Prevalence of diabetes mellitus and impaired fasting glucose levels in the Eastern Province of Saudi Arabia: results of a screening campaign

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ABSTRACT

Introduction: This study aimed to estimate the prevalence of diagnosed and undiagnosed diabetes mellitus (DM) in the Eastern Province of Saudi Arabia, and to study its relationship with socioeconomic factors.

Methods: The study targeted all Saudi subjects aged 30 years and above who resided in the Eastern Province in 2004. DM screening was conducted by taking the capillary fasting blood glucose (CFBG) after eight hours or more of fasting, or the casual capillary blood glucose (CCBG). A positive screening test for hyperglycaemia was defined as CFBG more than or equal to 100 mg/dl (5.6 mmol/l), or CCBG more than or equal to 140 mg/dl (7.8 mmol/l). A positive result was confirmed on another day through the measurement of fasting plasma glucose (FPG) levels from a venous sample. A diagnosis of DM was considered if FPG was more than or equal to 126 mg/dl (7.0 mmol/l), or when there was a history of a previous diagnosis.

Results: Out of 197,681 participants, 35,929 (18.2 percent) had a positive history of DM or a positive screening test for hyperglycaemia. After confirmation by venous blood testing, the prevalence of DM dropped to 17.2 percent while the prevalence of newly diagnosed DM was 1.8 percent. The prevalence increased with age and was higher in women, widows, divorcees, those who had a low education level and the unemployed.

Conclusion: The prevalence of DM in Saudi Arabia is one of the highest reported in the world, and its yield of screening is high.

Keywords: diabetes mellitus, prevalence, Saudi Arabia, screening

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INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder that is characterised by chronic hyperglycaemia and associated with a disturbance in carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.[1] The burden of DM is growing at an accelerating rate, even in developing countries. It has become a major health problem worldwide as a result of urbanisation, the ageing population and unhealthy lifestyles. In Saudi Arabia, several studies have been conducted to determine the prevalence of DM,[2-5] but owing to the different methodologies used, the reports show considerable variations in the prevalence rate, even for the same area. The World Health Organization estimates that the number of people with DM is projected to increase almost threefold in Saudi Arabia, from 890,000 in 2000 to a staggering 2,523,000 in 2030.[6] This situation demands careful observation in order to adopt the most strategic solutions.

One major limitation of recommending screening for DM is that the effectiveness of early diagnosis through the screening of asymptomatic individuals has not been determined. However, there is evidence that by the time DM is diagnosed, complications may have already occurred.[7,8] Besides, studies have consistently revealed that at least 50% of people with DM are unaware of the disease[9] because of the asymptomatic nature of the early stages of type 2 DM, which can remain undiagnosed for several years. Thus, screening for the early detection of DM appeals to both researchers and health institutes. Due to its ease of use, acceptability to patients and lower cost, fasting plasma glucose (FPG) has been the preferred and recommended screening test for DM.[10] A diagnosis of impaired fasting glucose (IFG) and DM in this study was based on the proposed American Diabetes Association diagnostic criteria issued in 1997 and modified in 2003.[11,12] The objective of this study was to determine the prevalence of IFG and DM from a community-based screening campaign and to evaluate its relationship with socioeconomic factors.

