Status of the diabetes epidemic in the Kingdom of Saudi Arabia, 2013

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ORIGINAL ARTICLE

Status of the diabetes epidemic in the Kingdom of Saudi Arabia, 2013

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Abstract
Objectives In the Kingdom of Saudi Arabia (KSA), current data on diabetes are lacking, and a rise of the epidemic is feared, given the epidemiologic transition in the country. To inform public health authorities on the current status of the diabetes epidemic, we analyzed data from the Saudi Health Interview Survey (SHIS).
Methods Saudi Health Interview Survey is a cross-sectional national multistage survey of individuals aged 15 years or older. A total of 10,735 participants completed a health questionnaire and were invited to the local health clinics for biomedical exams.
Results 1,745,532 (13.4 %) Saudis aged 15 years or older have diabetes. Among those, 57.8, 20.2, 16.6, and 5.4 % are undiagnosed, treated uncontrolled, treated controlled, and untreated, respectively. Males, older individuals, and those who were previously diagnosed with hypertension or hypercholesterolemia were more likely to be diabetic.
Conclusions Our findings call for increased awareness of pre-diabetes, diabetes, and undiagnosed diabetes in KSA. Combatting diabetes and other non-communicable diseases should be the task of the Ministry of Health and other ministries as well, to offer a comprehensive socio-cultural approach to fighting this epidemic.

Keywords Saudi Arabia · Diabetes · Survey · Undiagnosed · Screening

Introduction

From 1990 to 2010, the number of deaths attributable to type 2 diabetes doubled from 650,000 to 1.3 million worldwide (Lozano et al. 2012). Various epidemiological studies have found that the increase in diabetes prevalence is correlated with the global urbanization: a trend toward

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sedentary lifestyles and poor diet is becoming the norm (Stampfer et al. 2000; Key et al. 2002; WHO/FAO Expert Consultation 2003; Amuna and Zotor 2008). The Kingdom of Saudi Arabia (KSA) has witnessed a demographic shift over the last 20 years, accompanied by behavioral changes such as an increase in caloric, fat, and carbohydrate intake with a reduction in physical activity (Al-Hazzaa et al. 2011; Ng et al. 2011). In 2010, the country had a high proportion of years lost to disability (YLDs) due to diabetes, about 8 %, compared to ischemic heart disease, with YLDs of 0.81 %.

At the population level, the Saudi Ministry of Health (SMOH) is in charge of health promotion, early detection, and disease treatment of Saudis, a free health care system.

To best utilize its human and financial resources, SMOH needs accurate and timely data to allocate the appropriate resources for treatment by disease or disability. Current national data on diabetes in KSA are non-existent, and the most recent estimates date from 2005(Ministry of Health, Kingdom of Saudi Arabia, in collaboration with WHO 2005).

We conducted a large household survey to collect data on health, assess the prevalence of several non-communicable diseases (NCDs), and identify their risk factors. We analyzed data from this survey to inform the SMOH on the current status of diabetes.

Methods

The Saudi Health Interview Survey (SHIS) is a national multistage survey of individuals aged 15 years or older. Households were randomly selected from a national sampling frame maintained and updated by the Census Bureau. KSA was divided into 13 regions. Each region was divided into subregions and blocks. All regions were included, and a probability proportional to size was used to randomly select subregions and blocks. Households were randomly selected from each block. A roster of household members was conducted and an adult aged 15 or older was randomly selected to be surveyed. Weight, height, and blood pressure were measured at the household by a trained professional. Omron HN286 (SN:201207-03163F) and Omron M6 Comfort (HEM-7223-E) instruments were used to measure weight and blood pressure.

The survey included questions on socio-demographic characteristics, tobacco consumption, diet, physical activity, health care utilization, different health-related behaviors, and self-reported NCDs.

We used measured weight and height to calculate body mass index (BMI) as weight (kg)/height (m^2). Participants were classified into four groups: (1) underweight, BMI less than 18.5; (2) normal weight, BMI between 18.5 and 24.9; (3) overweight, BMI between 25.0 and 29.9; or (4) obese, BMI greater than or equal to 30.0. Respondents were classified as current, past, and never smoker based on self-reported data. We computed the servings of fruits and vegetables and red meats and chicken consumed per day from the detailed dietary questionnaire as the sum of the average daily consumption of fruits, fruit juices, and vegetables and red meats and chicken. We used the International Physical Activity questionnaire (Craig et al. 2003) to classify respondents into four groups of physical activity: (1) met vigorous physical activity, (2) met moderate physical activity, (3) insufficient physical activity to meet vigorous or moderate levels, and (4) no physical activity.

