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Prevention of type II diabetes mellitus in Qatar: Who is at risk?

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ABSTRACT

Background: Type II diabetes mellitus (DM) is one of the leading chronic diseases in Qatar as well as worldwide. However, the risk factors for DM in Qatar and their prevalence are not well understood. We conducted a case-control study with the specific aim of estimating, based on data from outpatients with DM in Qatar (cases) and outpatient/inpatient controls, the association between demographic/ lifestyle factors and DM.
Methods: A total of 459 patients with DM from Hamad General Hospital (HGH) outpatient adult diabetes clinics, and 342 control patients from various outpatient clinics and inpatient departments within Hamad Medical Corporation (HMC) (years 2006–2008), were recruited. The association between risk factors and DM was evaluated using bivariate and multivariable logistic regression analyses. In addition to odds ratios (OR) and 95% confidence intervals (95% CI), we estimated the population attributable risk fractions for the DM demographic/lifestyle risk factors.
Results: Qatari nationality was the strongest risk factor for DM (adjusted OR = 5.5; 95% CI = 3.5–8.6; $p < 0.0001$), followed by higher monthly income (defined as ≥3000 Qatari Riyals, adjusted OR = 5.1; 95% CI = 3.0–8.7; $p < 0.0001$), age >65 years (adjusted OR = 3.3; 95% CI = 0.9–11.4; p = 0.06), male gender (adjusted OR = 2.9; 95% CI = 1.8-4.8; $p < 0.0001$), obesity (BMI ≥30, adjusted OR = 2.2; 95% CI = 1.5-3.2; $p < 0.0001$), no college education (adjusted OR = 1.7; 95% CI = 1.2–2.6; p = 0.009), and no daily vigorous/moderate activity (adjusted OR = 1.5; 95% CI = 0.9–2.3; p = 0.12). Among Qatari nationals, obesity was found to be the main risk factor for DM (unadjusted OR = 3.0; 95% CI = 1.6–5.6;

$p < 0.0001$), followed by no college education (unadjusted OR = 2.7; 95% CI = 1.5 – 5.1; $p = 0.001$), while consanguinity did not appear to play a major role in predicting DM (unadjusted OR = 1.5; 95% CI = 0.8 – 2.8; $p = 0.21$). Our findings further suggested that eliminating obesity and improving access to education may reduce DM cases by up to one third for the population at large (31.7% and 26.8%, respectively) and up to half (46.9% and 49.3%, respectively) for Qatari nationals. Promoting physical activity may reduce the burden of DM by up to 9.4% for the population at large and up to 17.3% for Qatari nationals.

Conclusions: Demographic/lifestyle factors appear to be the main risk factors for the high DM levels observed in Qatar, with a contribution that outweighs that of genetic risk factors. While further evaluation of DM risk factors among the Qatari population (as opposed to the resident population) is important and of interest, these findings highlight the need to focus short-term DM interventions on addressing demographic/lifestyle risk factors to achieve substantial and timely declines in DM levels.

Keywords: epidemiology, diabetes mellitus, demographic factors, lifestyle, Qatar, Middle East, North Africa

BACKGROUND

Type II diabetes mellitus (DM) is a global health problem and one of the most common non-communicable diseases of the twenty-first century.[1] DM is a major cause of disability and reduced quality of life, and among the top five leading causes of mortality in affluent societies.[1] The disease is growing rapidly in low and middle income countries, and the developing world currently hosts about 80% of individuals affected by DM.[1,2]

The Middle East and North Africa (MENA) region is particularly affected by the disease with the highest prevalence of type I and II DM among adults aged 20 – 79 years in the world (11%), and with 48% of DM cases being undiagnosed.[1] DM also contributes more than 10% of adult mortality in MENA with half of these deaths occurring among the population under 60 years of age.[1] Out of the ten countries listed as having the highest DM prevalence worldwide (2013), several were MENA countries including Saudi Arabia (24%), Kuwait (23%) and Qatar (23%).[1] DM prevalence in these countries is nearly three-fold that of the global average at 8%.[1] The highest levels of impaired glucose tolerance globally were also observed in several MENA countries such as Kuwait (18%), Qatar (17%), the United Arab Emirates (17%) and Bahrain (16%).[1] The burden of DM in the MENA region is projected to nearly double by 2035.[1]

The alarming increase in the burden of non-communicable chronic diseases including DM in MENA, particularly in the Arabian Gulf, may be, to a large extent, a reflection of the rapid demographic and epidemiological transitions occurring in the region.[3,4] The rising socio-economic conditions in the Arabian Gulf countries have led, in the last few decades, to remarkable improvements in the health infrastructure, an increase in life expectancy, an increasing ageing population, and a fast pace of urbanization and lifestyle changes.[4,5] The rapidly developing economies have also attracted large numbers of workers coming from different countries. For instance, in Qatar, migrant workers constitute at least 86% of the total population.[4,6,7] This rapid population growth has outpaced the rolling out of sufficient health programs in many MENA countries.[8] Nonetheless, health expenditure on DM treatment alone has grown enormously in the MENA region reaching up to approximately 14 billion US Dollars in 2013.[1]

