World Journal of Public Health
2017; 2(2): 81-88
http://www.sciencepublishinggroup.com/j/wjph
doi: 10.11648/j.wjph.20170202.14

Prevalence and Correlates of Diabetes Mellitus Among Adult Obese Saudis in Al-Jouf Region

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To cite this article:

Mohamed Yahya Saeedi, Ahmed Jameel Almadani, Abdelgadier Ibrahim Jamo, Fayez G. Alruwailly, Ashraf Bashir Albaraka, Ahmed K. Ibrahim, Kassim A. Kassim. Prevalence and Correlates of Diabetes Mellitus Among Adult Obese Saudis in Al-Jouf Region. *World Journal of Public Health.* Vol. 2, No. 2, 2017, pp. 81-88. doi: 10.11648/j.wjph.20170202.14

Received: January 24, 2017; **Accepted**: March 22, 2017; **Published**: April 12, 2017

Abstract: Background: Saudi Health Information Survey reported that diabetes affects 13.2% of the population while 16.3% are borderline, also obesity affects 28.7% of the population. Diabetes has a major impact on health and quality of life. whereas, early control of type 2 diabetes also reduces the risk of mortality. Aim: we aimed to explore the prevalence and the most important determinants of diabetes among a sample of Saudi obese adults and discover the reliability and validity of the CANRISK scale. Methods: A cross-sectional study of 390 obese, adult Saudis attending the 9th Olive Festival in Al-Jouf region, KSA using CANRISK questionnaire and blood sugar testing was carried out. Results: There was statistically significant association between diabetes and participants' age ($p<0.001$) and insignificant association for gender, marital status, educational level, monthly income, smoking and healthy habits ($p>0.05$). The risk of having diabetes was increased 3.7 times for the older age group (64-74 years) in comparison to the younger group with a steady risk increase with advanced age (AOR=3.7, 95% CI 1.5-9.4). The risk of having pre-diabetes or diabetes was high in 72%, moderate in 22.5% and low in only 5.5% of the studied sample. Conclusion: Prevention strategies need to address the differential risks for diabetes among the expected high-risk groups and consider them as targets for clinical and public health action.

Keywords: Prevalence, Diabetes, Validity, Canrisk

1. Introduction

Diabetes and obesity are major causes of morbidity and mortality both are costly in both health-related and economic terms [1] [2]. The worldwide prevalence of diabetes and obesity has been doubled between 1980 and 2014. WHO estimated that, globally, 422 million adults aged over 18 years were living with diabetes and over 600 million were obese [3-5]. Worldwide, the number of people with diabetes has substantially increased from 108 million in 1980 to current numbers that are around four times higher [3, 4]. Diabetes prevalence was correlated with the global urbanization: a trend toward sedentary lifestyles and poor diet [6-9].

The Kingdom of Saudi Arabia (KSA) has witnessed a demographic shift over the last 20 years, accompanied by behavioural changes such as an increase in caloric, fat, and carbohydrate intake with a reduction in physical activity [10]. In 2015; There were 3.4 million cases of diabetes in Saudi Arabia and more than 35.4 million people in the Middle East and North Africa (MENA) Region; by 2040 this will rise to 72.1 million [11]. Saudi Health Information Survey reported that diabetes affects 13.2% (14.8% males, 11.7% females) of the population and 16.3% are borderline (17.0% males, 15.5% females), while obesity affects 28.7% of the population (24.1% males, 33.5% females) [12].

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 [13, 14]. Consequently, people with diabetes tend to live an average of 5 to 10 years less than those without diabetes. Early detection of type 2 diabetes and pre-diabetes leads to earlier control of blood glucose which is crucial for preventing these complications. Early control of type 2 diabetes also reduces the risk of mortality and co-morbidity as evidenced by the United Kingdom Prospective Diabetes Study (UKPDS) [15]