To assess diagnosed hypertension, diabetes, and hypercholesterolemia status, respondents were asked three separate questions: "Have you ever been told by a doctor, nurse, or other health professional that you had: (1) high blood pressure, otherwise known as hypertension; (2) diabetes mellitus, otherwise known as diabetes, sugar diabetes, high blood glucose, or high blood sugar; (3) hypercholesterolemia, otherwise known as high or abnormal blood cholesterol?" Women diagnosed with diabetes or hypertension during pregnancy were counted as not having these conditions. Those who were diagnosed with either of these conditions were further asked if they are currently receiving any treatment for their condition. Similarly, the same type of questions was used to determine previous diagnosis of stroke, myocardial infarction, atrial fibrillation, cardiac arrest, congestive heart failure, chronic obstructive pulmonary disease, asthma, renal failure, and cancer. We considered a person to be diagnosed with a chronic condition if they reported being diagnosed with any of these conditions.

In addition, respondents who reported being diagnosed with diabetes, were asked: "What type of diabetes do you have?" and whether they are being treated via the following question: "During the past 30 days, or since your diagnosis, have you ever taken medication for this condition?".

Respondents who completed the questionnaire were invited to local primary health care clinics to provide a blood sample for laboratory analysis. All blood samples were analyzed in a central lab at the King Fahd Medical City in Riyadh. COBAS INTEGRA400 plus was used to measure blood levels of HbA1C, or glycated hemoglobin. We followed the National Health and Nutrition Examination Survey (NHANES) for determining diabetes status (NHANES 2009). Respondents were considered to be diabetic if they met any of the following criteria: (1) measured HbA1c equals or exceeds 6.5 % (48.5 mmol/mol), or (2) measured HbA1c not equaling or exceeding 6.5 % (48.5 mmol/mol), but the respondent reported taking medications for diabetes. Hence, the subgroup diabetic

Table 1 Classification criteria for the different categories of non-diabetics, diabetics, and borderline diabetics, Saudi Health Interview Survey, Kingdom of Saudi Arabia, 2013

	History of diagnosis with diabetes	Currently taking treatment for diabetes	Measured HbA1c		
			<5.7 %	5.7–6.49 %	≥6.5 %
Non-diabetic	No	No	Yes	No	No
Diabetic					
Diagnosed not treated	Yes	No	No	No	Yes
Diagnosed treated uncontrolled	Yes	Yes	No	No	Yes
Diagnosed treated controlled	Yes	yes	Yes	yes	No
Undiagnosed	No	No	No	No	Yes
Borderline diabetic	No	No	No	Yes	No

includes those with measured HbA1c equal or above 6.5 % or taking medication for diabetes. Respondents were considered to have borderline diabetes if: (1) they did not report taking drugs for diabetes, and (2) their measured HbA1c blood level was between 5.7 % (35.3 mmol/mol) and less than 6.5 % (48.5 mmol/mol). Respondents were considered undiagnosed if they reported not being previously diagnosed with diabetes but their measured HbA1c was equal or above 6.5 % (48.5 mmol/mol). The classification criteria for the different categories of diabetes are detailed in Table 1. Moreover, we examined diabetes status among those who reported that they were previously diagnosed as pre-diabetic.

Statistical analysis

We used a multivariate logistic regression model to measure association between outcome variables and socio-demographic factors first. Diabetics were compared to borderline diabetics and non-diabetics; borderline diabetics were compared to non-diabetics, and undiagnosed diabetics were compared to non-diabetics. Then, we used a backward elimination multivariate logistic regression model to measure association between outcome variables and all associated factors. All factors were first included in the models. Then variables were eliminated based on a Wald Chi-square test for analysis of effect. Variables were removed one by one based on the significance level of their effect on the model, starting with the variable with the highest $p > 0.5$, till all variables kept had a $p \leq 0.5$ in the analysis of effect. Our results are based on a national sample for adults aged 15 or older who completed the survey and went to a clinic to undergo a physical exam.

Weighting methodology

Two sets of sampling weights were generated and incorporated into the dataset for analysis. First, we created an individual sampling weight for all respondents to account for (1) the probability of selection of an eligible respondent within a household, (2) the probability of selection of the household within a stratum, and (3) the post-stratification differences in age and sex distribution between the sample and the Saudi population.