The STEPwise survey, a standardized nationally representative survey, was conducted recently in Qatar.[6] The survey assessed the baseline levels of specific non-communicable diseases and their risk factors among Qatari nationals. The overall prevalence of raised blood glucose (≥ 6 mmol/L [≥ 110 mg/dl]) was found to be 17% among Qatari adults aged 18 – 64 years, while the proportion of those with impaired fasting hyperglycemia was 6%.[6] More than two thirds of the respondents reported having a family history of DM.[6]

In addition to its alarming prevalence, DM in Qatar is associated with several important complications and consequences including diabetic retinopathy,[9 – 11] renal failure,[12,13] vitamin D deficiency,[14] cardiovascular and cerebrovascular diseases,[15 – 18] and mortality.[19,20] The contribution of DM to some of these complications, such as myocardial infarction, appears to be, in many instances, more pronounced in Qatar compared to other MENA countries or to North America.[18] Accordingly, DM has been recently identified by the Qatar National Health Strategy as one of the high-priority diseases for preventive healthcare.[21]

The aim of this work was to inform DM prevention efforts in Qatar by identifying the key risk factors for type II DM among the total population of Qatar including Qatari nationals and non-Qatari expatriates. To achieve this aim, we conducted a case-control study with primary data collection at Hamad General Hospital (HGH), Hamad Medical Corporation (HMC) in Qatar.

METHODS

The study was conducted between the years 2006 and 2008 at HMC hospitals, the main healthcare provider in Qatar. Patients aged 18 years or older were considered eligible to participate in the study. The study methodology is detailed in the following description of recruitment of cases and controls, data collection and sampling procedures.

Cases' recruitment and ascertainment

Research coordinators in Qatar identified prospectively all eligible DM patients: Qatari nationals and non-Qatari expatriates, aged 18 years or older, who had received care at HMC outpatient adult diabetes clinics during the time period 2006 to 2008. Random samples of patients were selected from the appointment books for each session (morning/evening) of the eight diabetes clinics operating each week at HMC. The research coordinators presented the list of eligible patients to the diabetes clinics' physicians who were asked to review the list for any subjects who would not be appropriate for inclusion in the study. The physicians also advised patients about the study and gave permission to the researchers to approach eligible patients. Individuals were excluded from the study for reasons such as severe medical illness, communication disabilities such as stroke-related aphasia, or significant language barriers.

Patients approved for inclusion in the study were approached and told that: 1) a study about DM management was being conducted in Qatar; 2) they were selected as possible participants because they had recently received care at the HMC outpatient adult diabetes clinics; 3) their doctors were aware of the study and gave permission for them to be contacted; 4) the study involved a medical record review, a structured interview, a brief physical examination, and blood and urine tests; and 5) the study did not involve any diagnostic procedure or treatment. If the patients expressed interest in the study, it was explained to them in more detail and informed consent was obtained. The informed consent conversation and form were administered in Arabic, Hindi, or English, depending on the patient's language preference.

Data collection

Many of the blood and urine tests needed for this study were already obtained through routine medical care. Additional blood and urine specimens were obtained, as needed, for study purposes only. Questionnaire, chart review, and patient examination data were collected by research assistants who were bilingual (Arabic or Hindi and English), had medical training, were familiar with Qatari culture, and who were employees of Weill Cornell Medical College in Qatar. Research assistants and patients were paired in a gender-appropriate manner, consistent with socio-cultural norms; that is, male patients were paired with male or female research assistants, and female patients were paired only with female research assistants.

The medical record review form included patients' height, weight, heart rate, blood pressure, medical history, medications, results of blood and urine tests performed as part of medical care, referrals for ophthalmology and podiatry/foot examinations, results of the referrals, and receipt of vaccinations. The structured interview included questions related to patients' demographics, family history, health habits (smoking, food intake, and physical activity), health status, neuropathy, and depression. The health habits questions were based on similar questions used in The National Health and Nutrition Examination Survey (NHANES) in the United States.[22] Questions related to alcohol intake were omitted in order not to offend the study participants, of whom more than half were likely to be Muslim. The structured interview was translated into and conducted in Arabic, Hindi, and English. The brief physical examination included measurements of height, weight, blood pressure, heart rate and waist circumference, as needed, to fill in data that was missing in the medical record. Additional blood and urine tests needed for this study (blood [12 ml] and urine [20 ml)]), and not collected as part of regular medical care, were arranged to be collected by the clinic staff at the study visit. Patients' physicians were given access to all laboratory results obtained for this study.