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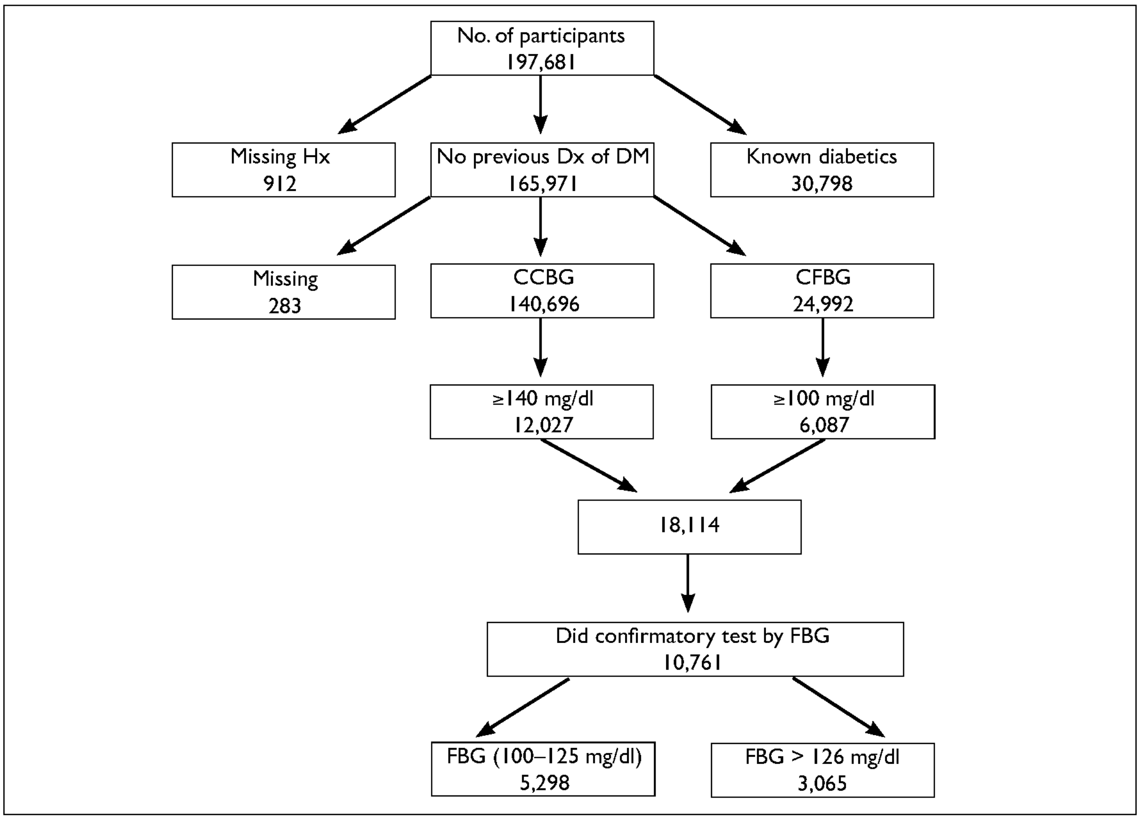

Fig. 1 Flow chart of newly diagnosed diabetes mellitus participants during the campaign.
Hx: history; Dx: diagnosis; DM: diabetes mellitus; CCBG: casual capillary blood glucose; CFBG: capillary fasting blood glucose; FBG: fasting blood glucose

METHODS

This study was part of a community screening campaign conducted between August 28, 2004 and February 18, 2005. The aim was the early detection of DM and hypertension. Details of the study design and methods have been previously published.[13] A scientific committee was formed to establish the detailed logistics required to carry out the campaign, including outlining the standards for running the campaign and obtaining accreditation for the instruments and health education materials to be used, as well as to oversee staff training, financial matters, supervision and health education committees, data processing and data entry. A mass media campaign was organised through the use of pamphlets, street posters and audiovisual aids. The target population size of the study was 650,000 participants; this was the estimated number of Saudi residents aged ≥ 30 years in the Eastern Province.

Saudis aged ≥ 30 years who were residing in the Eastern Province were invited to participate in this campaign through any of the 301 primary healthcare centres, Ministry of Health hospitals, and other government and private hospitals. Data was also collected by outreach mobile teams who approached participants in their workplaces, major public places, malls and other venues across the entire Eastern Province. A structured questionnaire, developed through a focus group and validated by experts in the fields of DM and hypertension, was used by pre-trained health teams. Demographic information such as age, gender, place of residence, marital status, occupation and level of education was recorded, in addition to lifestyle status such as physical activity and smoking. Additional information regarding a previous diagnosis of DM or hypertension was obtained. The weight, height and blood pressure of all the participants were measured. Body mass index was calculated as weight (kg) divided by height (m^2).