CANRISK can help raise the public's awareness of their risk for diabetes to prevent or manage the disease. CANRISK is a questionnaire that helps to identify the pre-diabetes or type 2 diabetes. It is mainly for adults between the ages of 45 and 74 years, but may also be used for younger groups in high-risk populations [16]. Completing the questionnaire gives patients an overall CANRISK score that shows their risk of having pre-diabetes or diabetes. CANRISK was adapted from a similar questionnaire that is being used in Finland as part of its national diabetes prevention program (FINDRISC). The Public Health Agency of Canada (PHAC) convened a group of clinical and academic experts to modify the questionnaire so it would more accurately reflect known diabetes risk factors applicable to Canadians, such as the addition of new questions on ethnicity, education and gestational diabetes [16]

The aim of the present study was to evaluate the prevalence of diabeties among the studied group, to investigate the determinants of the disease among the studied cohort and to the validity of the screening scale.

2. Method

2.1. Design and Procedures

The study was a cross-sectional survey of obese (BMI ≥ 25), adult (age ≥ 40 years) Saudis attending the Crown Health Program Exhibition at the 9th Olive Festival in Al-Jouf region, KSA. The study was carried out during the period from 10/2015 to 2/2016. A convenience sampling technique was applied recruiting eligible candidates for the study and using a self-administered questionnaire for data collection.

Sample size calculation was carried out according to the WHO guidelines for descriptive study designs (1), provided that the prevalence of diabetes among Al-Jouf population was 24% according to Saudi national Survey [12], with 95% confidence level, an error of 0.05 and 90% power of calculation. The resulted minimum sample was 292.

Participants were asked to fill the study questionnaire after a brief introduction about the research aim, concept, methods, and benefits. A group of trained medical personnel helped in the data collection procedure. Participants were asked to fill in each question to overcome missing data. The questionnaire was anonymous, informed consent was obtained and confidentiality was assured. For the blood sample, each applicant was asked to sign a written consent after full explanation of the aims, risks, and benefits.

2.2. Measure

A. Socio-demographic data questions included; age, sex, marital status, occupation, and educational level.

B. The Canadian Diabetes Risk Questionnaire (CANRISK) [15]; it is a structured questionnaire composed of 12 questions that help in identifying the risk of pre-diabetes or type 2 diabetes. It is mainly for adults between the ages of 40 and 74 years, but may also be used for younger groups in high-risk populations. Completing the questionnaire gives patients an overall CANRISK score that shows their risk of having pre-diabetes or diabetes. CANRISK was adapted from a similar questionnaire that is being used in Finland as part of its national diabetes prevention program (FINDRISC). The Public Health Agency of Canada (PHAC) convened a group of clinical and academic experts to modify the questionnaire so it would more accurately reflect known diabetes risk factors applicable to Canadians, such as the addition of new questions on ethnicity, education, and gestational diabetes. In a recent Canadian peer-reviewed study involving over 6000 blood-tested adults, CANRISK scores were validated against diagnostic gold standard blood tests used in assessing diabetes risk in Canada's multi-ethnic population 3. CANRISK scores can be easily interpreted by summing up point scores for each of the 12 questions then comparing the results with threshold scores for each of the 3 risk categories;

a) Low < 21; the risk of having pre-diabetes or type 2 diabetes is fairly low, though it always pays to maintain a healthy lifestyle

b) Moderate: 21–32; based on the identified risk factors, the risk of having pre-diabetes or type 2 diabetes is moderate. Should consult a health care practitioner about the risk of developing diabetes

c) High > 32; based on the identified risk factors, the risk of having pre-diabetes or type 2 diabetes is high. Must consult a health care practitioner to discuss getting blood sugar tested.

The score can also be converted to estimate the probability of current dysglycemia by using a formula described in Robinson, et al., 2011, Validating the CANRISK prognostic model for assessing diabetes risk in Canada's multi-ethnic population [3].

A. Clinical Data included smoking status, weight in kilogram, height in meter, body mass index (BMI = weight in kg/(height in m)^2), waist circumference in cm and blood pressure measurement.

