OPPORTUNISTIC SCREENING FOR UNDIAGNOSED DIABETES MELLITUS AND PRE-DIABETES IN SULAIMANI CITY AND ITS ASSOCIATED RISK FACTORS

Shelan Omer Rasheed [a], Zhian Salah Ramzi [b], and Taha Othman Mahwi [a]

Submitted: 13/7/2020; Accepted: 23/10/2020; Published: 21/3/2021

ABSTRACT

Background

Diabetes mellitus is one of the most common non-communicable diseases worldwide, and is one of the major global risks for mortality, especially due to cardiovascular diseases. Pre-diabetes is a transitional stage between normal and diabetes, it is thus important to identify people in the pre-diabetic state early by active screening to prevent its micro-and macrovascular complications.

Objectives

This study aimed to find out the prevalence of undiagnosed diabetes mellitus and pre-diabetes Mellitus among adults in Sulaimani City, and its associated risk factors

Materials and Methods

A cross-sectional study was conducted in five Primary Health Care Centers in Sulaimani City which is located in Kurdistan Region of Iraq from 23 July to 20 December 2019. Data were gathered through direct interviews with the participants aged 30 years and above. The questionnaire includes demographic characteristics and risk factors. Participants were subjected to random blood glucose assessments. Those random blood glucose >140mg/dl were subjected to further confirmatory tests of fasting plasma glucose, HbA1c, and lipid profile. Analysis of the data was done by using SPSS program, chi square test and logistic regression analysis used. significant level set at ≤ 0.05.

Results

A total of 1300 participants 30 years and above were studied, Mean age (SD) of the participants was 46.2 ±10.7years. The prevalence of undiagnosed diabetes and pre-diabetes was 3.8%, and 2.6% respectively. The significant risk factors of diabetes were age, family history of diabetes, both overweight and obesity, hypertension, and lipid abnormality ($p<0.05$)

Conclusion

The prevalence rate of undiagnosed diabetes mellitus and pre-diabetes is at a seasonable level. Age more than 40 years, history of hypertension, were strong predictors for undiagnosed diabetes mellitus and pre-diabetes, also hypercholesterolemia and hypertriglyceridemia were positively correlated with hyperglycemia.

Keywords: *Undiagnosed diabetes mellitus; Pre-diabetes, Opportunistic screening, Risk factors of DM.*

[a] College of Medicine, University of Sulaimani, Kurdistan Region, Iraq.
[b] College of Nursing, University of Sulaimani, Kurdistan Region, Iraq.
Correspondence: shelan.rasheed@univsul.edu.iq

https://doi.org/10.17656/jsmc.10293

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder characterized by chronic hyperglycemia, In 2017 the International Diabetes Federation indicates that approximately 425 million adults are accounting for 8.8%, who were living with diabetes. This figure is expected to be 629 million which is equal to 9.9% of the total number of an adult by 2045 [1].

In Iraq, the prevalence of diabetes mellitus (DM) is at increasing direction so that in the year 2013 the prevalence was 7.4% when it was projected to 8.8% by the year 2030 with adjustment to the national population of Iraq, while after adjustment to the world population the prevalence in 2013 was 9.5% when it was predicted to 9.7% by 2030 [2].

Globally the number of people with type 2 diabetes mellitus is increasing [3], and approximately half of all people with diabetes mellitus remain undiagnosed [4]. People with undiagnosed type 2 diabetes and pre-diabetes are announced to have significant clinical importance and impose substantial public health implications because these subjects remain untreated and at risk for complications [3]. The characteristic of undiagnosed diabetes mellitus (UDM) is uncontrolled elevated blood glucose level, which leads to the development of micro-and macrovascular complications [5].

The defining diagnostic feature of diabetes is an abnormal glucose metabolism categorized as pre-diabetes in its early stage [6]. Pre-diabetes refers to the condition defined as glycemic levels that are higher than normal, but lower than diabetes thresholds [7]. Studies of pre-diabetes among populations are required to spread knowledge concerning ascertain risk factors to design effective preventive interventions [8]. To reduce the progression of pre-diabetes to diabetes, early screening is of great significance for early detection, because pre-diabetes is a transitional stage between normal and diabetes [9]. On the other aspect, people diagnosed through opportunity screening had a good prognosis compared to those who are diagnosed by clinical onset of symptoms [10]. Thus, This study aimed to find out the prevalence of UDM and pre-diabetes among adults in Sulaimani City, and its associated risk factors.