For individuals who completed the lab-based blood analysis, we computed an additional sampling weight used in analyzing data from clinic visits to account for (1) the individual sampling weight described above, (2) the probability of visiting a clinic, (3) socio-demographic, behavioral, and health differences between respondents who visited the clinic and those who did not, and (4) the post-stratification differences in age and sex distribution between the respondents who visited the clinic and the Saudi population.

We used SAS 9.2 (SAS Institute Inc., Cary, NC, USA) for analyses and to account for the complex sampling design.

Results

Survey response and sample characteristics

Between April and June 2013, a total of 10,735 participants completed the SHIS—a response rate of 89.4 %—and were invited to the local health clinics. The remaining 1,265 completed part of the household enumeration, or all of it, but the selected adult did not complete the survey. A total of 5,590 individuals went to the local clinics and provided blood samples for analyses—a response rate of 52.1 %. The characteristics of respondents who completed the questionnaire and the laboratory exam are presented in Table 2.

Prevalence of diagnosed, measured, borderline, and undiagnosed diabetes

Overall, 1,095,776 (8.5 %) Saudis reported being diagnosed with diabetes. However, a total of 1,745,532

Table 2 Socio-demographic characteristics, Saudis 15 years or older who completed the questionnaire and laboratory exam, Saudi Health Interview Survey, Kingdom of Saudi Arabia, 2013

Socio-demographic and risk factors	Categories	Complete sample			Clinical exam sample		
		N	Weighted (%)	SE	*N*	Weighted (%)	SE
Sex	Male	5,253	50.64	0.69	2,576	52.86	1.08
	Female	5,482	49.36	0.69	3,014	47.14	1.08
Age	15–24	2,382	40.31	0.73	1,163	42.32	1.14
	25–34	2,757	21.50	0.52	1,299	22.05	0.84
	35–44	2,339	15.18	0.41	1,241	14.35	0.58
	45–54	1,520	12.38	0.40	860	11.51	0.55
	55–64	862	6.47	0.29	485	6.03	0.40
	65+	875	4.17	0.20	542	3.74	0.24
Marital status	Currently married	3,286	26.32	0.58	2,024	28.39	0.91
	Never married	4,872	52.83	0.68	2,325	51.92	1.07
	Separated, divorced, or widowed	2,557	20.85	0.53	1,236	19.69	0.82
Education	Primary school or less	6,976	49.35	0.69	3,657	46.52	1.05
	Elementary or high school completed	2,829	45.87	0.71	1,423	49.74	1.08
	College degree or higher education	897	4.78	0.23	492	3.75	0.27

SE standard error

(13.4 %) Saudis aged 15 years or older had diabetes. This total group is the sum of measured diabetes (1,193,075, 68.4 %) and those who were currently on diabetes medication with controlled levels of HbA1c (552,457, 31.6 %). Among those that our survey identified as diabetic from blood exams, 43.6 % were undiagnosed. Moreover, 15.2 % of Saudis, or 979,953, had borderline diabetes. Characteristics of respondents with undiagnosed diabetes, diabetes, and borderline diabetes are presented in Table 3.

Type, treatment, and control of diagnosed diabetes

Among participants diagnosed with diabetes, 13.4 % reported being diagnosed with type 1 diabetes, 66.7 % reported being diagnosed with type 2 diabetes, and 19.9 % did not know their type. Also, 91.0 % reported taking medication for their condition. About 70.9 % of participants on medication for diabetes had their diabetes controlled. Hence, about 397,541 adults had uncontrolled diabetes. Among all those who are diabetic, 57.8, 20.2, 16.6, and 5.4 % were undiagnosed, treated uncontrolled, treated controlled, and untreated, respectively (Fig. 1).

Predictors of diabetes, borderline diabetes, and undiagnosed diabetes

Age, sex, and diagnosis history of hypertension and hypercholesterolemia were associated with diabetes (Table 4). The risk of being diabetic was lower among females [adjusted odds ratio (AOR) = 0.68; 95 % confidence interval (CI): 0.53–0.89] but increased with age (AOR = 1.04; 95 % CI: 1.04–1.06) and previous diagnosis of hypertension (AOR = 1.82; 95 % CI: 1.31–2.53) and hypercholesterolemia (AOR = 2.18; 95 % CI: 1.51–3.15). Marital status, education, smoking status, diet, daily hours spent watching television, levels of physical activity, and history of NCDs were not associated with the risk of diabetes (Table 4). When we excluded respondents who reported being diagnosed with type 1 diabetes, our results remained unchanged (data not presented). The risk of borderline diabetes was not associated with any of the socio-demographic characteristics or other risk factors studied (Table 5).