B. Laboratory Data

i. Glycated haemoglobin (HbA1C) test indicates the average blood sugar level for the past two to three months. It measures the percentage of blood sugar attached to haemoglobin (the oxygen-carrying protein in red blood cells). The higher the blood sugar levels, the more sugar will be attached with haemoglobin. An A1C level of ≥ 6.5% on two separate tests indicates diabetes. An A1C between 5.7 and 6.4% indicates pre-diabetes. Below 5.7% is considered normal. False A1C test results could be due to pregnancy or having an uncommon form of haemoglobin.

ii. Random blood sugar test. A blood sample will be taken at a random time. Regardless of the time of the last meal, a random blood sugar level of ≥ 200 milligrams per deciliter (mg/dL) — 11.1 millimoles per liter (mmol/L) suggests diabetes.

2.3. Statistical Analysis

Data were analyzed using SPSS version 21 software. To prepare the data for analysis, basic statistics were calculated (frequencies, cross-tabulation, and histogram). Frequency tables were examined to explore missing data, errors in the data and data consistency. Missing data in the main variables (IAS and PHQ) were treated by replacing the missing value with median values. Age and sex were added as a priori variables. Basic univariate analyses (chi-square and t-test) were conducted to test the associations between A1C results and the exposure variables.

An initial multivariate logistic regression model was built containing a priori variables (age and sex) plus the associated variables from the univariate screening analyses to report the adjusted odds ratio (AOR). Likelihood Ratio Test (LHR) and Confidence Intervals (CIs) were calculated to assess the significance. The final model fitting was carried out in three stages; 1st; a priori variables and the significant variables in the initial model were included, 2nd; all non-significant variables from the initial model were included in the final model one at a time to test for their effect on the model, 3rd; to adjust for the effects of the other factors (non-significant variables from the univariate analysis), these factors were simultaneously incorporated into the model and the likelihood ratio test was used to test for model robustness. Additionally, possible effect modification by sex was examined by testing for interactions between sex and each of the predictor variables individually ($p \leq 0.05$).

For reliability and validity of the CANRISK; Correlation analysis was used to test the association between variables (Spearman's rank correlation). Item analysis was performed, Cronbach αs and Intra-Class Correlation Coefficient (ICC) were calculated for total PDI and for separate items. A significant p-value was considered when it is less than or equal 0.05.

3. Results

The current study included 390 participants attending the Crown Health Program Exhibition at the 9th Olive Festival in Al-Jouf region, KSA in 2015. The participants' age ranged from 40 to 74 years. About three quarters were males where the majority of them (90%) were married. Most of the respondents (65%) were non-smokers. Also, about 60% were employed and 36% had university degree. Moreover, about 37% had monthly income > 10,000 SR. Regarding healthy habits; only 11% were physically active and 18% were eating vegetables and fruits regularly. The demographic data of these patients are shown in Table 1 & Figure 1. In this study, 159 participants (41%) were found to be Diabetics according to the HbA1C test.

Table 1. *Socio-demographic characteristics of Diabetic Adult Obese Saudis in Al-Jouf Region, 2015.*

Variable	**Total no. = 390**	**(%)**
Age Group in years		
< 44	121	31.0
44-54	143	36.7
54-64	86	22.1
64-74	40	10.2
Gender		
Male	294	75.4
Female	96	24.6
Marital Status		
Not Married	42	10.8
Married	348	89.2
Educational Level		
Some High School or less	222	56.9
High School Diploma	24	7.2
College or University Degree	140	35.9
Occupation*		
Not Working	158	40.5
Working	232	59.5
Monthly Income (SR)		
≤ 10,000	218	59.9
> 10,000	146	37.4
Missing	26	6.7
Smoking Status		
Non-smoker	254	65.1
Smoker	92	23.6
Ex-smoker	44	11.3
Physical Activity		
No	349	89.5
Yes	41	10.5
Eating Fruits & Vegetables		
No	320	82.1
Yes	70	17.9

*Not working (unemployed, housewife, student and retired), working (Governmental, private & others)