MATERIALS AND METHODS

A cross-sectional study was performed in Sulaimani city which is located in Kurdistan Region of Iraq. According to the department of planning in Sulaimani General Directorate of Health there are 40 Primary Health Care (PHC) centers in Sulaimani City. To select PHC centers in a way to represent the whole Sulaimani City, we depend on the geographical distribution of those PHC centers according to East, West, North, South, and Center of City region of Sulaimani City. In each region, the total number of PHC centers was detected, and then by simple random sampling, one PHC center was selected for the region. To obtain a representative sample from each PHC center stratified sampling technique was applied to obtain a representative sample from each PHC center. Each PHC center is delivering services for a number of the population according to the certain geographic distribution of the population. The number of individuals of each stratum is proportional to the fraction of that stratum in the population [11]. The sample size was estimated according to the sample size equation, to detect the prevalence of 7.4% from the global estimation of DM prevalence for 2013 in Iraq [2]. The minimum sample required to estimate prevalence in Sulaimani city calculated was 432, but the researchers decided to increase the sample size to 1300 to be a more accurate representative sample.

All individuals aged 30 years and above attending PHC centers for receiving health service, males and females had been invited to participate in the study for opportunistic screening. Patients with known diabetes mellitus, Dibetogenic drugs such as steroids, diuretics, and beta-blockers, pregnant women, and individuals less than 30 years old were excluded from the study. Data was collected from 23rd July to 20 December 2019. Participants had received clear information regarding the aims and objectives of the study, and verbal informed consent was obtained from each participant.

A questionnaire designed for the study was filled through a direct interview conducted by the investigator with the illegible participants during the study period. The questionnaire is composed of three parts: the first part socio-demographic variables such as: (age, gender, and marital status. For occupation, education, and Socioeconomic status (SES) variables in this study we depend on an index for SES [12]. Socioeconomic status variable divided into three levels which were (low, moderate, and high) based on SES index equation [12]:

SES = Education + Occupation + House ownership * 0.5 + Car ownership * 0.1

+ (age-20)/100 - Retired/unemployed/deceased

The final result of SES was estimated to find scores:

0 to 5 considered low SES, from 6 to 9 is considered moderate SES, and more than 9 considered high SES [12].

The second part of the questionnaire contains variables that may be associated with DM such as (family history of diabetes, history of hypertension, abnormal lipid profile, tobacco smoking, and alcohol drinking). The third part of the questionnaire including measurements of height and weight for body mass index(BMI) estimation and it was calculated by obtaining the ratio of weight (kg)/height2 (m), and it was grouped into 4 categories, according to World Health Organization (WHO)'s classification, less than 18.5 kg/m2 (underweight), 18.5 to 24.9 kg/m^2 (normal weight), 25.0 to 29.9 kg/m^2 (overweight), and 30.0 kg/m^2 or higher (obese) [13]. The blood pressure of the participants was measured by using a mercury sphygmomanometer (A MERCURO sphygmomanometer- Germany). Subjects were diagnosed to be hypertensive (if systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg [14].

Participants were subjected to random blood glucose (RBG) screening by (Auto Code blood glucose monitoring system (Preci-Chek, Model AC Germany)). Individuals who had an RBG level of ≥140 mg/dl based on the glucometer reading were subjected to further confirmatory tests for diabetes mellitus and were instructed to come to the PHC center the next day in overnight fasting status for fasting blood glucose (FBG) test. Participants with FBG with more than 100mg/dl, 5ml of blood were collected, and put in two tubes: one tube for hemoglobin A1c while the other tube for fasting plasma glucose (FPG) and lipid profile, the samples were sent to Shaheed Baxteyar clinic laboratory in Sulaimani City within 1-2 hours of duration. Participants were classified as diabetics based on the diagnostic criteria of the American Diabetic Association (ADA), FPG 100 mg/dl (5.6 mmol/L) to 125 mg/dL (6.9 mmol/L), and HbA1c cutoff level of 5.7–<6.5%, for pre-diabetes, FPG ≥ 126 mg/dl (7.0mmol/l). HbA1c cutoff level is ≥6.5%, for diagnosis of diabetes [15]. Cut value for hyperlipidemia was used according to the national education program adult treatment panel lll [16].

Data were analyzed by using SPSS version 21.0 software. For identifying associated factors, a chi-square test was used. The OR with a 95% confidence interval (CI) was estimated using multinomial logistic regression analysis to find out the factors associated with diabetes. Correlation between different measurable variables was assessed by Spearman's correlation. P-value ≤0.05 was considered statistically significant.

RESULTS

A total of 1300 participants were subjected to random blood glucose measurement, 149 (11.5%) of them had RBG ≥140 mg/dl, these were turn out for a confirmatory test, 65 (43.6%) have normal blood glucose, and 84 (56.4%) have abnormal blood glucose. Among those with abnormal blood glucose, UDM represents 50(59.5%), and pre-diabetes was 34(40.5%). The prevalence of UDM was 3.8% and prediabetes was 2.6%.