Controls' selection

Fifty percent of the controls were designed to come from inpatient settings and fifty percent from outpatient settings. Control patients were identified prospectively from inpatients at HMC admitted for gastrointestinal, urological, or orthopedic conditions, and from two HMC outpatient clinics: the HMC staff clinic and the dermatology clinic. Many of the conditions/diagnoses for which patients were seen at each of the sites are unlikely to be related to known or potential risk factors for DM and therefore constituted appropriate diagnoses for the control group in this study. All exclusion criteria pertaining to the diabetic cases also pertained to the controls (e.g., $<$18 years of age excluded).

Inpatients at HMC

Control inpatients were identified using the HMC admission logbooks. A random sample of ten subjects from those identified as eligible (performed at each interview visit) was drawn using a random number generator. Research assistants went to the wards to locate, consent, and interview the selected subjects. Blood and urine request forms for the non-routine tests, required for the study, were filled by the research assistants for each consented subject. The forms were then put in the laboratory (lab) request folder of each ward. The following day, a 100 Qatari Riyal telephone card (Hala card) was given to the subjects whose blood and urine samples had been obtained. Subjects who were selected but not contacted, because they were not in their rooms (either patient went for surgery or for another procedure), were not included and were not contacted the following day (since the random sampling process was performed again each day).

HMC Staff Clinic

Patients eligible for control recruitment from the staff clinic included those who were at the clinic for sick leave requests, pre-employment screening, treatment/follow-up, vaccines, and prescription renewals. Approximately 50-60 patients visited the staff clinic each day. A private room was assigned for the team to interview patients there twice a week. Since this was a walk-in clinic, it was not feasible to obtain an appointment list beforehand. Usually patients were given numbers and their names were registered at the registration counter. They would then wait until their files were retrieved from the medical records at HMC before being seen by the doctor. A random number generator was used to select 40 numbers from the registration list. The names of the respective patients were highlighted. The clinic's nurses then sent the selected subjects to the study team for consenting and interviewing after they had been seen by the clinic's doctors. Following the interview, the subjects were given two copies of the non-routine blood and urine test forms and asked to go the HMC's outpatient lab for collection of the samples. The participating subjects returned one of the copies to the research team to collect the Hala card. The patient's waist circumference was then measured and recorded by the research assistants.

HMC Outpatient Dermatology Clinic

Patients eligible for control recruitment from the dermatology clinic included those seen at the clinic for vitiligo, acne, alopecia, and laser treatment. Similar to the staff clinic, the dermatology clinic was visited by the team twice a week. The appointment lists of the seven dermatology consultants at this site were collected one day in advance. The list contained the names of the patients and their HMC identification numbers, but not their age nor their diagnosis. The patients on the lists were numbered and a random number generator was used to select 40 subjects from the list, far greater than the target accrual of 4-5 subjects per day. The names of those patients selected were highlighted and each physician was given his appointment list with the highlighted names. The subjects were consented and interviewed after being examined and informed about the study by their physicians, and the interviews were conducted in a private room that was assigned to the team by the Head of the Dermatology Department at HMC. The consented subjects were then given the two copies of the non-routine blood and urine tests forms and were asked to go to a small lab in the dermatology clinic. After samples were obtained, the participating subjects returned one of the copies to collect the Hala card. Height, weight, blood pressure, heart rate, and waist circumference were measured and recorded. Subjects who were selected but not interviewed, because the nurses did not send them to the research team or they did not show up for their appointment, were not pursued further for recruitment.

Ethical considerations

The study was approved by the Institutional Review Board of HMC and Weill Cornell Medical College in

New York, in full accordance with international standards for the ethical use of human subjects in research. Written informed consent was obtained from the physicians of eligible patients. A written informed consent was similarly collected from all study participants including proxy respondents. In some instances, a close relative such as the head of the family (husband, father, brother or son) signed the informed consent jointly with a women participant to avoid cultural sensitivities.

Statistical considerations

Sample size

The odds ratio (OR) for the association between the presence of obesity (BMI ≥ 30) and the occurrence of DM constituted the measure of interest for the sample size calculation. A sample size of 300 patients with DM and 300 inpatient/outpatient controls would allow for the detection of ORs (for the association between obesity and DM) of ≥ 1.6 with 80% power and an alpha level of 5% (two-sided test). Moreover, adjusting the alpha level due to multiplicity of risk factors (i.e., nine hypothesized risk factors under the primary aim) to an alpha level of 0.006 (i.e., 0.05/9 risk factors = 0.006), allowed for the detection of ORs ≥ 1.8 with 80% power. The magnitude of the detectable ORs would also vary depending on the prevalence of the risk factors in the Qatar population. Three hundred DM cases and 300 controls would allow for the detection of a range of modest ORs based on varied risk factor prevalence's in the Qatar population. In addition, 300 DM cases would allow for the detection of an expected risk factor prevalence of 30% (in the cases) with a 95% confidence interval (CI) width of 10.4% (i.e., ± 5.2%).

