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Prevalence of Prediabetes Among Adults in Baghdad/Iraq

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Abstract

Background In prediabetes, neither individuals having diabetic range nor normal glycemic parameters in terms of fasting plasma glucose, impaired glucose tolerance or glycated hemoglobin. Two-thirds of those with prediabetes will ends eventually with type 2 diabetes. Early detection with the proper intervention will halt or reverse this progression. Data about prediabetes prevalence in Iraq are scarce.

Objective To estimate the prevalence of prediabetes among adults in Baghdad/Iraq and to identify socio-demographic and associated risk factors among the studied population and to evaluate glycated hemoglobin in the detection of prediabetes.

Methods This cross-sectional study enrolled adults (20-79 years) attending primary health care centers in Baghdad/Iraq for one year, those with known diabetes or on anti-diabetic drugs, pregnant women and those with other medical conditions that interfere with glycated hemoglobin level were excluded from the study. Data collected through direct interview. Anthropometric measurements and laboratory analysis after overnight fast were done to measure fasting plasma glucose, glycated hemoglobin and lipid profile.

Results Prediabetes prevalence was 20.6%. Prevalence was higher in older people (40-60 years) and individuals with overweight, obesity, and dyslipidemia, the agreement between fasting plasma glucose and glycated hemoglobin was very good.

Conclusion Prevalence of prediabetes in Iraq is higher than estimated and share the same risk factors to those with type 2 diabetes. Glycated hemoglobin compared to fasting plasma glucose, is a reliable test to screen for prediabetes in Iraq.

Keywords Prediabetes; intermediate hyperglycemia; glycated hemoglobin; Iraq

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List of abbreviations: ADA = American Diabetes Association, BMI = Body mass index, FPG = Fasting plasma glucose, A1C = Glycated hemoglobin, HDL-c = High-density lipoprotein cholesterol, IDF = International Diabetes Federation, LDL-c = Low-density lipoprotein cholesterol, OGTT = Oral glucose tolerance test, PHC = Primary health care, TGS = Serum triglycerides, T2DM = type 2 diabetes mellitus, WHO= World health organization

Introduction

Type 2 diabetes (T2DM) is now pandemic and is expected to persist so. In 2017, about 424.9 million (8.8%) individuals in the world (20-79 years) have diabetes and are estimated to be about 628.6 million (9.9%) in 2045, half of those are unaware of their disease especially in low and middle-income countries (84.5%). Diabetes estimated to kill about four million people in 2017 and (10.7%) of global all-cause mortality among people in this age group [(1)].

In Iraq, studies suggested a prevalence of diabetes to be (13.9%) [(2)].

At the time diagnosed, many patients with T2DM have already organ damage or advanced subclinical atherosclerosis [(3-5)]. Metabolic abnormalities precede the onset of overt diabetes by years and are linked to decrease insulin sensitivity or increased insulin resistance. Those people share the same risk factors associated with overt diabetes (advanced age, overweight, excess calorie intake, lack of physical activity and smoking ...etc) [6]. This state in which people's oral glucose tolerance test (OGTT) or fasting plasma glucose (FPG) or glycated hemoglobin (A1C) between normal and diabetic range are defined as prediabetes. The majority of those with prediabetes will develop in future T2DM with annual conversion rate about (5-10%) and approximately 25% of them will be diabetics within 3-5 years [7,8]. Besides; people with prediabetes are at higher risk of developing many of the diabetes complications, such as diabetic retinopathy, nephropathy, neuropathy, and macro-vascular complications even before a diagnosis of diabetes has been established and thus subjected to higher healthcare expenditure [9,10].

The onset of prediabetes or the progression to T2DM can be significantly reduced or reversed through early recognition, diagnosis and proper lifestyle modifications [11]. Pooled results of 16 randomized controlled trials showed that prediabetes individuals who received lifestyle intervention had a lower rate of conversion to T2DM after one and three years of following up [12].