Table1. Shows socio-demographic characteristics of the study sample. The study population age ranged from (30-86) years. The mean age (± SD) of the participants was 46.2 ±10.7years, with no significant association between male and female (45.6±10.7and versus 46.6±10.8, P=0.110). Among the study sample, 871(67 %) participants were females while 429 (33%) of them were males, and the female to male ratio was (2.03:1). The majority of participants were from the age group 40-49 years representing 471(36.2%) and the least number of participants were in the ≥ 70 years group representing 33(2.5%).

Most of the participants were married representing (88.8%). Amongst the study subjects, 637(49%) were housewives which represented the majority, while governmental employees represent 390 (30%), self-employed was 174 (13.4%) and the remaining 99 (7.6%) was distributed between other categories of occupations. (Table.1). Regarding education 436(33.5%) of the participants were illiterate, the percentage of females with no education was significantly higher compared to males (43.9%) versus (12.6%) P<0.001. The majority of the study samples were from low socioeconomic status accounting for 849 (65.3%), significantly female more than male (P<0.001), as shown in (Table 1).

Table 2. Shows the medical characteristic of the study sample. In this study, positive family history of diabetes mellitus was found in 483(37.2%) of the participants. The participants having a history of hypertension was 430 (33.1%), history of hyperlipidemia was 264(20.3%). Among the study participants only 113(8.7%), subjects were smokers, and 91.3% of participants were non-smokers. Only 15(1.2%) of the study participants consumed alcohol and the majority was nonalcoholic at a percentage of 1178(98.2%).

Regarding body mass index BMI the highest number of participants were obese account 649(49.9%),. The overall participants who overweight 506(38.9%), Only 145 (11.2%) were normal weight, with zero underweight participants.

Table 3 shows that the highest prevalence of hyperglycemia was noticed in age group (40-49) and (60-69) years, which represent (32%)for UDM and (29.4%) for pre-diabetes, so hyperglycemia increased with advancing age except for 70+ age groups was lower than other groups. This difference was found to be highly significant (P < 0.001). Women among UDM and pre-diabetes, (58%) and (76.5%) respectively. Hyperglycemia was higher in females compared to males, but there was no significant association (P > 0.05).

Although 80% of UDM have low SES compare to (0%) high SES and (73.5%) of pre-diabetic were in low SES class compare to only 2.9% having high SES, but this association statistically was not significant (P >0.05). Positive family history of DM was found in 36.8% of the normal glycemic group compared to the hyperglycemic group 53.6% had a positive family history of DM. Among the UDM 50% had a positive family history of DM, and 52.9% for pre-diabetes, with statistically significant differences (P <0.05). The percentage of normal glycemic participants having a previous history of hypertension, was 31.9%, those with UDM 56% and pre-diabetes 42.1% had a previous history of hypertension, with high statistical significant differences (P <0.001). (Table 3).

Among normal glycemic individuals, 19% of them had a history of hyperlipidemia, and it is lower than observed among UDM 36% and pre-diabetic, 44%, with a highly significant association (P<0.001). Regarding smoking and alcohol drinking there is no association between consumption of two substances and hyperglycemia P>0.05). (Table 3)

Regarding BMI, the percentage of obesity among the normal glycemic group was 57.3%, overweight was31.1% normal weight and underweight was 11.6%. prevalence of hyperglycemia increasing proportionally with increasing levels of BMI (normal and underweight, overweight, and obese) which represent (6%), (30%) and (64%), for UDM and pre-diabetic group there were 2.9%, 11.8%, and 85.3%, respectively, with highly significant association (P<0.001).

Among normal glycemic cases Only 18.6%, of them had systolic hypertension, and 24.3% had diastolic hypertension. While 50% of UDM cases had SBP >l40mmHg, and 58.8% of pre-diabetic cases had SBP >140mmHg. The percentage of UDM with DBP>90mmHg was 60%, and pre-diabetes was 55.9%, the difference was found to be statistically highly significant for both systolic and diastolic hypertension (P < 0.001). (Table 3).

Multiple logistic regression model was used to predict the potential effect of risk factors in UDM which were; Age >40 (P=0.008) with an OR= 7.060& 95% CI (1.674 -29.771), and DBP (P=0.03) with an OR= 2.528 & 95% CI(1.081, 5.908). (Table 4).

Multiple logistic regression show that strong predictor for pre-diabetes was History of hypertension (P=0.008) with an OR= 3.521 & 95% CI (1.396-8.883), and SBP (p-value<0.001) with an OR=7.697 & 95% CI (2.466, 24.026). (Table 5).

Lipid profile measurement was done for only hyperglycemic groups, by using Spearman correlation coefficients, between HbA1c and lipid profile, the results indicated that total cholesterol TC (p=0.03 and triglycerides TG (P= 0.04), positively correlated with HbA1c, as shown in (Table 6).

Table 1. Socio-demographic characteristics of participants.