The risk of being diabetic but undiagnosed with diabetes was only associated with age (Table 6). Indeed, older individuals were less likely to be diagnosed with diabetes (AOR = 1.03; 95 % CI: 1.03–1.04).

Among Saudis aged 15 years or older, 191,957 (1.5 %) were previously diagnosed with pre-diabetes. Of those, 55.1 % were currently diabetic by our definition [measured HbA1c ≥6.5 % (48.5 mmol/mol)] or undergoing treatment for diabetes), but only 22.8 % had blood HbA1c levels ≥6.5 % (48.5 mmol/mol).

Discussion

In a nationally representative sample of Saudis aged 15 years or older, we found a high prevalence of diabetes (13.4 %). A large proportion (43.6 %) of diabetic individuals were undiagnosed, and 29.1 % of those receiving treatment had uncontrolled diabetes. An additional 15.2 %

Table 3 Socio-demographic characteristics of undiagnosed diabetic, diabetic, and borderline diabetic Saudis 15 years or older, Saudi Health Interview Survey, Kingdom of Saudi Arabia, 2013

Socio-demographic and risk factors	Undiagnosed diabetic			Diabetic			Borderline diabetic		
	N	Weighted (%)	SE	*N*	Weighted (%)	SE	*N*	Weighted (%)	SE
Sex									
Male	194	5.96	0.64	593	14.84	0.88	430	15.51	1.08
Female	195	5.70	0.65	506	11.70	0.79	453	14.76	1.08
Age									
15–24	54	4.13	0.75	67	4.70	0.76	152	13.46	1.43
25–34	69	5.74	0.95	98	7.82	1.06	184	13.82	1.32
35–44	88	5.96	0.86	165	12.42	1.23	236	19.37	1.59
45–54	82	7.35	1.11	259	26.94	2.09	155	17.88	1.86
55–64	56	13.51	2.60	239	47.78	3.36	73	16.86	2.83
65+	40	8.06	1.84	271	50.40	3.11	83	14.95	2.08
Marital status									
Currently married	279	7.36	0.63	821	20.63	0.03	616	16.32	0.85
Never married	70	4.11	0.66	99	5.08	0.70	193	14.12	1.30
Separated, divorced, or widowed	38	9.33	2.58	176	33.31	3.28	72	14.83	2.36
Education									
Primary school or less	153	6.89	0.84	619	22.46	1.30	311	15.51	1.35
Elementary or high school completed	144	4.94	0.60	320	9.33	0.74	365	14.02	1.07
College degree or higher education	92	6.70	1.16	160	11.02	1.31	207	17.80	1.80
Smoking status									
Never smoked	340	5.62	0.47	917	13.39	0.61	746	14.89	0.83
Ex-smoker	16	7.03	2.97	78	26.71	4.15	44	17.86	3.35
Current smoker	33	7.12	1.66	100	16.04	2.10	91	16.32	2.39
Type of fat consumed									
Vegetable oils	330	5.61	0.49	941	13.13	0.64	758	15.47	0.84
Margarine	16	12.68	3.50	32	18.43	3.93	21	7.86	22.20
Animal fat	12	4.38	1.51	36	14.16	3.21	20	11.94	3.40
None in particular	26	7.19	1.68	72	15.88	2.25	71	17.66	2.50
Daily servings of fruits and vegetables									
0	9	4.04	1.46	32	10.78	2.54	27	12.59	3.05
0.1–2.9	280	5.37	0.52	802	12.91	0.68	682	15.82	0.91
3–4.9	56	6.25	1.05	142	13.08	1.51	92	13.57	2.08
5+	38	10.44	2.40	88	17.66	2.73	66	11.89	1.96
Daily servings of meat and chicken									
0–0.9	94	4.95	0.78	338	14.42	1.13	272	16.20	1.35
1–1.9	127	5.08	0.69	362	12.15	0.95	316	15.8	1.37
2–2.9	82	6.72	1.11	189	14.61	1.56	127	11.79	1.86
3+	84	8.02	1.32	191	13.12	1.47	157	14.54	1.73
Daily hours spent watching TV									
0–0.9	34	8.22	2.51	120	22.06	3.15	69	14.57	3.04
1–2.9	131	6.27	0.83	370	14.37	1.07	322	16.66	1.39
3–4.9	70	5.15	0.92	181	10.96	1.24	165	13.06	1.51
5+	62	5.20	0.98	175	13.04	1.42	134	15.10	1.96
Levels of physical activity									
None	164	6.67	0.80	495	18.25	1.17	342	15.72	1.26
Low	85	5.17	0.88	268	12.82	1.16	237	15.06	1.46