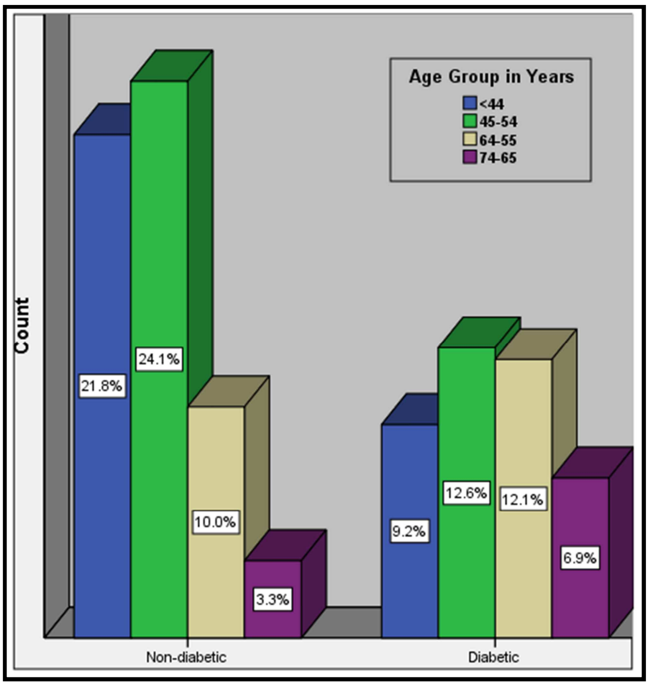


Figure 1. *Age Distribution of Diabetic Cases among the studied cohort.*

Table 2 showed the univariate risk factors associations with diabetes. There was statistically significant association between diabetes and participants' age ($p<0.001$); i.e. the older the participant, the higher the prevalence of diabetes. Also, higher percentages of diabetes were reported for unemployed participants. On the other hand, insignificant association was noticed for gender, marital status, educational level, monthly income, smoking and healthy habits ($p>0.05$).

Moreover, about two-thirds of diabetics were obese ($p<0.05$) and 70% of them have abnormal waist circumference ($p<0.05$). Also, the mean systolic and diastolic blood pressure were higher among obese compared with non-obese respondents ($p<0.01$ & $=0.05$, respectively). Respecting the participants' history; we found that about 45% of diabetics had history of hypertension ($p<0.01$) and about two-thirds had history of high blood glucose and family history of diabetes ($p<0.001$) (Table 2).

Table 2. *Univariate analysis of Risk Factors.*

Variables	Non-diabetic (n=231)	Diabetic (n=159)	P-value
Age Group in years			
< 44	85 (70.2%)	36 (29.8%)	
44-54	94 (65.7%)	49 (34.3%)	< 0.001*
54-64	39 (45.3%)	47 (54.7%)	
64-74	13 (32.5%)	27 (67.5%)	
Gender			
Male	179 (60.9%)	115 (39.1%)	= 0.148*
Female	52 (54.2%)	44 (45.8%)	
Marital Status			
Not Married	20 (8.7%)	22 (13.8%)	= 0.074*
Married	211 (91.3%)	137 (86.2%)	
Educational Level			
Some High School or less	125 (54.1%)	97 (61.0%)	= 0.067*
High School Diploma	15 (6.5%)	13 (8.2%)	
College or University Degree	91 (39.4%)	49 (30.8%)	
Occupation*			
Not Working	149 (64.5%)	82 (52.2%)	= 0.010*
Working	82 (35.5%)	76 (47.8%)	
Monthly Income (SR)			
≤ 10,000	125 (57.9%)	93 (62.8%)	= 0.200*
> 10,000	91 (42.1%)	55 (37.2%)	
Smoking Status			
Non-smoker	153 (66.2%)	101 (63.5%)	= 0.269*
Smoker	52 (22.5%)	40 (25.2%)	
Ex-smoker	26 (11.3%)	18 (11.3%)	
Physical Activity			
No	209 (90.5%)	140 (88.1%)	= 0.273*
Yes	22 (9.5%)	19 (11.9%)	
Eating Fruits & Vegetables			
No	191 (82.7%)	129 (81.1%)	= 0.396*
Yes	40 (17.3%)	30 (18.9%)	