Variables	No.	%
Gender		
Male	429	33
Female	871	67
Age		
30-39	379	29.9
40-49	471	36.2
50-59	269	20.7
60-69	148	11.4
70+	33	2.5
Marital status		
Single	38	2.9
Married	1554	88.8
Widow	13	1.0
Divorce	95	7.3
Occupation		
Governmental employee	390	29.9
Private sector employee	11	0.8
Self employee	174	13.4
Housewife	638	49.1
Student	0	0
Retired	65	5.0
Unemployed	23	1.8
Education		
Illiterate	436	33.5
Primary school	322	24.8
Secondary school	153	11.8
High school	123	9.5
Bachelor degree	188	14.5
Diploma	71	5.5
Master degree	4	0.5
PhD	2	0.2
Socio economic status		
Low	849	65.3
Moderate	403	31.0
High	48	3.7
Total	1300	100

Table 2. Medical characteristic of the study sample.

Variables	No.	%
Family history DM		
Yes	483	37.2
No	817	62.8
History of hypertension		
Yes	430	33.1
No	870	66.9
History of hyperlipidemia		
Yes	264	20.3
No	1036	77.9
History of GDM		
Yes	39	3.0
No	1261	97.0
Tobacco smoking		
Yes	113	8.7
No	1178	91.3
Alcohol drinking		
Yes	15	1.2
No	1285	98.8
BMI		
Under weight	0	0
Normal weigh	145	11.
Overweight	506	38.9
Obese	649	49.9
Total	1300	100

Table 3. Association of socio-demographic characteristic and medical risk factors among the hyperglycemic group (UDM and pre-diabetes).

Risk factors	Normal glycemic No. (%)	UDM No. (%)	Pre-diabetes No. (%)	P-value
Gender				
Male	400 (32.9)	21 (42.0)	8 (23.5)	0.200
Female	816 (67.1)	29 (58.0)	26 (76.5)	
Age				
30-39	372 (30.6)	2 (4.0)	5 (14.7)	
40-49	445 (36.6)	16 (32.0)	10 (29.4)	
50-59	248 (20.4)	13 (26.0)	8 (23.5)	
60-69	122 (10)	16 (32.0)	10 (29.4)	
70+	29 (2.4)	3 (6.0)	1 (2.9)	<0.001
Socio economic status				
Low	784 (64.5)	40 (80.0)	25 (73.5)	
Moderate	385 (31.7)	10 (20.0)	8 (23.5)	0.143
High	47 (3.9)	0 (0)	1 (2.9)	
Family history of DM				
Yes	440 (36.2)	25 (50)	18 (52.9)	0.022
No	776 (63.8)	25 (50)	16 (47.1)	
History hypertension				
Yes	388 (31.9)	28 (56)	18 (52.9)	
No	828 (68.1)	25 (50)	16 (47.1)	
History of Hyperlipidemia				
Yes	231 (19)	18 (36)	15 (44.1)	<0.001
No	985 (81)	32 (64)	19 (55.9)	
Tobacco Smoking				
Yes	107 (8.8)	5 (10)	1 (2.9)	0.463
No	1109 (91.2)	45 (90)	33 (97.1)	
Alcohol drinking				
Yes	15 (1.2	0 (0)	0 (0)	0.592
No	1201 (98.8)	50 (100)	34 (100)	
Total	**1216 (100)**	**50 (100)**	**34 (100)**	

Table 3. Continued ...

Risk factors	Normal glycemic No. (%)	UDM No. (%)	Pre-diabetes No. (%)	P-value
BMI				
Underweight	0 (0)	0 (0)	0 (0)	
Normal	141 (11.6)	3 (6)	1 (2.9)	<0.001
Overweight	376 (40.1)	11 (30)	3 (11.8)	
Obese	697 (48.4)	36 (64)	30 (85.3)	
Systolic hypertension				
SBP>140	226 (18.6)	25 (50)	20 (58.8)	<0.001
SBP<140	990 (31.7)	25 (50)	14 (41.2)	
Diastolic hypertension				
DBP>90	295 (24.3)	30 (60)	19 (55.9)	<0.001
DBP<90	921 (75.7)	20 (40)	15 (44.1)	
Total	**1216 (100)**	**50 (100)**	**34 (100)**	

Table 4. Factors associated with UDM in multivariate logistic regression analysis.

Risk factors	B	P-value	OR	(95%CI) Lower	Upper
Age >40	1.959	0.008	7. 060	1.674	29.771
Family history of DM	-0.557	0.064	0.573	0.318	1.032
History of hypertension	-0.0.06	0.873	0.949	0.454	1.955
History of hyperlipidemia	-0.539	0.119	0.584	0.296	1.149
BMI >25	0.490	0.424	1.632	0.491	5.427
SBP >140	0.380	0.389	1.462	0.616	3.468
DBP >90	0.927	0.032	2.528	1.081	5.908

Table 5. Factors associated with pre-diabetes in multivariate logistic regression analysis.