Worldwide, the prevalence of prediabetes is about 7.3% (4.8-11.9%) of adults (20-79) years and the vast majority (72.3%) of these individuals live in low and middle-income countries. By 2045, the prevalence expected to be 8.3% (5.6-13.9%) in this age group [1].

Iraq categorized by the International Diabetes Federation (IDF) 2017 in the Middle East and North Africa Region (MENA) and due to a lack of data, sources and information about the real situation, the prevalence of prediabetes was estimated by IDF using extrapolated data from similar ethnicity countries, geography, language, and income level [1].

In 1997, the American Diabetes Association (ADA), recommended that FPG becomes the main diagnostic test for diabetes, rather than the expensive and time-consuming OGTT [13]. In 2009, ADA recommended that the diagnosis and screening for prediabetes could also be made using A1C [14]. It is worth to mention that world health organization (WHO) does not recommend using A1C to screen prediabetes till now [15].

Although FPG was historically linked to the screening and diagnosis of prediabetes and T2DM, systematic reviews on A1C for adults (more than 40,000) adopted from 16 studies showed consistent linear association with future development of T2DM, the five-year risk for developing diabetes when A1C ≥5.7% was 9-25%, and up to 50% when A1C ≥6.0–6.5% [16]. Also, prediabetes, whether defined by A1C or FPG, is associated with a higher risk of developing T2DM [17,18].

This study aimed to estimate the prevalence of prediabetes among adults in Baghdad/Iraq and to identify socio-demographic and associated risk factors among the studied population and to evaluate glycated hemoglobin in the detection of prediabetes.

Methods

Baghdad is the capital of Iraq (5169 km^2) with a population of about 8 million. Tigris River is sandwiched by the city two halves; Karkh and Rusafa. To calculate the sample size, we assumed that 8% of the adult population would have prediabetes based on IDF prediabetes estimation in Iraq 2017, and to achieve this sample size at the 95% confidence level with an acceptable error of 5%, a single proportion formula used [19]:

$N= Z^2 p (1-p)/d2$

The selection of PHC centers had done using a multistage random sampling technique from health directorates at both sides of Baghdad yielding five health sectors sampled from Al-karkh health directorate (from a total of ten sectors) and four health sectors sampled from Al-Rusafa health directorate (from a total of nine sectors). Then four Primary health care

(PHC) centers were randomly selected from each health sector with an average ten individuals from each one, resulting in 342 adults; (178) individuals from Al-karkh Health Directorate and (164) individuals from Al-Rusafa health directorate. Diabetics or those on anti-diabetic drugs, pregnant women, those with hemoglobinopathies, malignant disease, hypo-hyperthyroidism, drugs or alcohol abuse were not included. A direct interview with each participant had done. Requested information regarding demographic data (age, sex, residence, occupation, etc.), history of smoking, hypertension, diabetes, and other medical conditions were reported.

The weight was measured (to nearest 0.5 kg), in erect position without shoes and with light clothing using an electronic scale (recommended to be used in nutrition clinics). Height was measured by using a height tape measure, which is suitable to measure a person's height with an approximation of ±0.1 cm. Body mass index (BMI) was used as an indicator of body fat, overweight, and obesity. It was calculated as body weight/height^2 (Kg/m^2). WHO criteria were used to classify people into under, normal, overweight and obese [20].

Blood pressure was measured in a participant's arm using a mercury sphygmomanometer in a sitting position. Two blood pressure readings were taken at 5 minutes interval, and the mean value was taken. Blood pressure is expressed in millimeters of mercury (mmHg) [21]. Hypertension was considered when the systolic blood pressure equal to or above 140 mmHg and/or diastolic blood pressure equal to or above 90 mmHg or on antihypertensive drugs [22].