*Chi-square analysis was used to compare the difference in proportions

Table 2. *Continued.*

Variables	Non-diabetic (n=231)	Diabetic (n=159)	P-value
BMI			
Normal	30 (13.0%)	10 (6.3%)	< 0.028*
Over-weight	77 (33.3%)	50 (31.4%)	
Obese	124 (53.7%)	99 (62.3%)	
Waist Circumference			
Normal	93 (40.3%)	48 (30.2%)	= 0.027*
Abnormal	138 (59.7%)	111 (69.8%)	
Systolic Blood Pressure			
Mean ± SD	128.8 ± 17.3	134.2 ± 18.1	= 0.004**
Median (Range)	130.0 (85 - 190)	82.5 (55 - 178)	
Diastolic Blood Pressure			
Mean ± SD	82.7 ± 13.3	85.6 ± 14.9	= 0.050**
Median (Range)	82 (35.5%)	76 (47.8%)	
History of Hypertension			
No	167 (72.3%)	88 (55.3%)	= 0.001*
Yes	64 (27.7%)	71 (44.7%)	
History of High Glucose Level			
No	191 (82.7%)	38 (23.9%)	< 0.001*
Yes	40 (17.3%)	121 (76.1%)	
Family History			
No	104 (45.0%)	43 (27.0%)	< 0.001*
Yes	127 (55.0%)	116 (73.0%)	

*Chi-square analysis was used to compare the difference in proportions
**Student t-test was used to compare the mean difference between the two groups

Table 3 illustrated the adjusted OR for the most common risk factors associated with diabetes. The final logistic regression model contained seven predictors for diabetes in the studied cohort which are; age, BMI, waist circumference, systolic blood pressure, history of high glucose level, family history and monthly income using the Likelihood Ratio Test (LRT) ($P < 0.05$).

The risk of having diabetes was increased 3.7 times for the older age group (64-74 years) in comparison to the younger group with a steady risk increase with advanced age (AOR=3.7, 95% CI 1.5-9.4). BMI and waist circumference increased the risk of diabetes. Obese participants were about five times more liable to have diabetes (AOR=4.95, 95% CI 1.7–12.4). Moreover, those with abnormal waist circumference were about two times more likely to have diabetes (AOR=2.2, 95% CI 1.2–3.9). Systolic hypertension also had an impact on diabetes as those with high systolic blood pressure were 2% more liable to have diabetes (AOR=1.02, 95% CI 1.01–1.04). As regards participants' history; those with positive history of high glucose level were more likely to have diabetes (AOR=1.2, 95% CI 1.16–1.25) and those with family history of diabetes were 45% more likely to have the disease (AOR=1.45, 95% CI 1.09–1.93). Finally, higher monthly income (>10,000 SR) increased the risk of diabetes by 80% (AOR=1.8, 95% CI 1.03–3.15). Based on the risk factors identified in the CANRISK questionnaire, the risk of having pre-diabetes or diabetes was high in 72% of the studied sample, moderate in 22.5% and low in only 5.5% (Figure 2).

Table 3. *Adjusted OR of Risk Factors of PPD.*

Variables	Initial Model*			Final Model**		
	Adjusted OR	**95% CI**	**LRT P-value**	**Adjusted OR**	**95% CI**	**LRT P-value**
Age Group in years						
< 44	1			1		
44-54	1.04	0.53 – 2.04	= 0.018	1.08	0.57 – 2.06	= 0.010
54-64	2.80	1.20 – 6.57		2.61	1.26 – 5.41	
64-74	4.60	1.42 – 14.41		3.69	1.45 – 9.43	
Gender						
Male	1		= 0.264			
Female	1.32	0.83 – 2.10				
Occupation						
Not Working	1					
Working	1.25	0.67 – 2.34	= 0.481			
BMI						
Normal	1		= 0.025	1		= 0.003
Over-weight	1.95	0.88 – 4.33		3.10	1.11 – 8.58	
Obese	2.40	1.12 – 5.14		4.95	1.70 – 12.37	
Waist Circumference						
Normal	1		= 0.043	1		= 0.007
Abnormal	1.56	1.02 – 2.39		2.20	1.24 – 3.90	
Systolic Blood Pressure	1.02	1.01 – 1.04	= 0.038	1.02	1.01 – 1.04	= 0.044
Diastolic Blood Pressure	1.01	0.98 – 1.03	= 403			