Table 3 continued

Socio-demographic and risk factors	Undiagnosed diabetic			Diabetic			Borderline diabetic		
	N	Weighted (%)	SE	*N*	Weighted (%)	SE	*N*	Weighted (%)	SE
Moderate	44	5.76	1.41	131	11.89	1.63	104	13.95	1.92
High	96	5.71	0.80	205	10.01	0.98	200	15.29	1.56
Obesity									
Not obese	217	5.19	0.55	556	10.75	0.69	504	13.51	0.90
Obese	166	7.79	0.88	516	19.87	1.22	350	18.63	1.46
History of diagnosis with hypertension									
No	337	5.65	0.46	774	10.79	0.57	784	15.09	0.80
Yes	50	6.95	1.49	317	49.59	3.02	90	16.23	2.36
History of diagnosis with hypercholesterolemia									
No	345	5.77	0.48	798	11.21	0.59	806	15.21	0.80
Yes	33	6.00	1.36	239	47.84	3.39	56	14.43	2.45
History of diagnosis of chronic condition									
No	364	5.73	0.46	972	12.56	0.60	829	15.07	0.78
Yes	25	7.33	2.25	122	24.53	3.21	52	16.24	3.51

Undiagnosed diabetic: Respondents reported not being previously diagnosed with diabetes but their measured HbA1c equals or exceeds 6.5 % (48.5 mmol/mol)

Diabetic: measured HbA1c equals or exceeds 6.5 % (48.5 mmol/mol), or measured HbA1c does not equal or exceed 6.5 % (48.5 mmol/mol) but the respondent reported taking medications for diabetes

Borderline diabetic: Respondents did not report taking drugs for diabetes, and their measured HbA1c blood level was between 5.7 % (35.3 mmol/mol) and less than 6.5 % (48.5 mmol/mol)

SE standard error

were borderline diabetic. These numbers are alarming as they indicate a total of 1,745,532 diabetic and 979,953 borderline diabetic Saudis. The KSA population is a very young population, with 80 % of the population under the age of 40 in 2013 (Ministry of Health, Kingdom of Saudi Arabia 2013), and the burden of type 2 diabetes is likely to overwhelm the health system of the country in the near future. Our results call for a national program to prevent and control diabetes. Moreover, screening campaigns are needed to detect borderline and undiagnosed diabetes at early stages for proper preventive measures and treatment.

Diabetes has a major impact on health and quality of life and is a worsening problem in both the developed and the developing world due to the complications it generates, such as heart disease, kidney disease, eye damage, neuropathy, and many others (Alberti and Zimmet 1998; Ceriello 2006). These cause an increased number of years lived with disability, during which patients suffer greatly, and increasingly, from these associated complications (Stewart and Liolitsa 1999; Egede 2004; Kalyani et al. 2010). In our study, diabetes was associated with self-reported hypertension and hypercholesterolemia. It was also associated with these diseases as measured in our survey (results not shown). These results demonstrate the joint occurrence of these three diseases, and hence a higher burden carried by Saudi patients. Moreover, Saudis treated for hypercholesterolemia were more likely to be diabetic but undiagnosed (results not shown). As hypercholesterolemia is a risk factor for diabetes, this suggests many missed opportunities within the health care system where patients with diagnosed hypercholesterolemia are not evaluated for diabetes as well.

Indeed, diabetes is preventable through a healthy lifestyle and early detection (Harris and Eastman 2000; Goldberg 2006; Lindström et al. 2006). However, Saudis do not seem to use medical preventive services, despite the fact that they are covered by a free national health system (Clark 2011). Our findings showed that only 14.8 % reported visiting a health clinic for a regular checkup within the last year (results not shown). This finding is of concern, as we found that most pre-diabetic individuals who progressed to become diabetic were able to control their diabetes once they started treatment. In a country such as KSA where medical care is free, the lack of health services utilization should be addressed through awareness campaigns. Moreover, Saudis are engaged in behavioral activities that are contributing to the high rates of diabetes and borderline diabetes. For example, our survey shows low levels of fruit and vegetable intake and physical activity.