Whole blood glucose concentration was measured for all the participants using uniform portable glucometer machines with a Medisafe Reader (Terumo Co, Tokyo, Japan) based on reflectance photometry, where glucose was catalytically oxidised by glucose oxidase and peroxide enzymes with a colour change reaction. The screening test was considered to be positive for hyperglycaemia if the capillary fasting blood glucose (CFBG) was ≥ 100 mg/dl (≥ 5.6 mmol/l) after at least eight hours of fasting, or if the casual capillary blood glucose (CCBG) was ≥ 140 mg/dl (≥ 7.8 mmol/l) without considering the time of the last meal. A CFBG of 100–125 mg/dl (5.6–6.9 mmol/l) and a

Table I. Prevalence of newly diagnosed diabetes mellitus during screening and after confirmation.

Gender	No. (%)				
	Screened with no history of DM	High blood sugar from screening	Pre-DM* from screening	DM after confirmation	IFG after confirmation
Male	85,861	2,661 (3.1)	6,127 (7.1)	1,476 (1.7)	2,121 (2.5)
Female	80,092	2,364 (3.0)	6,940 (8.7)	1,589 (2.0)	2,987 (3.7)
Total[a]	165,971	5,025 (3.0)	13,067 (7.9)	3,065 (1.8)	5,108 (3.1)

* FCBG: 100–125 mg/dl; CCBG: 140–199 mg/dl
[a] Data was missing for 18 participants.
DM: diabetes mellitus; IFG: impaired fasting glucose; CFBG: capillary fasting blood glucose; CCBG: casual capillary blood glucose

Table II. Prevalence of diabetes mellitus and IFG by gender and age.

Age (yrs)	No. (%)						
	Total*	Total DM†	DM		Total IFG	IFG	
			Female†	Male†		Female†	Male†
30–39	95,804	5,473 (5.7)	2,870 (6.1)	2,603 (5.3)	1,408 (1.5)	783 (1.7)	625 (1.3)
40–49	57,242	11,098 (19.4)	6,222 (21.7)	4,873 (17.1)	1,916 (3.3)	1,188 (4.1)	728 (2.6)
50–59	24,410	8,960 (36.7)	4,868 (39.7)	4,091 (33.7)	1,132 (4.6)	690 (5.6)	442 (3.6)
60–69	11,965	5,581 (46.6)	2,706 (49.1)	2,875 (44.5)	527 (4.4)	291 (5.3)	236 (3.7)
> 70	6,431	2,747 (42.7)	1,222 (45.9)	1,525 (40.5)	313 (4.9)	135 (5.1)	178 (4.7)

† All differences are statistically significant at $p < 0.0001$.
* The total number of analysable data by age is 195,852 out of 197,681 participants. Data was missing for 1,829 participants.
DM: diabetes mellitus; IFG: impaired fasting glucose

CCBG of 140–199 mg/dl (7.8–11 mmol/l) was considered to be consistent with IFG and impaired glucose tolerance (IGT), respectively. The initial screening test was considered to be consistent with a diagnosis of DM if the CFBG was ≥ 126 mg/dl (≥ 7.0 mmol/l), or the CCBG was ≥ 200 mg/dl (≥ 11.0 mmol/l).

DM was diagnosed either by a positive history of DM or through the screening test. All participants without a history of DM who had been screened positive for hyperglycaemia visited the central laboratory the following day, after fasting for at least eight hours, to confirm the results by venous blood testing through the measurement of FPG. Confirmatory FPG was considered to be diagnostic for DM if it was ≥ 126 mg/dl (≥ 7.0 mmol/l), while an FPG of 100–125 mg/dl (5.6–6.9 mmol/l) was considered to be diagnostic for IFG.[11,12] A second check for completeness of the forms was then conducted. Incomplete forms were sent back with a cover letter requesting for corrections to be made.