Risk factors	B	P-value	OR	(95%CI) Lower	Upper
Age >40	0.421	0.416	1.524	0.552	4.207
Family history of DM	-0.694	0.057	0.500	0.244	1.621
History of hypertension	1.259	0.008	3.521	1.396	8.883
History of hyperlipidemia	-1.373	0.001	0.253	0.109	0.587
BMI >25	1.425	0.151	4.416	0.582	33.515
SBP >140	2.041	0.000	7.697	2.466	24.026
DBP >90	0.062	0.912	1.064	0.353	3.302

Table 6. Spearman correlation between HbA1c and lipid profiles.

	HbA1c	
Variables	**r**	**P value**
TC	0.243	0.03
TG	0.309	0.04
LDL	0.116	0.29
HDL	-0.016	0.89

DISCUSSION

In this cross-sectional study, the prevalence of undiagnosed diabetes and pre-diabetes were (3.8%) and (2.6%) respectively. In this study five primary health centers in Sulaimani city were covered. To the best of our knowledge, this is the first opportunistic screening carried out in this region.

Compare to this finding a study conducted by Mansour *et.al*, in the Al-Madina district in Northern Basrah in Iraq reported that the prevalence of UDM was 2.14% and pre-diabetes was seen in 2.02% [17]. In Baghdad city, the same prevalence of UDM (3.7%) and higher prevalence of pre-diabetes (17.8%) were noted by Al-Timimi. D. J *et.al* [18]. Also, in Iran a study conducted by Esteghamati A *et.al* has been reported that the prevalence of type 2 diabetes among Iranian adults be (7.7%); of these half had undiagnosed diabetes and (16.8%), Iranian adults have impaired fasting glucose and their results were higher than this study [19].

Ghoraba M A *et.al* from Saudi Arabia showed the prevalence of pre-diabetes as 23.6%, while 3.8% of respondents were newly diagnosed with diabetes [20]. The prevalence of newly diagnosed was 7.5 % and pre-diabetes was 8.2 % reported by Satman I *et.al* among the Turkish population [21]. The prevalence of UDM and pre-diabetes in our study was more than the prevalence of a reported study in Sudan by Noor, S.K.M. *et.al* which showed that the prevalence of UDM was 2.6% and pre-diabetes was 1.3% [22]. The variation in our study compared to reported prevalence from different studies might be due to the socio-demographic and lifestyle differences in the populations studied and sample size.

In the present study the prevalence of UDM and pre-diabetes increasing with increasing age, but in the age group, 70 + the prevalence decreased that's because most participants among these age groups were already had previously diagnosed with diabetes, and few numbers of old age visiting PHC centers. The highest prevalence was observed in the age (40-49) and (60-69) represent 32% for UDM and 29.4% for pre-diabetes and lowest prevalence of both of them in the age group (30-39) years and the difference statistically highly significant for both sexes. Similarly, this trend was also observed in studies done by Aldossari K. K *et.al* in Saudi Arabia [23], and Mansour A.A *et.al* [24].

In this study, the prevalence of hyperglycemia in females was higher compared to males with no significant difference. Similarly, Muthunarayanan L. *et.al* in India was showing no significant differences in the prevalence of hyperglycemia between males and females [25]. In contrast, a higher prevalence of hyperglycemia was noted in males compared to females, found in the study by Al-Daghri N *et.al* in Saudi Arabia [26], and. Anjana R.M *et.al* in India [27]. In this study, the higher prevalence of UDM and pre-diabetes in female was more than male, because the majority of participants visiting PHC centers was female, and the response rate was higher in female compare to male.

Although this study reported a higher prevalence of both UDM and pre-diabetes among low socioeconomic class 80% and 73.5% respectively, it fails to show statistically significant differences (P>0.05). Compare to other studies such as Ferdi *et.al* from Algeria which show statistical differences [28]. and Fakir M *et.al* in Bangladesh reported highly significant differences [29]. In this study, the higher prevalence of hyperglycemia among low SES class was due to the majority of study samples live at low SES level, because three of the selected PHC centers are located in low SES district.

A significant association was noted between family history of DM and UDM 50% and pre-diabetes 52.9% (P<0.05). A similar study by Arora I *et. al,* found family history as an important risk factor strongly associated with the development of diabetes. [30]. On the contrary, there was no significant association between family history of DM and pre-diabetes occurrence as reported in other studies like Megerssa YC *et.al* [31]. Type 2 diabetes is associated with a family history of diabetes, the pathogenesis has been assumed to involve

a genetic abnormality in the molecules related to the regulatory system of glucose metabolism, [32]. It is well recognized that the lifetime risk of any offspring developing diabetes if both parents have diabetes is higher than one parent have diabetes [33].