Statistical analysis plan

The primary aim of this case-control study was to estimate the association between demographic and lifestyle factors, including age, gender, nationality, marital status, education, income, physical activity, cigarette/sheesha consumption, and obesity, and the development of DM. Descriptive statistics were calculated to characterize the cases and controls. The prevalence of the hypothesized factors were reported for cases and controls along with 95% CIs to assess the precision of the obtained proportions. The univariate association between the hypothesized risk factors and development of DM was estimated by the OR, and 95% CIs were calculated to assess the precision of the obtained estimates. Adjusted ORs and 95% CIs for each risk factor of interest were estimated using multivariable logistic regression. The logistic regression model included all of the risk factors that were evaluated by exploratory univariate analysis. Univariate analyses were also performed for the Qatari nationality subset. However, since the number of Qatari subjects in the control group was low, no multivariable model was developed for the Qatari nationality subgroup due to the likelihood of unstable adjusted effect estimates. Univariate and multivariable results based on all cases and controls are presented first, followed by univariate analyses for the Qatari nationality subgroup. Analyses conducted in the Qatari nationality subset were considered exploratory (i.e., hypothesis generating), as the study of risk factors for DM specifically among Qataris was not the primary aim of the study (i.e., the study was intended to inform the overall Qatar population, which includes both native and expatriate individuals).

The population attributable risk percent (PAR%) for each risk factor was estimated using the prevalence of the risk factor in the DM subjects. The PAR% estimates the proportion of disease in the population (e.g., DM) that could be eliminated if the risk factor in question was removed from the population (assuming causality). In a case-control study, the PAR% can be derived using the OR and prevalence estimate of the risk factor in the case group (e.g., DM) based on the approximate relation: $p\left(\frac{OR-1}{OR}\right)$.[23–25] Here, p is an estimate of the prevalence of the risk factor in the DM group and OR is the adjusted odds ratio for the association between a risk factor and DM.

All p-values are two-sided with statistical significance evaluated at the 0.05 alpha level. All analyses were performed in SAS Version 9.3 (SAS Institute Inc., Cary, NC) and Stata Version 13.0 (StataCorp, College Station, TX).

RESULTS

During the time period of the study (2006-2008), 459 patients with DM were recruited from HMC outpatient adult diabetes clinics and 342 controls were recruited from various outpatient clinics and inpatient departments within HMC.

Table 1 details the prevalence of nine hypothesized demographic and lifestyle factors among the diabetic cases and controls. Crude (univariate) ORs and 95% CIs are presented for each of these factors. Of the

Table 1. Demographic and lifestyle factors in DM cases and controls.

Demographic/lifestyle factors	DM cases (n = 459) n (%)	Controls (n = 342) n (%)	Crude OR (95% CI)	Odds ratio and 95% CI (Adjusted for all factors)
Age >65	27 (5.9)	5 (1.5)	4.2 (1.6, 11.1)	3.3 (0.9, 11.4)
Female gender	265 (58.0)	152 (44.4)	1.7 (1.3, 2.3)	0.4 (0.2, 0.6)
Qatari nationality	272 (59.5)	52 (15.2)	8.2 (5.8, 11.6)	5.5 (3.5, 8.6)
Live alone	92 (20.1)	45 (13.2)	1.7 (1.1, 2.5)	1.3 (0.8, 2.3)
No college education	292 (63.9)	166 (48.5)	1.9 (1.4, 2.5)	1.7 (1.2, 2.6)
Monthly income ≥3000 Qatari Riyals[1]	351 (90.0)	211 (63.6)	5.2 (3.5, 7.7)	5.1 (3.0, 8.7)
No daily or vigorous/ moderate activity	139 (30.4)	45 (13.2)	2.9 (2.0, 4.2)	1.5 (0.9, 2.3)
Ever smoked cigarettes and/or sheesha	117 (25.6)	112 (32.7)	0.7 (0.5, 1.0)	0.9 (0.6, 1.4)
Obesity (BMI ≥30)[2]	270 (61.6)	107 (32.1)	3.4 (2.5, 4.6)	2.2 (1.5, 3.2)
Metabolic syndrome[3]	Males: 62.5% Females: 85.7%	n/a	n/a	n/a