Diabetes has major economic impact, including loss in human capital, decrease in productivity, and medical costs

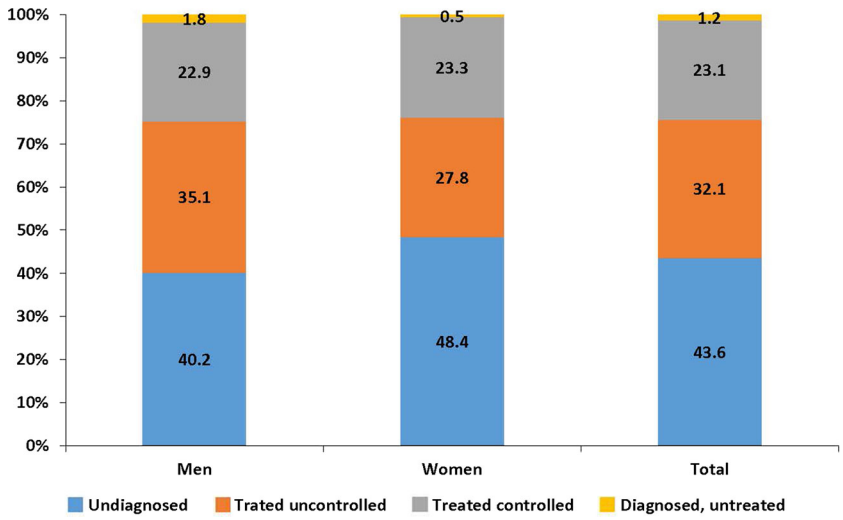

Fig. 1 Percent distribution of diagnosis and treatment status among diabetic Saudis 15 years or older, 2013

(American Diabetes Association 2013; WHO 2014; Ng et al. 2014). The medical costs not only arise from the direct cost of treatments for high glucose levels but extend to include the treatment costs of diabetes complications. In the United States, one in five health care dollars is spent on diabetes (American Diabetes Association 2013).

Previous studies have reported on the prevalence of diabetes in KSA. Data from the 1980s showed a prevalence of 4.7 % among Saudis aged 15 years or older in rural Saudi Arabia (Fatani et al. 1987). A study conducted from 1995 to 2000 revealed a 23.7 % prevalence of type 2 diabetes among individuals 30–70 years old (Al-Nozha et al. 2004). The last reported prevalence of diagnosed and measured diabetes in KSA was in 2005, which revealed a 15.3 % prevalence of diagnosed diabetes and an 18.3 % prevalence of measured diabetes [HbA1c greater or equal to 7.0 % (53 mmol/mol)] among Saudis aged 15–64 years (Ministry of Health, Kingdom of Saudi Arabia, in collaboration with WHO 2005). When restricted to the same age groups and using the same cutoff point, our data revealed a prevalence of 7.1 and 5.4 % for these categories, respectively. However, the two surveys cannot be compared. In our survey, we applied post-stratification weights to reflect the Saudi population and adjusted for the increased probability of sick individuals to agree to visit health facilities for physical examinations and blood samples. As these steps were not taken in the previous survey, the prevalence of diabetes and other NCDs may have been overestimated. Indeed, when we did not apply adjustments based on post-stratification and the predicted probability of completing the clinic visit, our diagnosed and measured diabetes estimates were 8.9 % (95 % CI: 8.3–9.4) and 10.3 % (95 % CI: 9.3–11.3), respectively. In our survey, 50 % of participants went to a clinic for physical measurements. When we compared the two groups, those who went to a clinic were more likely to self-rate their health as good, fair, or poor, be overweight or obese, and to have received a diagnosis of pre-diabetes. They were less likely to smoke and to have had their last routine physical exam prior to 2012. Hence, our adjustment for the predicted probability of completing the clinic visit was critical to produce nationally representative estimates of diabetes. Both our survey and the 2005 report were conducted by medical staff from local health facilities. It is possible that sick individuals were more likely to participate in the 2005 survey. However, in our study, we enforced a random selection within a household, and our electronic data capture registered the selected individual and would not allow for a replacement.