Hypertension is a well-known risk factor for diabetes and had a significant association. In those participants with a history of hypertension, (56%) of UDM and (41.2%) pre-diabetes having a previous history of hypertension, with P<0.001. A similar study has suggested a temporal relationship between diabetes and hypertension such as Aksu *et.al.* in Turkey [34], During blood pressure measurement, systolic hypertension of >140 mmHg was found among 50% UDM cases and 58.8% of pre-diabetic cases, while regarding diastolic hypertension of >90mmHg the prevalence of UDM was 60%, and pre-diabetes was 55.9%, compared to respondents with normal SBP and DBP, the prevalence of hyperglycemia was higher, and the difference was found statistically significant (P < 0.001). The same finding was reported by Anjana RM *et. al* [26], and Balagopal *et.al* [35]. The pathophysiological mechanisms that describe the association between hypertension and DM are unclear. However, high blood pressure was shown to induce microvascular and endothelial dysfunction, which may contribute to insulin resistance [36].

In the present study, no significant differences were found between hyperglycemia and smoking, the prevalence of UDM and pre-diabetes was low among smokers compared to nonsmokers, because the majority of the study sample was female, and they did not give a real history of smoking. Similarly, results reported by Muthunarayanan L *et.al* there is a lack of association between smoking and pre-diabetes [25], and Raghupathy P *et. al* in India showed that smoking was not associated with the undiagnosed DM [37].

In the present study, there is an association between BMI and hyperglycemia, the prevalence of UDM and pre-diabetes were increasing proportionally with increasing levels of BMI, P<0.001. In agreement with other studies by Mansour A A *et.al* [24], Deepthi R *et.al* [38], and Jain A *et.al* [39], their studies also reported BMI>25 was increased risk of diabetes which was statistically significant. Obesity causes insulin resistance, and decreases insulin-stimulated glucose disposal, leading to the development of pre-diabetes and DM [40], also it is associated with fat deposition, particularly in the liver which leads to increase insulin resistance [41].

Also in this study, the results suggest that TC and TG were found to be positively correlated with hyperglycemia, P<0.05. Many studies reported the same finding Yun Q *et.al* among the Chinese population [42], and Ozder A in Turkey [43]. This can be explained that there are several factors associated with diabetic dyslipidemia, including insulin effects on liver apoprotein production, regulation of lipoprotein lipase, actions of cholesteryl ester transfer protein (CETP), and peripheral actions of insulin on adipose and muscle tissue [44]. Triglycerides are the main constituents of body fat in humans, and irresponsible for the bidirectional transference of adipose fat and blood glucose from the liver [45].

Multiple logistic regression analysis revealed that older age and DBP were significantly associated with an increased risk of UDM (P=0.006). Subjects aged >40 years had a 7.53 times higher chance of having diabetes compared to age <40 years. Satman *et.al* also reported that aging-related to diabetes [46]. History of hypertension and SBP measurement were significantly related to having pre-diabetes (P=0.006). Those with a history of hypertension had 3.8 times higher than those who don't have hypertension, which was consistent with the study conducted by Zhao M *et.al* in China [7]. Family history of DM determined as protective factor diabetes also the history of hyperlipidemia appeared protective factor for pre-diabetes.

In conclusion, the prevalence rate of UDM and pre-diabetes is at a reasonable level. Our study has identified the important risk factors that are prevailing within the population. Age more than 40 years, and previous history of hypertension (SBP>140 mmHg and DBP>90 mmHg) are significantly and independently related to UDM and pre-diabetes, also hypercholesterolemia and hypertriglyceridemia were positively correlated with hyperglycemia.

REFERENCES

1. Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohelrogge AW, et.al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes Res Clin Pract. 2 0 1 8; 138: 2 7 1 – 2 8 1.

2. Guariguata L, Whiting DR, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Res Clin Pract 2014;103(2):137–149.

3. Hadaegh F, Bozorgmanesh MR, Ghasemi A, Harati H, Saadat N, and Azizi F. High prevalence of undiagnosed diabetes and abnormal glucose tolerance in the Iranian urban population: Tehran Lipid and Glucose Study. BMC Public Health 2008; 8:176: 1-7

4. Gillies CL, Lambert PC, Abrams KR, Sutton AJ, Cooper NJ, Hsu RT, et al. Different strategies for screening and prevention of type 2 diabetes in adults: cost effectiveness analysis. BMJ. 2008; 336 (7654):1180–1185.

5. Asmelash D, and Asmelash Y. The Burden of Undiagnosed Diabetes Mellitus in Adult African Population: A Systematic Review and Meta-Analysis. J Diabetes Res. 2019; 4134937: 1-8.

6. Chi PW, Cheng TY, Shan PT, Hui LH, Shu LW. Increased mortality risks of pre-diabetes (impaired fasting glucose) in Taiwan. Diabetes Care. 2005; 28 (11): 2756–2761.

7. American Diabetes Association, "Diagnosis and classification of diabetes mellitus," Diabetes Care 2011; 34 (1): S62–S69.