Laboratory analysis

A venous blood sample was obtained from each participant after confirmation of overnight fast, one-milliliter collected in a vacuum collection K3 EDTA tube (mixed thoroughly) and one-milliliter in a gel and clot activator glass tube, both stored in ice-cool box (2-8 °C) and analyzed by laboratory technician (within 4-5 hours).

Siemens Dimension EXL 200 used to measure serum FPG concentrations and the lipid profile. Venous blood sample used for A1C measurement was analyzed using the enzymatic method [ion exchange high performance liquid chromatography (HPLC) technology to separate glycated (labile A1C (L-A1c) and stable A1C (S-A1c)) and non-glycated (HbA0) forms of hemoglobin] with Arkray ADAMS A1C HA-8180V (Menarini).

Prediabetes was defined as not having previous diabetes, but having A1C between 5.7% and 6.4%, or FPG between 100 and 125 mg/dl according to ADA classification. Diabetes is considered when the FPG was 126 mg/dl or more, A1C was 6.5 or more [23].

Low density lipoprotein cholesterol (LDL-c) was calculated using the Friedewald formula [24]:

LDL-c = [total cholesterol – (HDL-c) – [(TGS)/5].

Total cholesterol was considered high when it was ≥ 200 mg/dl. TGS high if it was 150 mg/dl or more. LDL-c was high if ≥160 mg/dl while HDL-c considered low when < 40mg/dl [25].

Data analysis

Data were coded, entered and analyzed using (Statistical Packages for Social Sciences program, version 24). Descriptive data were expressed as means and standard deviations for continuous measurements and as frequencies and percentages for categorical measurements.

Student t-test and 1-way analysis of variance were used to compare Continuous data, Chi-square test or Fisher exact test was used to test the association of Categorical data and to test agreement between testing results.

Statistical significance was accepted for a 2-sided $p < 0.05$

Results

Of the total individuals (342) enrolled, 12 (3.5%) found to be in diabetes range either by FPG or A1C and were excluded from the analysis.

Among study participants 262 (79.4%) were normoglycemic, and 68 (20.6%) had prediabetes (Table 1). Of those with prediabetes, A1C identified 65 (95.6%) and FPG identified 55 (80.9%) individuals. Those who had prediabetes with both A1C and FPG were 52 (15.8%).

The mean age of participants was (43.8±14.4 years), those with prediabetes were older (51.5% of them between the age of 40 and 59 years) with slight male excess. The majority of them were married with lower employment and education rate. Compared to those with normoglycemia, prediabetes individuals had a higher rate of hypertension with significantly higher BMI, total cholesterol, TGS, and LDL-c. There was no significant difference between study groups concerning smoking and HDL-c level.

Table 1. Baseline characteristics for the study populations

Parameter	Total (n=330)	Normal (n=262)	Prediabetes (n=68)	P-value
Age* (years)	43.8 (14.4)	42.1 (14.6)	50.2 (11.4)	<0.001
Male sex**%	144 (43.6)	108 (41.2)	36 (52.9)	0.082
Married** (%)	262 (79.4)	202 (77.1)	60 (88.2)	0.043
Employed** (%)	144 (43.6)	116 (44.3)	28 (41.2)	0.154***
Education** (%)				
– Illiterate	45 (13.6)	27 (10.3)	18 (26.5)	0.002
– High level	89 (27.0)	76 (29.0)	13 (19.1)	
Hypertension** (%)	88 (26.7)	63 (24.0)	25 (36.8)	0.035
Current smoker** (%)	86 (26.1)	66 (25.2)	20 (29.4)	0.508
BMI*	26.8 (4.1)	26.4 (4.0)	28 (4.3)	<0.001
FPG*	91 (12)	87 (8)	108 (12)	<0.001
A1C*	5.1 (0.6)	4.9 (0.5)	6.0 (0.3)	<0.001
TC*	189 (38)	183 (34)	218 (38)	<0.001
TGS*	146 (53)	141 (47)	168 (66)	<0.001
LDL*	108 (39)	102 (35)	133 (42)	<0.001
HDL*	52 (7)	52 (7)	51 (7)	0.69

*Values are expressed as mean ± Sd
**Values are expressed as absolute number (percentage of group)
*** Fisher exact test

Statistically significant (P<0.001) agreement (kappa=0.84) was found between the results of A1C and FPG, the sensitivity and specificity of A1C was 95.3 % and 94.5%, respectively (Table 2).