Over the last few years, the SMOH started several initiatives to control chronic diseases and the diabetes epidemic, including a national awareness program around diabetes (Ministry of Health, Kingdom of Saudi Arabia 2014). These initiatives could have resulted in some decline in diabetes prevalence over the last eight years. Also, in September 2012, the SMOH in collaboration with the World Health Organization's Eastern Mediterranean Regional Office (EMRO) organized an international conference that aimed to address the topic of NCDs in the area (WHO Regional Office for the Eastern Mediterranean 2012). The conference resulted in the Riyadh Declaration that included ten recommendations to combat NCDs at the regional level (WHO EMRO 2012). The SMOH worked with EMRO, and the declaration was adopted by EMRO during the regional committee meeting in October 2012. This step will amount to a major impact on health in KSA and the region. Indeed, the Gulf countries have similar habits and health profile (Mokdad et al. 2014). Hence our findings could be used by the gulf countries and the gulf council to promote health, control and treat diabetes in the

Table 4 Association between socio-demographic characteristics, risk factors, and diabetes among Saudis 15 years or older, Saudi Health Interview Survey, Kingdom of Saudi Arabia, 2013

Socio-demographic and risk factors	Categories	Socio-demographic model		Full adjusted model	
		AOR	95 % CI	AOR	95 % CI
Sex	Male	REF		REF	
	Female	**0.74**	**0.58–0.95**	**0.68**	**0.53–0.89**
Age		**1.06**	**1.05–1.07**	**1.04**	**1.04–1.06**
Marital status	Currently married	REF		REF	
	Never married	0.80	0.55–1.16	0.88	0.59–1.27
	Separated, divorced, or widowed	1.23	0.85–1.80	1.28	0.82–1.89
Education	Primary school or less	REF			
	Elementary or high school completed	0.99	0.75–1.31		
	College degree or higher education	0.92	0.66–1.30		
Type of fat consumed	Vegetable oils			REF	
	Margarine			1.75	0.91–3.38
	Animal fat			0.80	0.44–1.46
	None in particular			1.08	0.68–1.73
Daily servings of fruits and vegetables	0			REF	
	0.1–2.9			1.32	0.69–2.51
	3–4.9			1.10	0.55–2.20
	5+			1.64	0.77–3.47
Daily servings of meat and chicken	0–0.9			REF	
	1–1.9			0.92	0.68–1.25
	2–2.9			1.30	0.90–1.87
	3+			1.07	0.72–1.58
Levels of physical activity	None			REF	
	Low			0.78	0.57-1.06
	Moderate			0.59	0.39-0.88
	High			0.67	0.48–0.94
Obesity	Not obese			REF	
	Obese			1.21	0.94–1.55
History of diagnosis with hypertension	No			REF	
	Yes			**1.82**	**1.31–2.53**
History of diagnosis with hypercholesterolemia	No			REF	
	Yes			**2.18**	**1.51–3.15**
History of diagnosis of chronic condition	No			REF	
	Yes			1.25	0.87–1.79

Diabetic: Measured HbA1c equals or exceeds 6.5 % (48.5 mmol/mol), or measured HbA1c does not equal or exceed 6.5 % (48.5 mmol/mol) but the respondent reported taking medications for diabetes

Bold values represent 95 % CI that are larger or smaller than, but do not contain 1.0

CI confidence interval, *AOR* adjusted odds ratio

region (Secretariat General 2012). More so, inter-countries collaboration, especially through the developed–developing countries model, can be beneficial to KSA and the region in their fight against NCDs (Maziak et al. 2013).

Our study has some limitations. First, our data are from a cross-sectional study, and therefore, we cannot assess causality. Second, many of our behavioral data, such as diet and physical activity, are self-reported and subject to recall and social desirability biases. However, our study is based on a large sample and used a standardized methodology for all its measures. Third, only 52 % of respondents completed the visit to a health clinic and had their blood drawn for analysis. However, our weighting methodology accounted for this bias by applying a post-stratification adjustment using socio-demographic characteristics, health behaviors, previously diagnosed NCDs, and anthropometric measurements of respondents from the household survey.