8. Al-Shafaee MA, Bhorgava K, Al-Farsi YM, Mcilvenny S, Al-Mandhari A, Al-Adawi S, et al. Prevalence of pre-diabetes and associated risk factors in an adult Omani population. Int J Diab Dev Ctries.2011; 31 (3): 166–173.

9. Zhao M, Lin H, Yuan Y, Wang F, Xi Y, Wen L, et.al. Prevalence of Pre-Diabetes and Its Associated Risk Factors in Rural Areas of Ningbo, China. Int. J. Environ. Res. Public Health. 2016; 13 (8): 808 1-13.

10. Mark W, Bahman P, Michael B, Rayb B, William H. Opportunistic Screening for Diabetes in Routine Clinical Practice. Diabetes Care. 2004; 27 (1): 9–12.

11. Kothari CR. Research methodology: Method and techniques 2nd ed New Delhi: New Age International: 2004; Chapter 4: 62-63.

12. Omer W and Al-Hadithi T. Developing a socioeconomic index for health research in Iraq. EMHJ 2017; 23 (10): 670-677.

13. World Health Organization. Global Database on Body Mass Index. BMI classification.WHO; 2012. Available from: who.int/bmi/index.jsp

14. World Health Organization. (‏2007)‏. Prevention of cardiovascular disease : pocket guidelines for assessment and management of cardiovascular risk :WHO/ISH cardiovascular risk prediction charts for the European Region). World Health Organization. https://apps.who.int/iris/handle/10665/43784

15. American Diabetes Association. Classification and diagnosis of diabetes: Standards of Medical Care in Diabetes. Diabetes Care 2019; 42(1): 13 –28.

16. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). JAMA. 2001; 285(19): 2486-2497.

17. Mansour AA, Wanoose HL, Hani I, and Abed-Alzahrea A. Diabetes screening in Basrah, Iraq: A population-based cross-sectional study. Diabetes Res Clin Pract. 2007; 79(1): 147-150.

18. Al-Timimi DJ and Al-Ubaidy AK. The frequency of 2 hours glucose loud hyperglycemia in subject with normal fasting glucose. Dohuk Med J 2007; 1 (1): 105-110.

19. Esteghamati A, Gouya M, Abbasi M, Delavari A, Alikhani S, Alaedini F, et.al. Prevalence of diabetes and impaired fasting glucose in the adult population of Iran: National Survey of Risk Factors for Non-Communicable Diseases of Iran. Diabetes care. 2008; 31(1):96-98.

20. Ghoraba MA, Shiddo OA, Almuslmani M, Jallad I, Khan A, Maranan G, et.al. Prevalence of pre-diabetes in Family and Community Medicine Department, Security Forces Hospital, Riyadh, Saudi Arabia. International Journal of Medical Science and Public Health ijmsph. 2016; 5 (8): 777-784.

21. Satman I, Omer B, Tutuncu Y, Kalaca S, Gedik S, and Dinccag N, et.al. Twelve-year trends in the prevalence and risk factors of diabetes and pre-diabetes in Turkish adults. Eur J Epidemiol. 2013; 28 (2):169–180.

22. Noor SK, Bushara SO, Sulaiman AA, Elmadhoun WM, and Ahmed MH. Undiagnosed diabetes mellitus in rural communities in Sudan: prevalence and risk factors. EMHJ. 2015; 21(3): 164-170.

23. Aldossari K , Aldiab A, Al-Zahrani J , Al-Ghamdi S , Abdelrazik M, Ali Batais M, et.al. Prevalence of Pre-diabetes, Diabetes, and Its Associated Risk Factors among Males in Saudi Arabia: A Population-Based Survey. J Diabetes Res. 2018; 2194604: 1- 12.

24. Mansour A.A, Al-Maliky A.A, Kasem B, Jabar A, and Mosbeh K. A. Prevalence of diagnosed and undiagnosed diabetes mellitus in adults aged 19 years and older in Basrah, Iraq. Diabetes Meta Synd Ob 2014; 2(7):139-144.

25. Muthunarayanan L, Ramraj B, Russel J.K. Prevalence of pre-diabetes and its associated risk factors among rural adults in Tamil Nadu. Arch Med Health Sci. 2015; 3 (2):178-184.

26. Al-Daghri N.M, Al-Attas O.S, Alokail M.S, Alkharfy K.M, Yousef M, Sabico S.L, e.al. Diabetes mellitus type 2 and other chronic non-communicable diseases in the central region, Saudi Arabia (Riyadh cohort 2): a decade of an epidemic. BMC Med. 2011; 9:7: 1-6

27. Anjana R, Pradeepa R, Deepa M, Datta M, Sudha V, Unnikrishnan R, et al. Prevalence of diabetes and pre-diabetes (impaired fasting glucose and/or impaired glucose tolerance) in urban and rural India: Phase I results of the Indian Council of Medical Research-India Diabetes (ICMR-INDIAB) study. Diabetologia. 2011; 54 (12): 3022-3027.