OR = odds ratio; CI = confidence interval.
[1] Income unavailable for 69 cases and 10 controls.
[2] BMI measurements unavailable for 21 cases and 9 controls.
[3] Metabolic syndrome defined as three or more of the following five components:
1) waist circumference ≥102 cm [40 inches] for males/≥88 cm [35 inches] for females.
2) triglycerides ≥1.7 mmol/L [150 mg/dL].
3) HDL <1.03 mmol/L [40 mg/dL] for males/<1.29 mmol/L [50 mg/dL] for females.
4) blood pressure ≥130/80 mm Hg.
5) fasting glucose ≥5.56 mmol/L [100 mg/dL].

nine factors, Qatari nationality was the strongest risk factor (unadjusted analysis) for DM (crude OR = 8.2). Interestingly, higher monthly income (defined as ≥3000 Qatari Riyals) was also a strong unadjusted risk factor for DM (crude OR = 5.2), followed by age >65 (crude OR = 4.2), obesity (crude OR = 3.4), and lack of physical activity (crude OR = 2.9). Female gender (crude OR = 1.7), living alone (crude OR = 1.7), no college education (crude OR = 1.9), and cigarette and/or sheesha usage (crude OR = 0.7) were modestly associated with DM (Table 1). Metabolic syndrome (defined as three or more of the following five components: 1) waist circumference ≥102 cm [40 inches] for males / ≥88 cm [35 inches] for females, 2) triglycerides ≥1.7 mmol/L [150 mg/dL], 3) HDL <1.03 mmol/L [40 mg/dL] for males /<1.29 mmol/L [50 mg/dL] for females, 4) blood pressure ≥130/80 mm Hg, 5) fasting glucose ≥5.56 mmol/L [100 mg/dL]) was present in 85.7% of female diabetics and 62.5% of male diabetics in the study.

Table 1 also presents the adjusted ORs for the nine hypothesized demographic and lifestyle factors. After covariate adjustment, Qatari nationality remained the strongest risk factor for DM (adjusted OR = 5.5; 95% CI = 3.5 – 8.6; $p < 0.0001$), followed by higher monthly income (defined as ≥3000 Qatari Riyals, adjusted OR = 5.1; 95% CI = 3.0 – 8.7; $p < 0.0001$), age >65 years (adjusted OR = 3.3; 95% CI = 0.9 – 11.4; $p = 0.06$), male gender (adjusted OR = 2.9; 95% CI = 1.8-4.8; $p < 0.0001$), obesity (BMI ≥30, adjusted OR = 2.2; 95% CI = 1.5 – 3.2; $p < 0.0001$), and no college education (adjusted OR = 1.7; 95% CI = 1.2 – 2.6; $p = 0.009$). Of the nine relationships assessed in Table 1, only living alone, lack of physical activity, and cigarette and/or sheesha usage were not statistically associated with the development of DM after multivariable adjustment. However, lack of physical activity was still suggestive of a trend for increased risk of DM (adjusted OR = 1.5, 95% CI = 0.9 – 2.3, $p = 0.12$).

No collinearity was observed between nationality and income (kappa = 0.2) or between obesity and physical activity (kappa = 0.1). As well, no collinearity was observed between other regressors of interest. As a result, all of the hypothesized variables of interest were included in the multivariable model simultaneously. Further control for family history of diabetes (adjusted OR = 6.2; 95% CI = 2.8 – 6.2) and dietary intake (i.e., meat, fruit, and vegetable consumption) in the multivariable model did not materially alter the adjusted odds ratios and 95% confidence limits for the nine hypothesized risk factors of interest (data not shown). However, questions assessing diet were limited and insufficient to build a satisfactory understanding of the composition of nutritional intake in the Qatar population.

Table 2 contains the prevalence of the nine hypothesized demographic and lifestyle factors among the DM cases and controls of Qatari nationality (n = 324 participants). Crude (univariate) ORs and 95% CIs are presented for each of these factors. Of the nine factors, obesity (BMI ≥ 30) was revealed as the strongest risk factor (unadjusted analysis) for DM among Qatari nationals (crude OR = 3.0; $p < 0.0001$). Interestingly, higher monthly income was no longer associated with the development of DM when the analysis was restricted to Qatari participants (crude OR = 1.0; p = 0.98), although this is likely due to the fact that higher monthly income was relatively ubiquitous in both the Qatari cases and controls (93.8% and 93.9%, respectively). Other factors to note in the Qatari national subgroup include the lack of a college education (crude OR = 2.7; p = 0.001), lack of physical activity (crude OR = 1.9; p = 0.07), and, to a lesser extent, consanguinity (crude OR = 1.5; p = 0.21). However, many of these analyses were underpowered due to the small sample size of Qatari controls (n = 52) in the study. As a result, the size of the OR estimates and shape of the 95% CIs should only be considered as suggestive of potential trends (i.e., consanguinity, lack of physical activity, and living alone) (Table 2). Metabolic syndrome was present in 85.8% of female Qatari diabetics and 64.7% of male Qatari diabetics in the study.