Table 5 Association between socio-demographic characteristics, risk factors, and borderline diabetes among Saudis 15 years or older, Saudi Health Interview Survey, Kingdom of Saudi Arabia, 2013

Socio-demographic and risk factors	Categories	Socio-demographic model		Full adjusted model	
		AOR	95 % CI	AOR	95 % CI
Sex	Male	REF		REF	
	Female	0.90	0.71–1.14	0.82	0.61–1.10
Age		1.03	1.02–1.04	**1.03**	**1.02–1.04**
Marital status	Currently married	REF		REF	
	Never married	1.19	0.88–1.61	1.42	0.98–2.06
	Separated, divorced, or widowed	0.90	0.58–1.41	1.14	0.65–1.98
Education	Primary school or less	REF		REF	
	Elementary or high school completed	1.00	0.73–1.38	0.99	0.68–1.43
	College degree or higher education	1.21	0.84–1.74	1.26	0.81–1.94
Type of fat consumed	Vegetable oils			REF	
	Margarine			0.51	0.25–1.02
	Animal fat			0.55	0.24–1.30
	None in particular			1.24	0.73–2.13
Daily servings of fruits and vegetables	0			REF	
	0.1–2.9			1.37	0.67–2.80
	3–4.9			1.02	0.45–2.32
	5+			0.89	0.40–1.97
Daily hours spent watching TV	0–0.9			REF	
	1–2.9			1.20	0.66–2.16
	3–4.9			0.85	0.45–1.59
	5+			1.02	0.53–1.94
Obesity	Not obese			REF	
	Obese			1.20	0.87–1.67
History of diagnosis with hypercholesterolemia	No			REF	
	Yes			1.39	0.80–2.43

Borderline diabetic: Respondents did not report taking drugs for diabetes, and their measured HbA1c blood level was between 5.7 % (35.3 mmol/mol) and less than 6.5 % (48.5 mmol/mol)

Bold values represent 95 % CI that are larger or smaller than, but do not contain 1.0

CI confidence interval, *AOR* adjusted odds ratio

Our study revealed a high rate of diabetes in a young population in KSA. The country, however, is not alone in this epidemic. In 2010, diabetes ranked the fifth cause of death in the Arab World, an increase from the 11th cause as reported for 1990(Mokdad et al. 2014). Moreover, our findings of the low utilization of free health services for preventive care call for a major effort to inform the public of the value of prevention. In addition to regular physical checkups and screenings, programs to improve diet and increase physical activity are urgently needed. These programs should take into account the culture and environment in KSA. Creative methods will need to be adopted to increase physical activity in a very hot environment. In many places in the world, outdoor activities are encouraged, but in KSA indoor activities have to be established and made available to the public and communities, perhaps using the KSA's large indoor infrastructure including malls and public spaces.

Our findings call for increased awareness of diabetes and undiagnosed diabetes in the Kingdom. Moreover, our study calls for an improvement in the early detection of pre-diabetes, as it is the first step in prevention, especially among adults 35 years and older. The detection campaigns should be coupled with intensive and aggressive programs for prevention and control of diabetes. A national chronic disease program should be established and involve several partners. Indeed, to combat NCDs, a large segment of the government and society has to be involved. This is not a task for the Ministry of Health alone, but requires involvement of other ministries to offer a comprehensive socio-cultural approach to fighting this epidemic.

Table 6 Association between socio-demographic characteristics, risk factors, and undiagnosed diabetes among diabetic Saudis 15 years or older, Saudi Health Interview Survey, Kingdom of Saudi Arabia, 2013

Socio-demographic and risk factors	Categories	Socio-demographic model		Full adjusted model	
		AOR	95 % CI	AOR	95 % CI
Sex	Male	REF		REF	
	Female	0.90	0.64–1.28	0.93	0.66–1.29
Age	Age	1.03	1.02–1.05	**1.03**	**1.03–1.04**
Marital status	Currently married	REF			
	Never married	0.88	0.55–1.43		
	Separated, divorced, or widowed	1.21	0.61–2.40		
Education	Primary school or less	REF			
	Elementary or high school completed	1.02	0.67–1.56		
	College degree or higher education	1.21	0.76–1.93		
History of diagnosis of chronic condition	No			REF	
	Yes			1.31	0.65–2.65

Undiagnosed diabetic: Respondents reported not being previously diagnosed with diabetes but their measured HbA1c equals or exceeds 6.5 % (48.5 mmol/mol)

Bold values represent 95 % CI that are larger or smaller than, but do not contain 1.0

CI confidence interval, *AOR* adjusted odds ratio

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