Statistical analysis was conducted using the Statistical Package for the Social Sciences version 15 (SPSS Inc, Chicago, IL, USA). The significance of the univariate difference was tested using the chi-square test for categorical variables. Variables found to be associated with DM or IFG were included in the multiple logistic regression analyses so as to explore the association of each individual characteristic with the probability of the presence of DM, while keeping other characteristics in the model unchanged. Glucose status was dichotomised into the categorical variables, type 2 DM and normal glucose; however, individuals with IFG were excluded from this analysis. IFG and normal glucose were also dichotomised, but individuals with DM were excluded. Age and gender variables were included in every model. The odds ratio and 95% confidence interval were calculated, and a p-value < 0.05 was considered statistically significant.

RESULTS

Of the 197,681 participants in the campaign, 30,798 (15.6%) were known DM patients. Data was missing for 912 (0.5%) individuals. In all, 33,668 and 163,652 participants underwent fasting and CCBG testing, respectively, constituting 99.8% of the participants. Among participants with no previous diagnosis of DM, 6,087 (3.7%) were found to have CFBG ≥ 100 mg/dl, and 12,027 (7.2%) were found to have CCBG ≥ 140 mg/dl, of whom 10,761 (59.4%) had confirmation tests by FPG. The rest of the participants could not be traced due to refusal, failure of referral or loss of contact (Fig. 1). Out of the particpants who had a positive screening

Table III. Socioeconomic characteristics of the study population and the prevalence of DM and IFG.

Variable	No. (%)					
	Total	Male	Female	Prevalence of DM*	Prevalence of newly diagnosed DM*	Prevalence of IFG*
Marital status[a]						
Single	11,683 (6.0)	5,508 (47.1)	6,175 (52.9)	566 (4.8)	77 (0.7)	126 (1.1)
Married	172,548 (88.4)	93,285 (54.1)	79,263 (45.9)	29,160 (16.9)	2,665 (1.8)	4,430 (2.6)
Widowed	8,311 (4.3)	418 (5.0)	7,893 (95.0)	3,254 (39.1)	243 (4.6)	425 (5.1)
Divorced	2,665 (1.4)	261 (9.8)	2,404 (90.2)	584 (21.9)	48 (2.3)	86 (3.2)
Occupation[b]						
Self-employed	14,328 (7.5)	13,837 (96.6)	489 (3.4)	3,322 (23.2)	287 (2.5)	358 (2.5)
Housewife	71,946 (37.5)	0.0	71,941 (100.0)	15,379 (21.4)	1,382 (2.4)	2,578 (3.6)
Military	21,934 (11.4)	21,932 (100.0)	0.0	2,194 (10.0)	302 (1.5)	459 (2.1)
Professional	21,650 (11.3)	12,396 (57.3)	9,254 (42.7)	1,899 (8.8)	171 (0.9)	300 (1.4)
Technical	8,329 (4.3)	6,100 (73.2)	2,228 (26.8)	1,007 (12.1)	82 (1.1)	143 (1.7)
Non-technical	6,382 (3.3)	5,187 (81.3)	1,195 (18.7)	1,164 (18.2)	124 (2.3)	201 (3.1)
Administration	34,298 (17.9)	28,005 (81.7)	6,290 (18.3)	3,901 (11.4)	334 (1.1)	522 (1.5)
Unemployed	12,825 (6.7)	9,973 (77.8)	2,852 (22.2)	4,090 (31.9)	318 (3.5)	449 (3.5)
Education level[c]						
Illiterate	44,976 (23.4)	11,214 (24.9)	33,760 (75.1)	14,507 (32.3)	1,289 (4.1)	2,162 (4.8)
Literate	13,816 (7.2)	5,054 (36.6)	8,760 (63.4)	3,378 (24.5)	288 (2.7)	439 (3.2)
Primary	28,394 (14.8)	14,968 (52.7)	13,424 (47.3)	4,903 (17.3)	486 (2.0)	793 (2.8)
Intermediate	26,895 (14)	17,794 (66.2)	9,098 (33.8)	3,443 (12.8)	359 (1.5)	577 (2.1)
Secondary	41,190 (21.4)	27,210 (66.1)	13,977 (33.9)	4,174 (10.1)	354 (0.9)	604 (1.5)
University	35,332 (18.4)	20,226 (57.2)	15,104 (42.8)	2,430 (6.9)	208 (0.6)	425 (1.2)
Higher degree	1,896 (1.0)	1,425 (75.2)	471 (24.8)	202 (10.7)	19 (1.3)	22 (1.2)
Income level (SR)[d]						
< 2000	35,976 (21.2)	12,928 (35.9)	23,047 (64.1)	8,657 (24.1)	877 (3.1)	1,447 (4.0)
2000 – < 5000	50,468 (29.7)	28,237 (56.0)	22,228 (44.0)	8,520 (16.9)	891 (2.1)	1,465 (2.9)
5000 – < 7000	36,025 (21.2)	22,524 (62.5)	13,495 (37.5)	4,588 (12.7)	464 (1.5)	835 (2.3)
≥ 7000	47,377 (27.9)	29,913 (63.1)	17,462 (36.9)	6,591 (13.9)	494 (1.2)	837 (1.8)