Table 3 shows the PAR% for various demographic and lifestyle factors related to DM, calculated for all DM cases and for Qatari national DM cases. These findings suggest that eliminating obesity and improving access to education could reduce DM cases by up to one third for the population at large (31.7% and 26.8%, respectively) and up to half (46.9% and 49.3%, respectively) for Qatari nationals. Promoting physical activity may as well reduce the burden of DM by up to 9.4% for the population at large and up to 17.3% for Qatari nationals. Meanwhile, discouraging consanguineous marriages may, at most, reduce the risk of DM among Qatari nationals by 14.5%.

Table 2. Demographic and lifestyle factors in Qatari national DM cases and controls (N = 324).

Demographic/lifestyle factors	DM cases (n = 272) n (%)	Controls (n = 52) n (%)	Crude OR	95% CI for Crude OR
Age > 65	17 (6.3)	0 (0.0)	–	–
Female gender	204 (75.0)	41 (78.8)	0.8	(0.4, 1.7)
Consanguinity	120 (44.1)	18 (34.6)	1.5	(0.8, 2.8)
Live alone	76 (27.9)	12 (23.1)	1.3	(0.6, 2.6)
No college education	211 (77.6)	29 (55.8)	2.7	(1.5, 5.1)
Monthly income ≥ 3000 Qatari Riyals[1]	211 (93.8)	46 (93.9)	1.0	(0.3, 3.6)
No daily or vigorous/moderate activity	99 (36.4)	12 (23.1)	1.9	(1.0, 3.8)
Ever smoked cigarettes and/or sheesha	42 (15.4)	8 (15.4)	1.0	(0.4, 2.3)
Obesity (BMI ≥ 30)[2]	191 (74.3)	25 (49.0)	3.0	(1.6, 5.6)
Metabolic syndrome[3]	Males: 64.7% Females: 85.8%	n/a	n/a	n/a

OR = odds ratio; CI = confidence interval.
[1] Income unavailable for 47 cases and 3 controls.
[2] BMI measurements unavailable for 15 cases and 1 control.
[3] Metabolic syndrome defined as three or more of the following five components:
1) waist circumference ≥ 102 cm [40 inches] for males/≥ 88 cm [35 inches] for females.
2) triglycerides ≥ 1.7 mmol/L [150 mg/dL].
3) HDL < 1.03 mmol/L [40 mg/dL] for males/< 1.29 mmol/L [50 mg/dL] for females.
4) blood pressure ≥ 130/80 mm Hg.
5) fasting glucose ≥ 5.56 mmol/L [100 mg/dL].

Table 3. Population attributable risk fractions (PAR%) for demographic/lifestyle factors and DM.

	Population attributable risk fraction	
Demographic/lifestyle factors	Percent of all DM cases (n = 459) attributed to Factor* (%)	Percent of Qatari national DM cases (n = 272) attributed to factor** (%)
Age >65	n/a	n/a
Female gender	n/a	n/a
Consanguinity	n/a	14.5%
No college education	26.8%	49.3%
Monthly income ≥3000 Qatari Riyals[1]	n/a	N/A (protective)
No daily or vigorous/moderate activity	9.4%	17.3%
Ever smoked cigarettes and/or sheesha	n/a (protective)	n/a (one case)
Obesity (BMI ≥30)[2]	31.7%	46.9%
Metabolic syndrome[3]	n/a (no OR)	n/a (no OR)

* Calculated using adjusted OR.
** Calculated using crude OR.

DISCUSSION

The aim of this study was to inform DM prevention efforts in Qatar by characterizing individuals at higher risk of DM in the country and thereby identifying the risk factors for the disease. The findings of our research revealed being Qatari-national, male, obese, having higher monthly income, lower educational attainment, and lower levels of physical activity as factors associated with DM. An exploratory analysis of DM risk factors among Qatari-nationals also suggested higher odds of the disease among obese individuals and individuals with lower educational attainment.