Table 3. *Continue.*

Variables	Initial Model*			Final Model**		
	Adjusted OR	**95% CI**	**LRT P-value**	**Adjusted OR**	**95% CI**	**LRT P-value**
History of Hypertension						
No	1		= 0.364			
Yes	0.93	0.79 – 1.08				
History of High Glucose Level						
No	1		< 0.001	1		< 0.001
Yes	1.21	1.16 – 1.26		1.20	1.16 – 1.25	
Family History						
No	1		= 0.006	1		= 0.011
Yes	1.52	1.13 – 2.05		1.45	1.09 – 1.93	
Monthly Income (SR)						
≤ 10,000	1		= 0.342	1		= 0.041
> 10,000	1.23	0.80 – 1.89		1.80	1.03 – 3.15	

*The Initial model included the Significant Socio-demographic variables and clinical variables

** In the final mode (age, BMI, WC, systolic blood pressure, history of high glucose level and family history of diabetes) then the Likelihood Ratio Test (LRT) for adding the non-significant variables to the final model was performed (monthly income)

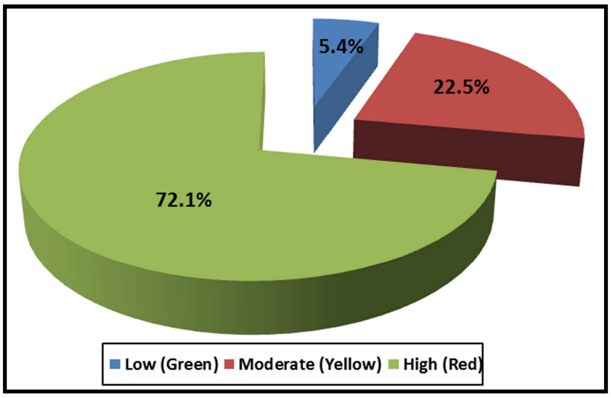


Figure 2. *Distribution of the studied cohort according to the CANARISK scores.*

The properties and distribution of the CANARISK scale were described in table 4 and figure 3. CANARISK ranged from 10 to 69 with the mean equals 41.2 (SD= 12.8), 95% Confidence Interval for Mean (39.9 - 42.4). The spread of scores was normally distributed (skewness = 0.07 and kurtosis = -0.06) (i.e. the curve of distribution is not shifted to left or right sides). The scale reliability was moderate (Cronbach's α was 0.52 and ICC was 0.6). The discrimination value which is the ability to discriminate between variables, that is an important indicator for validity, measured by Ferguson δ equals 0.61 (normally, Ferguson δ more than 0.5 is valid).

Table 4. *Statistical Properties of the CANARISK scale.*

Parameter	Statistic
Mean	41.15
95% Confidence Interval for Mean	39.9 - 42.4
5% Trimmed Mean	41.12
Median	41.00
Range	59 (10 – 69)
Std. Deviation	12.8
Inter-quartile Range	17
Skewness	0.07
Kurtosis	-0.06
Reliability (Cronbach α)	0.516
ICC	0.593
Discrimination (Ferguson δ –Delta-)	0.612