Table 2. Test of agreement (FPG and A1C)

		FPG	
		Normal	**Prediabetes**
A1C	Normal	262	3
	Prediabetes	13	52

Kappa= 0.84, sensitivity= 95.3%, specificity=94.5%, P<0.001

Discussion

A higher prevalence of prediabetes in Iraq than that estimated by IDF may be due to the scarcity of studies regarding this subject in Iraq and thus underestimation of the real prevalence. In addition, IDF estimation relied on measurement of impaired glucose tolerance (IGT) only as a screening tool for prediabetes, and not on other glycemic parameters (i.e. FPG or A1C) [(1)], considering more than one parameter in the screening for prediabetes and T2DM will boost the results [(26)].

Our prevalence rate was in the middle of what found in neighbored countries. For example, prevalence were 7.8% in Jordan, 11.4% in Iran and 13.8% in Qatar [(27-29)]. While it was higher in turkey (30.8%), Oman (44.2%) and Kuwait (44.2%) [(30-32)]. In Iraq, our prevalence rate was lower than that found by Al-Azzawi in Baghdad 2015 (33.7%) and what Mansour et al. found in Basrah (29.1%) [(33,34)]. This extreme variation reveals the complexity of the subject in term of screening tools and methods and even the sampling of the population, however, almost all studies showed an association of prediabetes with T2DM risk factors whatever the rate is.

Compared to normal participants, prediabetics were significantly older (50.4 vs. 42.1 years, $p < 0.001$), this finding is in agreement with other studies in the region [(27,28)]. T2DM especially attacks the elderly in developed countries while in Arab countries, it is dominated in those younger than 60 years. In Iraq, several articles were documented this fact [(33-35)]. In our study, more than half of those with prediabetes aged between 40 and 60 years, and this cause real impact on both economic production and health expenditure.

We found no significant difference in sex of individuals with prediabetes and this goes with the work in other parts of the world, which showed no difference or slight male excess [(36,37)].

Prediabetes was significantly associated with higher BMI. Also, there was a statistically significant difference in the weight of prediabetics compared to normal individuals and this goes with other studies conducted throughout the world. National Center for Health Statistics (NHANES III) estimated that 78.5% of diabetics were overweight and 45.7% were obese. A ten publications meta-analysis shows an odds ratio of 2.14 for obese subjects developing T2DM. Obesity is a strong predictor of T2DM in both genders and all ethnic groups [(38,39)].

The Centers for Disease Control and Prevention (CDC) in 2017 diabetes report card showed the inverse fit of diabetes prevalence with the level of education, this was consistent with our results.

Those with prediabetes had significantly higher hypertension rates with elevated lipids level except for HDL-c (Figure 1). Hypertension and dyslipidemia are well-known risk factors for T2DM [(40)]. The finding of very good agreement in prediabetes prevalence between FPG and A1C was incompatible with other studies, for example, the Canadian Health Measures Survey and survey of African ancestry Caribbean population [(41,42)]. This may be attributed to the difference in epidemiology and socio-demographic characteristics of our sample.