* All differences were statistically significant at $p < 0.0001$.
[a] Data was missing for 2,664 participants. [b] Data was missing for 6,192 participants. [c] Data was missing for 5,386 participants.
[d] Data was missing for 28,037 participants.
DM: diabetes mellitus; IFG: impaired fasting glucose; SR: Saudi Riyal

but did not return for a confirmatory test, 73.6% had CFBG in the IFG range and 70.3% had CCBG in the IGT range. 6,286 (67.6%) women had the confirmatory test done compared with 4,446 (50.8%) men ($p < 0.0001$). A large proportion of housewives (n = 5,359, 70.2%) returned for the confirmatory test, while a low proportion of administrative employees (n = 1,036, 41.5%) did so ($p < 0.0001$). The highest rate of confirmatory testing (n = 4,441, 73.4%) was found among those who were illiterate, while the lowest rate was among those holding postgraduate degrees (n = 47, 39.2%,) ($p < 0.0001$). No significant differences were found with regard to marital status and income level.

The overall prevalence of DM, based on the initial CCBG and CFBG screening and previous history was 18.2% (n = 35,929). In addition, 6.8% of the participants were found to have CFBG and CCBG in the IFG and IGT ranges. The overall prevalence of DM and IFG dropped to 17.4% and 2.7%, respectively, while the newly diagnosed DM prevalence amounted to 1.8% after the confirmatory FPG test was performed (Table I). DM was more prevalent among women (18.6%) than men (15.9%) ($p < 0.0001$). This was also the case for IFG, which had a prevalence rate of 3.2% in women and 2.2% in men ($p < 0.0001$) (Table II). DM and IFG both showed increasing trends with age, reaching a peak in participants aged 60–69 years among those with DM, and in those aged > 70 years among IFG participants ($p < 0.0001$) (Table II). On other hand, among newly diagnosed participants, the prevalence of DM was higher in men (3.1%) than in women (3%) at screening ($p < 0.0001$), but after the confirmatory test, the reverse was true, with a prevalence rate of 1.7% and 2.0% for men and women, respectively ($p < 0.0001$) (Table I).

The prevalence of DM and IFG among the different categories of socioeconomic factors was compared through univariate analyses. DM was found to be significantly more prevalent among participants who were illiterate and those with a lower income and a lower education level. It was higher among the unemployed and

Table IV. Prevalence of diabetes mellitus and IFG according to health sectors.

