, the survey methodology may provide a model for other countries in the Gulf Region.

The UAE population is rapidly changing as a result of the influx of workers coming to live in the UAE for varying periods of time. Therefore, national statistics need to be updated every few years to obtain reliable information. Every non-UAE national above the age of

18 years is legally required to obtain a health certificate every 2–3 years in order to renew their residency visa. Thus, the PMDs, at which the health examinations occur, were regarded as the ideal choice for recruiting a representative sample of non-UAE nationals. Those who attended PMDs for the initial issuance of their residency visa status, as well as those attending for their first renewal, were not included in the study because it was assumed that non-UAE nationals will need a few years to adapt to a new lifestyle. The proportion of illegal residents in the UAE is not known.

Limitations

The present study has some limitations. The response rate was lower for women than men. Attendance for fasting blood tests may have been more difficult for women looking after children, obtaining permission from employers to take time off may have been more difficult, and cultural and religious issues made some women reluctant to attend because of the need to take some of their clothing off to have their waist and hip circumference measured despite there being a specific allocated room in every center for the study. Nevertheless, we believe that much of this imbalance will be addressed by age and sex adjustment of the findings.

Socioeconomic and lifestyle factors for the non-Emirati population may not accurately reflect their circumstances before living in the UAE. Therefore, their risk for diabetes and related conditions may not be fully accounted for by assessments based on their current circumstance. To mitigate this, we required all study participants to have resided in the UAE for at least 4 years, but some misclassification will likely remain.

Despite these limitations, the study will present valuable information on the prevalence of diabetes and its risk factors in the UAE expatriate population.

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Disclosure

None declared.

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