Our study had points of strength and limitations; it throws a light on the rising global interest in prediabetes state especially in the contest of extreme scarcity of studies in this part of the world. Besides, settings that interfere with the A1C measurement level had been restricted as much as possible. We focused on the most important epidemiological risk factors (in individuals with normoglycemia and prediabetes) that believed to play a major role in accelerating the conversion from normal to prediabetes and then to eventual T2DM, notably, the majority of them were modifiable. We tested both (A1C and FPG) in the screening for prediabetes to assess the reliability and validity of A1C alone or in combination with FPG. Recently in Iraq, A1C was approximately available at a nearly affordable cost. Our sample size enlarged before we started the study, above the minimal requirement calculated by the single proportion formula. That was because we believed that IDF underestimates the prevalence of prediabetes in Iraq and hence we enrolled more participants to augment statistical power. Also, the vast majority of our sample included individuals in PHC centers setting but they were not coming to seek medical help (e.g. Mothers accompany children for immunization, relatives of patients, some adults working there, people coming to complete paperwork, …etc.) and thus our results can be generalized. However, of the limitations, it is an observational study and according to Bristol, "the full answers cannot be collected by observation alone" [43]. Also, the collection of past medical conditions and conditions that interfere with A1C measurement were relied on history taken from the participants and not confirmed by laboratory tests. In addition, while we used both FPG and A1C to screen for prediabetes, we didn't perform the IGT to go in line with WHO recommendations.

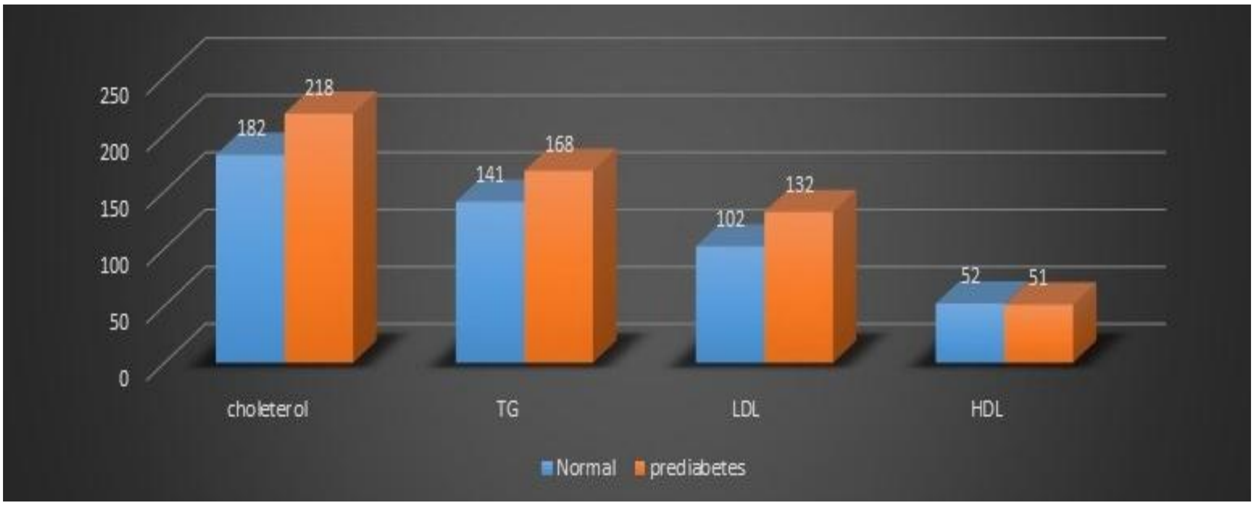

Figure 1. Lipid profile in normal and prediabetes (mean)

This study concluded that prevalence of prediabetes in Iraq is higher than estimated and necessitate more epidemiological studies to address the importance of this metabolic state. Peoples with prediabetes and T2DM were nearly similar in terms of risk factors, and hence efforts should be taken immediately to reverse this critical situation. A1C, compared to FPG, is a reliable test to screen for prediabetes in Iraq. More and larger studies are needed to assess the epidemiology of the condition and to further evaluate prediabetes screening modalities in Iraq.

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Author contribution

Dr. Alogaili: collected data, analyzed them and prepared the manuscript. Dr. Alsaffar: study design and manuscript revision. Dr. Hamid: final revision of the manuscript.

Conflict of interest

The authors declare no conflict of interest for the present study.

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