Sector	No. (%)					
	Total[a]	DM from screening or history		Total after confirmation[b]	DM after confirmation or from history	
		DM	Pre-DM		DM	IFG
Dammam*	30,636	5,638 (18.4)	1,928 (6.3)	30,564	5,239 (17.1)	535 (1.8)
Khober	30,560	5,028 (16.5)	1,705 (5.6)	30,558	4,825 (15.8)	736 (2.4)
Qateef	31,155	3,985 (12.8)	2,684 (8.6)	31,083	3,864 (12.4)	1,107 (3.6)
Hassa	57,617	12,804 (22.2)	3,606 (6.3)	57,561	12,093 (21)	1,348 (2.3)
Hafr Al-baten	11,574	2,262 (19.5)	933 (8.1)	11,572	2,215 (19.1)	589 (5.1)
Ras Tanura	5,754	831 (14.4)	296 (5.1)	5,754	868 (15.1)	205 (3.6)
Bqaiq	4,765	1,041 (21.8)	504 (10.6)	4,764	935 (19.6)	144 (3.0)
Safwa	4,475	636 (14.2)	83 (1.9)	4,475	628 (14.0)	30 (0.7)
Jubail	6,678	841 (12.6)	332 (5.0)	6,669	740 (11.1)	26 (0.4)
Khafji	4,184	678 (16.2)	304 (7.3)	4,184	625 (14.9)	138 (3.3)
Oraiera	865	258 (29.8)	82 (9.5)	865	246 (28.4)	64 (7.4)
Nuairia	3,932	758 (19.3)	352 (9.0)	3,932	674 (17.1)	36 (7.4)
Sarar	2,224	515 (23.2)	208 (9.4)	2,224	516 (23.2)	127 (5.7)
Qaria olia	1,897	420 (22.1)	293 (15.4)	1,897	377 (19.9)	138 (7.3)
Rafia	1,340	228 (17.0)	105 (7.8)	1,340	208 (15.5)	1,348 (2.3)
Total	197,656	35,923 (18.2)	13,415 (6.8)	197,44	34,053 (17.2)	5,298 (2.7)

[a] Data was missing for 215 participants. [b] Data was missing for 429 participants.
* p-value < 0.0001.
DM: diabetes mellitus; IFG: impaired fasting glucose

the self-employed, and was lowest among professionals ($p < 0.0001$). In addition, the prevalence of DM was highest among widows and divorcees (39.1% and 21.9%, respectively) and lowest among singles ($p < 0.0001$) (Table III). In terms of geographical distribution, DM was more prevalent among participants living in Oraiera and Sarar, and least prevalent among those living in Jubail ($p < 0.0001$) (Table IV).

Logistic regression analysis was used to quantify the effects of socioeconomic factors on DM as a dependent variable (Table V). The analysis indicated that an older age and being married, widowed or divorced were significant positive predictors of DM. Having a higher education level and employment in any profession (i.e. military, technical, non-technical or administrative positions) were all negatively associated with DM. The same findings were observed with regard to IFG; however, in this instance, the female gender was also found to be a predictor of increased risk.

DISCUSSION

This study involved a large sample of adult Saudi subjects aged ≥ 30 years residing in the Eastern Province, with the objective of estimating the prevalence of DM. Our findings revealed that the prevalence of DM in Saudi Arabia is very high compared to that in other countries.[9] These findings are consistent with those of previous studies conducted in Saudi Arabia.[14] However, the overall DM prevalence rate of 17.2% found in this study is considerably lower than that reported by Al-Nozha et al.[2] Comparisons with other published studies on the prevalence of DM in Saudi Arabia[2-5] are difficult due to differences in the methodologies adopted, the age groups studied and the cut-off values for diagnosis used. This study used a lower cut-off value to define hyperglycaemia so as to increase the sensitivity of the screening test in order to detect a higher number of undiagnosed DM patients. This has led to a decrease in the specificity and a drop in the prevalence rates of both IFG and DM after confirmatory testing, unlike other studies. For example, in a study conducted by Anokute,[5] a diagnosis of DM was confirmed in all patients by FPG using a cut-off value of ≥ 140 mg/dl for abnormal CFBG during the initial screening. The current study uses the latest definition of normal fasting glucose, that is < 100 mg/dl (< 5.6 mmol/l).[12]