One of the key risk factors for DM is being a Qatari national, which was associated with a five-fold increase in the odds of having DM (OR = 5.5; 95% CI = 3.5-8.6) in comparison with the rest of the population in Qatar. This finding is consistent with the recent trends of increasing DM levels in the MENA region in general, and in countries of the Arabian Gulf in particular.[1] Indeed, Qatar is among the countries identified as having the highest prevalence of DM in the world with a prevalence that is similar or close to other countries in the Arabian Gulf region such as the Kingdom of Saudi Arabia, Kuwait, the United Arab Emirates, and Bahrain.[1] In these countries, levels of DM were exceedingly high measuring more than double the global prevalence.[1]

The larger disease burden among Qatari nationals poses questions about the drivers of DM occurrence in this population. While, recently, there have been discussions about the role of genetic factors in the rising DM levels,[26–29] our analysis shows that the associations between socio-economic and lifestyle factors, and DM outweigh that of consanguinity. The lack of association between consanguinity and DM could be an artifact of the small sample size of Qatari nationals enrolled in this study or due to selective under-reporting of consanguinity in the Qatari diabetics subgroup. Still, the magnitude and statistical significance of the associations between obesity/ lower educational attainment and DM in the Qatar resident population and Qatari national subpopulation (Tables 1 and 2, respectively) suggest lifestyle and socio-economic factors as the main risk factors for DM in Qatar. Our results are further highlighted by the population attributable risk analyses, which indicated that eliminating obesity and the fraction of individuals with lower educational attainment may prevent up to 32% and 27%, respectively, of DM cases among the population of Qatar and up to 47% and 49%, respectively, of DM cases among Qatari nationals (Table 3). Promoting physical activity may also reduce DM cases by 9% among the population at large and 17% among Qatari nationals. Meanwhile, discouraging consanguineous marriages is not likely to prevent more than 15% of DM cases among Qatari nationals. This evidence collectively suggests that a health prevention program focusing on modifiable risk factors such as obesity, educational attainment, and physical activity may achieve substantial reductions in DM among Qatari nationals and non-Qatari expatriates.

The main drivers of the changes in socio-economic and lifestyle factors in the Arabian Gulf region can be attributed to the rapid economic development and the resulting demographic and epidemiological transition in these countries.[19,30,31] Qatar, for instance, has witnessed a spectacular economic development in recent years; the average annual growth rate between 2009 and 2014 was 10.6%.[32] The growing economies in the region have led to a rapid urbanization and a high per capita income, along with an increased affordability of processed fat-rich food, reliance on domestic labor, and access to modern amenities such as transportation vehicles.[19,30] The link between rapid economic development and the adoption of a "Western" lifestyle with calorie-rich diets, and subsequently, an increased risk of DM, is well-established.[19,31] This contributes to our findings of a five-fold increase in the odds of DM among individuals earning higher monthly income compared to those having a lower income in our study.

The resulting change in lifestyle, characterized by a high intake of calorie-rich foods and a decrease in physical activity, was also manifested in an unprecedented high prevalence of overweight and obesity in the Arabian Gulf region.[19,30,31] Indeed, the prevalence of overweight and obese individuals in the region is remarkably high ranging between 29-43% and 15-53%, respectively.[19] Qatar follows this trend with 29% of Qatari adults being overweight and an additional 41% being obese.[6] Physical inactivity is also highly prevalent in the region with about 60% of men and 70% of women engaging in less than 150 minutes per week of moderate physical activity or no physical activity at all.[33] More than half of Qatari adults report being physically inactive.[6,27] Such rates of physical inactivity are considerably higher than those found in developed countries such as the USA, England, or Australia.[33] Both obesity and physical inactivity have been established as major risk factors for chronic disease conditions such as DM, especially in affluent societies.[19,31,33] It is even believed that the imbalance between high energy consumption and low physical activity leads to an established insulin resistance and DM even prior to an excessive weight gain.[19]

The findings of our study are consistent with the empirical evidence showing a strong association between obesity, physical inactivity, and DM. In our study, physical inactivity increased the odds of DM by 45% (borderline statistical significance) in the population at large in Qatar, and by 91% among Qatari nationals (borderline statistical significance). Similarly, obesity increased the odds of DM by two-fold in the population at large in Qatar, and by three-fold among Qatari nationals. These results were in line with those of another study conducted among Qatari nationals which showed that obese individuals had 2.5 times higher odds of DM compared to others with normal weight.[27] Earlier studies conducted among Qatari nationals also identified obesity as one of the main risk factors for DM in Qatar.[34,35]

Our analysis has also identified lower educational attainment as another main risk factor for DM in Qatar. Lower educational attainment was associated with a two-fold increase in the odds of DM among the population at large in Qatar, and its impact was even more pronounced among Qatari nationals where it was associated with a three-fold increase in the odds of DM. The link between lower educational attainment and increased risk of DM has also been observed in other countries in the region such as Bahrain.[36] This trend can likely be explained through the increased tendency of individuals with lower education to engage in poorer lifestyles.[36]

An important strength of our study is the populations sampled for cases and controls. HMC is the main health provider in Qatar. It is, therefore, reasonable to assume that selected cases and controls share similar characteristics with the exception of the disease of interest, and are representative of the wider population at risk of DM in Qatar. Furthermore, the conditions/diagnoses for which patients were presenting at each of the sites selected for control recruitment, such as staff and dermatology clinics, are unlikely to be related to known or potential risk factors for DM and, thereby, constitute an appropriate control group for this study.