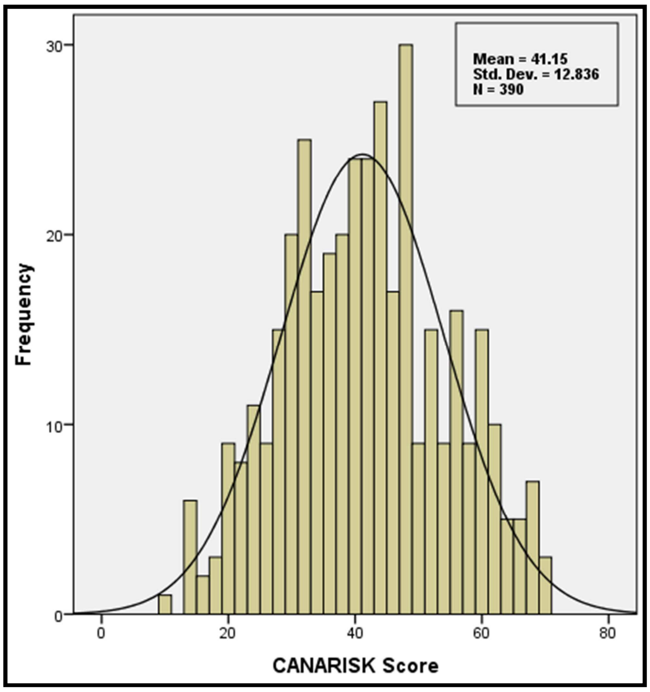


Figure 3. *Distribution of the CANARISK scale among the studied sample.*

Table 5 demonstrated the construct validity of the CANARISK scale was measured by Spearman's correlation. There was strong positive correlation between CANARISK scale scores and age, HbA1C, WC and history of high glucose level (correlation coefficient = 0.71, 0.62, 0.69 and 0.81 respectively; p<0.001). Moreover, moderate positive correlations were reported with RBS, BMI and History of hypertension (correlation coefficient = 0.52, 0.46 and 0.55 respectively; p<0.001). There was significant weak positive correlation between CANARISK scale scores and gender (coefficient = 0.23 respectively; p=0.026).

Table 5. *Spearman's correlation between CANARISK score, RBS, HBA1C, Socio-demographics and Clinical Data.*

Number (N=390)		
		CANARISK Score
RBS	r p-value	0.52* (< 0.001)
HBA1C	r p-value	0.62* (< 0.001)
Age	r p-value	0.71* (< 0.001)
Sex	r p-value	0.23** (=0.026)
BMI	r p-value	0.46* (< 0.001)
WC	r p-value	0.69* (< 0.001)
History of High Glucose Level	r p-value	0.81* (< 0.001)
History of Hypertension	r p-value	0.55* (< 0.001)

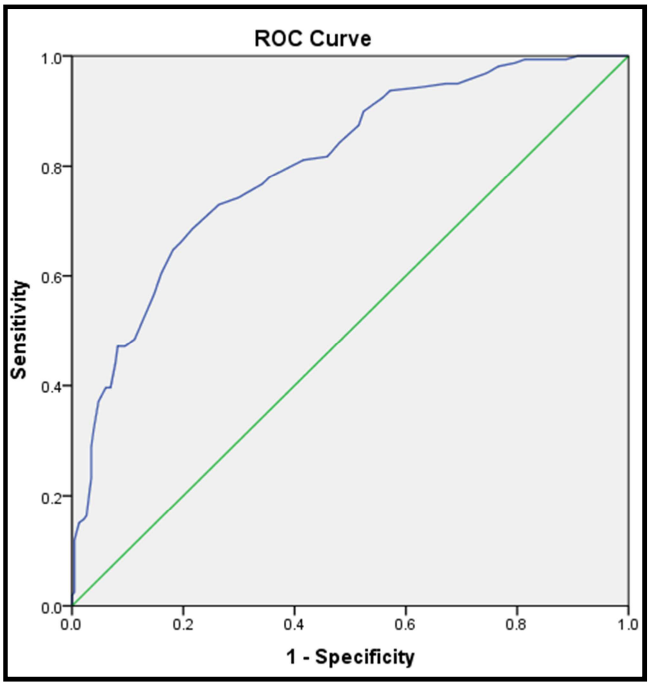
*Correlation is significant at the 0.05 level (2-tailed).

Table 6 and Figure 4 showed the CANARISK score discrimination among study sample. ROC curve was drawn by a nonparametric method using SPSS software (AUC = 0.803, 95% confidence interval: 0.76 - 0.86, p < 0.001). This curve and the corresponding AUC showed that CANARISK scale as a screening tool for diabetes mellitus has predictive ability to discriminate diabetic patients from normal subjects.