Nearly one-tenth of the participants in this survey had undiagnosed DM. This finding is lower than that reported by studies in other countries,[9] in which almost half the DM patients were undiagnosed. It is also lower than that reported by other studies from Saudi Arabia. For instance, a survey conducted by Al-Nuaim found 56% newly diagnosed DM patients at the time of the study,[4] while almost one-third of DM patients in Al-Nozha et al's study were newly diagnosed.[2] Our finding may indicate a marked improvement in Saudi Arabia's healthcare system, which has led to the early screening and diagnosis of DM patients, particularly with the new availability of primary healthcare centres all over Saudi Arabia. In addition to

Table V. Multiple logistic regression models of variables associated with DM and IFG vs. normal glucose.

Variable	DM vs. NG			IFG vs. NG		
	Logistic regression coefficient	OR	95% CI	Logistic regression coefficient	OR	95% CI
Age	0.65	1.067	1.066–1.069	0.38	1.038	1.035–1.042
Gender						
Female		1.000			1.000	
Male	0.050	1.051	0.992–1.114	−0.142	0.868	0.764–0.985
Marital status						
Single		1.000			1.000	
Married	0.580	1.786	1.616–1.975	0.43	1.537	1.267–1.864
Widowed	0.701	2.015	1.791–2.266	0.415	1.514	1.203–1.906
Divorced	0.876	2.401	2.068–2.787	0.479	1.615	1.190–2.193
Occupation						
Self-employed		1.000			1.000	
Housewife	0.100	1.105	1.024–1.193	0.336	1.399	1.179–1.660
Military	−0.230	0.794	0.741–0.851	0.170	1.186	1.016–1.385
Professional	−0.156	0.856	0.794–0.923	0.008	1.008	0.842–1.206
Technical	−0.153	0.859	0.787–0.937	0.021	1.021	0.833–1.253
Non- technical	−0.106	0.900	0.827–0.979	0.229	1.258	1.047–1.511
Administrative	−0.114	0.892	0.838–0.949	−0.025	0.975	0.838–1.134
Unemployed	−0.047	0.955	0.893–1.020	0.132	1.141	0.979–1.331
Education level						
Illiterate		1.000			1.000	
Literate	−0.006	0.994	0.942–1.050	−0.239	0.787	0.701–0.885
Primary	−0.170	0.843	0.804–0.885	−0.300	0.741	0.670–0.820
Intermediate	−0.409	0.664	0.628–0.703	−0.493	0.611	0.542–0.688
Secondary	−0.609	0.544	0.513–0.576	−0.807	0.446	0.394–0.506
University	−0.996	0.369	0.344–0.396	−0.965	0.381	0.326–0.445
Higher degree	−0.790	0.454	0.384–0.536	−0.964	0.382	0.246–0.592

DM: diabetes mellitus; IFG: impaired fasting glucose; NG: normal glucose; OR: odds ratio; CI: confidence interval

the decrease in specificity of the screening test through the use of a lower cut-off value, there is a possibility of an underestimation of the real prevalence of undiagnosed DM simply because this study was not a door-to-door screening campaign. The high proportion of participants who were positively screened during the initial test but did not show up for the confirmatory test may also be a contributory factor, particularly since > 70% of them had an abnormal screening test. On the other hand, the prevalence rate of 1.8% of newly diagnosed DM among Saudi participants aged ≥ 30 years is higher than that reported from the United Kingdom for individuals aged ≥ 45 years, with age as the sole risk factor for DM,[15] indicating the need for further improvement. The overall yield of screened individuals with newly diagnosed DM was relatively high, and it was significantly higher among participants with low or no education and among those with a lower income. With such a high diagnostic yield, we suggest that screening should best be targeted at these socioeconomically disadvantaged groups.