28. Ferdi N, Abla K, Chenchouni H. Effect of Socioeconomic Factors and Family History on the Incidence of Diabetes in an Adult Diabetic Population from Algeria. Iran J Public Health. 2016;45(12): 1636-1644.

29. Fakir M. Islam A, Chakrabarti R , Tauhidul- Islam M, Wahab M, Ecosse M , et.al. Pre-diabetes, diagnosed and undiagnosed diabetes, their risk factors and association with knowledge of diabetes in rural Bangladesh: The Bangladesh Population-based Diabetes and Eye Study. J of Diabetes. 2016; 8 (2): 260 – 268.

30. Arora I, Singh S, Bhuwal P. K, Singh S. Prevalence of diabetes mellitus and its associated risk factor assessment among elderly in urban area of Punjab. Int J Community Med Public Health. 2019; 6(2): 610-614.

31. Megerssa YC, Gebre MW, Birru SK, 1 , Goshu AR and Tesfaye DY. Prevalence of Undiagnosed Diabetes Mellitus and its Risk Factors in Selected Institutions at Bishoftu Town, East Shoa, Ethiopia. J Diabetes Metab. 2013; S12(008): 1-7

32. K Kohei: Pathophysiology of Type 2 Diabetes and Its Treatment Policy. JMAJ 2010; 53(1): 41–46.

33. InterAct Consortium; Scott RA, Langenberg C, Sharp SJ, Franks PW, Rolandsson O, Rogan D et al. The link between family history and risk of type 2 diabetes is not explained by anthropometric, lifestyle or genetic risk factors: the EPIC-InterAct study. Diabetologia. 2013; 56(1): 60-69.

34. Aksu H, Pala K, Aksu H. Prevalence and associated risk factors of type 2 diabetes mellitus in Nilufer District, Bursa, Turkey. I nt J Diabetes & Metabolism. 2006; 14: 98-102

35. Balagopal P, Kamalamma N, Patel TG, Misra R. A community-based diabetes prevention and management education program in a rural village in India. Diabetes Care 2008; 31 (6):1097-1104.

36. Kim MJ, Lim NK, Choi SJ, Park HY. Hypertension is an independent risk factor for type 2 diabetes: the Korean genome and epidemiology study. *Hypertens Res*. 2015;38(11):783–789.

37. Raghupathy P, Antonisami B, Fall C.H, Gethanjali F.S, Leary S.D, Saperia J, et.al. High prevalence of glucose intolerance even among young adults in south India. Diabetes Res and Clin Pract. 2007; 77(2) : 269-279

38. Deepthi R, Chandini C, Pratyusha K, Kusuma N, Raajitha B, Shetty G. Screening for Diabetes and their risk factors among adults in Rural Kolar – A community-based study. Int J Res Dev Health 2013;1(4):152-159.

39. Jain A, Paranjape S. Prevalence of type 2 diabetes mellitus in elderly in a primary care facility: An ideal facility. Indian J Endocrinol Metab 2013; 17 (7): 318-322.

40. Faerch K, Borch-Johnsen K, Holst J.J, Vaag A. Pathophysiology and etiology of impaired fasting glycaemia and impaired glucose tolerance: does it matter for prevention and treatment of type 2 diabetes? *Diabetologia* 2009; 52 (9):1714–1723.

41. Larson-Meyer D, Newcomer B, Ravussin E, Volaufova L, Bannet B, Cawla S et al. Intrahepatic and intramyocellular lipids are determinants of insulin resistance in pre-pubertal children. Diabetologia. 2011;54(4):869 – 875.

42. Yun Q, Lin Y, Zhang T , Bai J, Chen F, , Zhang Y, et.al. The characteristic of impaired fasting glucose association with obesity and dislipidemiain a Chinese population. BMC Public Health 2010; 10(139): 1-8.

43. Ozder A. Lipid profile abnormalties seen in T2DM patientsin primary healthcare in Turkey: a cross-sectional study. Lipids Health Dis. 2014;13(183):1-6.

44. Bhowmik B, Siddiquee T, Mujumder A, Afsana F, Ahmed T, Mdala I.A. Serum Lipid Profile and Its Association with Diabetes and Pre-diabetes in a Rural Bangladeshi Population. Int. J. Environ. Res. Public Health 2018; 15: 1 (9) 944: (1-12).

45. Nelson DL, Cox MM. Lehninger, Principles of Biochemistry. 3rd ed. New York: Worth Publishing; 2000. ISBN: 1–57259–153–156.

46. Satman I,Yilmaz T, SengulA, Salman S, Salman F, Uygur S, et.al. Population-based study of diabetes and risk characteristic in Turkey: results of the Turkish diabetes epidemiology study (TURDEP), Diabetes Care.2002; 25 (9): 1551-1556.