Our study was limited by the low number of Qatari nationals among DM cases and controls, which affected our ability to conduct a stratified comparative analysis of DM cases by nationality, and prevented the development of multivariable models for this sub-population. Similarly, we did not evaluate the non-Qatari expatriates as a defined subgroup in Qatar due to the fact that this heterogeneous group was comprised of 1) non-Qatari Arabs (27%; countries of origin: Palestine, Iraq, Jordan, Lebanon, Oman, Saudi Arabia, Bahrain, Sudan, Syria, Tunisia, Egypt, Yemen, Somalia, Kuwait, and the United Arab Emirates), 2) South Asians (22%; countries of origin: Sri Lanka, India, Nepal, Pakistan, Bangladesh, Indonesia, and Thailand), and 3) individuals from other countries of origin (10%; countries of origin: Afghanistan, Algeria, Myanmar, Ethiopia, Eritrea, Iran, Ireland, Philippines, and the United States). Despite these limitations, our exploratory analyses of the potential socio-economic and lifestyle determinants of DM among Qatari nationals enabled us to identify key risk factors for DM in this specific population. Only two other earlier studies have looked at DM risk factors in Qatar[27,35] however, both studies focused solely on Qatari nationals and looked at the risk factors for DM only in part, with one of the studies using convenience sampling as the method for participant recruitment.[35]

We feel our study is novel in three respects. This is the first study performed in Qatar that attempts to measure the attributable risk of risk factors for DM utilizing a case-control design. While the risk factors for DM globally are well-understood, the balance of these for any specific population may differ. Therefore, there is a need to quantify the contribution of each risk factor especially for this population. Qatar has one of the highest DM rates in the world and DM is the leading public health issue occupying the attention of health policymakers. Qatar also has the highest per capita income in the world, thereby allowing for the evaluation of the relative contribution of risk factors at an extreme location within the global population spectrum. Qatar also has a highly diverse population, allowing for the evaluation of potential effects that may not be as evident in more homogeneous populations. Finally, this study highlights the importance that modifiable lifestyle factors have in explaining a large fraction of DM prevalence in Qatar, and Qatar is as an example of countries in which similar socio-economic and lifestyle changes are taking place.

CONCLUSIONS

Demographic and lifestyle factors appear to be the main risk factors for the high DM levels observed in Qatar, with a contribution that outweighs that of genetic risk factors. While further evaluation of DM risk factors among the Qatari population (as opposed to the resident population) is important and of interest, these findings highlight the need for public health and medical interventions to address the demographic and lifestyle factors that are most strongly associated with DM. Such efforts will likely achieve significant reductions in the incidence and prevalence of this important and too often devastating disease.

The rapid socio-demographic, economic, and epidemiological transition that countries of the Arabian Gulf have been witnessing in the last few decades remains unmatched by an adequate medical and public health infrastructure to address the needs of preventing the diseases that are unfortunately associated with this growth. DM is one of the leading causes of morbidity and mortality in the region that could be prevented through a multi-component prevention strategy that addresses simultaneously structural factors such as education and awareness, and behavioral factors such as the adoption of a healthier lifestyle.

In an attempt to decrease its high burden of DM, Qatar has placed DM prevention and control on the list of top priorities for national health programming and scientific research.[21] Several initiatives have been undertaken to encourage the population to adopt healthier lifestyles including promoting awareness and encouraging and supporting sport activities. Evaluating the impact of such initiatives on reducing the burden of DM and its risk factors should be a high priority. Nationally-representative large-scale community-based surveys at the household level, investigating the key risk factors for DM as well as barriers to the engagement in a healthier lifestyle, such as the reasons for physical inactivity and higher rates of obesity, could be very informative and are much needed. Such data could help to justify the need for, and inform the development of specific interventions, as well as programs and policy guidelines to achieve substantial reductions in DM levels in the population of Qatar and in countries similar to it.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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AUTHORS' CONTRIBUTIONS

PJC participated in the design of the study, carried out the statistical analysis, provided interpretation of the data, helped to draft the manuscript, and revised the manuscript for important intellectual content. HC provided interpretation of the data, drafted parts of the manuscript, and revised the manuscript for important intellectual content. LJA provided interpretation of the data, helped to draft the manuscript, and revised the manuscript for important intellectual content. MAZ and DD contributed to the design of the study, helped with acquisition of the data, and revised the manuscript for important intellectual content. AIM conceived the study, participated in its design and coordination, provided interpretation of the data, helped to draft the manuscript, and revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

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