Our study has revealed that DM is a major health problem in both men and women, specifically those in the older age groups. We also observed that the prevalence of DM increases with age, peaking at 60–69 years of age. Almost half of our participants in this age group were DM patients. This pattern is similar to that reported in other studies.[16,17] On univariate analysis, a higher prevalence of DM was observed in women compared to men in our study, a finding that is similar to that reported by Karim et al,[3] but contrary to that reported by Al-Nozha et al.[2] However, logistic regression analysis performed in our study did not show any statistically significant differences between the genders. Logistic regression analysis also revealed that IFG was more prevalent in women than in men. The literature is inconsistent with regard to this,[18,19] although the prevalence rate is generally considered to be higher in the female gender due to a lower activity level in this sample.[20] On the other hand, the prevalence of a positive screening test was higher in men than in women, although on confirmatory testing, the prevalence of DM was lower in men ($p < 0.0001$). This indicates that women are more likely to have their DM diagnosed than men, which is possibly due to the fact that women tend to seek healthcare more frequently than men.

The prevalence of DM varied between regions, ranging from 28.3% in Oraiera to 11% in Jubail (p < 0.0001). The reason for the variation could not be determined from this study. Jubail is an industrial city, with a predominantly young working population. This may explain the relatively lower prevalence of DM in this area compared to other sectors. Although Oraiera is a rural area, it was found to have the highest prevalence of DM. This finding is contrary to that reported previously in Saudi Arabia and other parts of the world.(2,4,18)

A higher education level and employment as a professional were negative predictors for the development of DM. This finding may be related to the shift in obesity from the high to low socioeconomic groups,(20) and the fact that educated people with professional employment are more aware of the importance of good eating habits and lifestyle modifications. Literacy was found to be associated with an increased prevalence of DM and to be negatively correlated with the DM controls.(18,21,22) This supports the need for increased public awareness and education in order to achieve better control and prevention of DM. In this study, DM was more prevalent among patients with low income. It has been documented that the prevalence of DM is highest among lower socioeconomic groups in industrialised countries, while it is highest among the rich in developing countries.(23-25) Low income has also been found to increase the risk of developing DM among children,(26) and is correlated with postgestational DM.(27)

Our study also found that DM is less prevalent among singles. This finding can be attributed to the fact that in this study, the singles were younger than the participants in the three marital statuses. On the other hand, married participants had a lower prevalence rate of DM than divorced and widowed participants. This is consistent with the findings of Azimi-Nezhad et al,(18) who reported that married Iranian participants had a lower prevalence of DM compared to those who were widowed or divorced. Eaker et al have found that general marital communication conflict and strain are associated with diverse health outcomes.(28)

The lack of follow-up for confirmatory testing was related to both health team factors (failure of referral) and patient factors (such as a failure to attend the scheduled follow-up appointment or failure to meet the fasting requirement). However, psychological factors could have also played a role, as newly screened positive participants may be in denial of their condition. The failure to undergo the confirmatory test for screened positive participants was more apparent among the highly educated compared to the rest of the participants (p < 0.0001). Previous studies have shown that psychological factors and denial can have an impact on the screening of DM and metabolic control.(29,30)

The limitations of this study included the possibility of bias due to the different response rates from different sectors and the fact that only 59.3% of the screened population returned for confirmatory testing. In addition, only one sample of FPG was used to diagnose IFG and DM, and no effort was made to classify the type of DM. In spite of the above limitations, our study has significant strength, represented by its large sample size. In addition, our study population is closely comparable with the data from the latest census carried out in the Eastern Province of Saudi Arabia(31) in terms of age and gender distribution, which makes our results a fair representative estimate of the prevalence of DM and IFG in the Eastern Province.

In conclusion, the prevalence of DM in the Saudi population is high. Increasing age, being widowed or divorced, having a low income and a low education level were significant predictors of DM. Although this study highlighted improvements to the healthcare system in Saudi Arabia, as reflected in the decreased percentage of individuals with undiagnosed DM, the prevalence of IFG, which is considered to be a pre-DM state, remains high and thus, vigorous interventions to prevent its progression to DM are required. This campaign has important implications for the promotion of public health in the Eastern Province of Saudi Arabia. It advocates the early detection of DM and IFG through an increased awareness of other risk factors by ensuring that health promotion and preventive measures are applied at all levels.

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