Table 7. *CANARISK score discrimination among study sample.*

	CANARISK Score		P-value	95% CI+
	AUC*	SE**		
Diabetics	0.803	0.022	< 0.001	0.759 - 0.864

*AUC = Area under the Curve
**SE = Standard Error +CI = Confidence Interval



***Null hypothesis: true area = 0.5

Figure 4. *ROC for CANARISK scale.*

4. Discussion

Diabetes is on the rise worldwide; according to the latest report from the International Diabetes Federation, the global prevalence will rise from 8.3% in 2013 to 11.1% in 2033 and the number of people affected by the disease will increase by 57% from 382 to almost 600 million [17]. As demonstrated in the current study, diabetes prevalence among obese adults was 41% while Al-Saleem et al [18] reported that diabetes was reported among 20% of obese compared to 10% among individuals with normal weight in study conducted in 230 PHCCs in Aseer region. Also, the Health Survey for England (HSE) data from 2010-12 shows that 12.4% of people aged 18 years and over with obesity have diagnosed diabetes, five times that of people of a healthy weight. [19]. That can be explained by the close association between obesity and type 2 diabetes and the severity of type 2 diabetes are closely linked with body mass index (BMI) [20]. There are a seven times greater risk of diabetes in obese people compared to those of healthy weight, with a threefold increase in risk for overweight people also the body fat distribution can increase the risk of diabetes, the precise mechanism of association remains unclear [21]. So, any adult individual with overweight/obesity should be screened for diabetes as is a part of metabolic syndrome is common among Saudi adults as reported by Al-Nozha et al [22].

There was a statistically significant association between diabetes and participants' age. There is a clear association between increasing age and greater diabetes prevalence. These findings are in agreement with many studies which showed a strong association increasing age and diabetes prevalence [1, 18, 19, 23]

Insignificant association was noticed for smoking and healthy habits but U.S. Department of Health and Human Services [24] reported that the risk of developing type 2 diabetes is 30-40% higher for regular smokers than for non-smokers and that there is a positive dose-response relationship between the number of cigarettes smoked and the risk of developing diabetes [18, 25]. The meta-analysis of Willi C. et al [26] included more than 3.9 million participants and 140,813 cases of diabetes, with the number of participants in these studies ranging from 241 to 2,540,753. Follow-up ranged from 3.5–30 years, with a median of 10 years. Concluded active smokers had an increased risk of developing type 2 diabetes compared with non-smokers, with a pooled RR of 1.37 (95% CI, 1.31–1.44).

BMI and waist circumference increased the risk of diabetes, obese participants were about five times more liable to have diabetes (AOR=4.95, 95% CI 1.7–12.4), these findings are in agreement with many studies which showed associations between increasing levels of BMI, decreasing levels of physical activity and unhealthy diet on the development of type 2 diabetes [27, 28]. Also, Guh DPet al [29] noted the strongest association between overweight defined by body mass index (BMI) and the incidence of type II diabetes in females (RR = 3.92 (95% CI: 3.10-4.97)). Statistically, significant associations with obesity were found with the incidence of type II diabetes.

CANRISK is a statistically valid tool that may prove to be suitable for assessing diabetes risk in Canada's multi-ethnic population [30]. In current study and based on the risk factors identified in the CANRISK questionnaire, the risk of having pre-diabetes or diabetes was high in 72% of the studied sample, moderate in 22.5% and low in only 5.5% which is differ from data published by Chip P Rowan et al [31] in 2014 and shows that the overall risk score, 30.2% of participants fell into the "Small" risk category, 33.1% into the "Moderate" risk category 16.5% into the "High" risk category, 15.4% into the "Very High" risk category, and 4.8% into the "Extreme" risk category. 4.8% into the "Extreme" risk category that can be explained by that, our target group was obese.

5. Conclusion

Prevention and treatment need to address the differential risks for diabetes among the expected high-risk groups and consider them as targets for clinical and public health action. Such knowledge could lead to early detection provides increased awareness and the opportunity to individuals allowing them to make important lifestyle changes as quickly as possible with the goal of preventing, or delaying, the progression towards type 2 diabetes and the known associated complications.

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