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Prevalence and Risk Factors of Hyperglycemia among Diabetic and Non-Diabetic Rural Population in North Sudan

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Abstract

Background: Diabetes Mellitus (DM) is a major health problem worldwide with significant morbidity and mortality. Pre-diabetes (or "intermediate hyperglycemia"), based on glycemic parameters above normal but below diabetes thresholds is a high risk state for diabetes with an annualized conversion rate of 5%-10%; with similar proportion converting back to norm glycaemia.

Objectives: To determine the prevalence and associated risk factors of hyperglycemia among diabetic and non-diabetic rural population at Alkhannag village.

Methodology: It was descriptive cross-sectional community-based study carried out at Alkhannag Village during the period June-November, 2016. Four hundred and thirty (430) participants of 18 or more years of age living at the village at the time of the study were incorporated. Data was collected by structure questionnaire. Capillary blood glucose was obtained by a finger puncture under aseptic conditions to measure a random blood glucose using a portable electronic glucose monitor (CERA-CHEK1070®, Ceragem Medisys, Korea).

Results: 430 participants were selected, the age distribution ranged from 18 to 95 years with a mean (standard deviation) age of 38.87 years. The random blood glucose ranged from 65 to 478mg/dl with a mean (SD) of 160.83 mg/dl. High random blood glucose of 140mg/dl or more was detected in a hundred and seventy nine out of the four hundred and thirty participants (41.6%), 32.4% of them were not diabetic, 20.5% of the non-diabetic and 82.3% of the diabetic participants had a random blood glucose of ≥140mg/dl. Obesity was detected in 41.1% of the participants. Pre hypertension and hypertension were found in 50% and 20.7% respectively. The study finds strong association between the following risk factors and hyperglycemia P value >0.05 (age, six, tribe, education, marital status, and family history of DM or HIN, smoking, BMI and high blood pressure).

Conclusion: Our study demonstrated a high prevalence of hyperglycemia among diabetic and non-diabetic rural population in Sudan. Our results also showed that most of the diabetic participants had high RCBG, and poor control, which necessitates better health education.

Keywords: Hyperglycemia; RCBG; Prevalence; Risk factors

Introduction

Diabetes Mellitus (DM) is a group of metabolic disorders characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action or both.

DM is a major health problem with significant morbidity and mortality. The number of patients with type 2 diabetes is increasing rapidly in both developed and developing countries around the world. This emerging pandemic is driven by the combined effects of population ageing, rising levels of obesity and inactivity and changes in dietary habits [1].

Prediabetes or ("intermediate hyperglycemia"), based on glycemic parameters above normal but below diabetes thresholds is a high-risk state for diabetes with an annualized conversion rate of 5%-10%; with similar proportion converting back to norm glycaemia. The prevalence of prediabetes is increasing worldwide and it is projected that >470 million people will have prediabetes in 2030. Prediabetes is associated with the simultaneous presence of insulin resistance and β-cell dysfunction, abnormalities that start before glucose changes are detectable [2].

Estimated number of people having DM was 415 million in 2015 and is expected to be 642 million in 2040, 5 million adults died from DM in 2015 [1], The proportion of undiagnosed diabetes is 46.5% in the world with the highest proportion being in Africa (66.7%) [3]. The

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Table 1: Demographic and clinical characteristics of the 430 participants.

Percent	Frequency	Characteristic	
44.7	192	<40 years	**Age**
39.8	171	40 - <60 years	
15.5	67	≥ 60 years	
43.9	189	Male	**Sex**
56.1	241	Female	
58.6	252	Arakeieen	**Tribe**
41.4	178	Others	
13.7	59	Farmer	**Occupation**
74.9	322	Laborer or Housewife	
11.4	49	Employee	
33.5	144	Illiterate	**Education**
53.7	231	Secondary	
12.8	55	University & above	
79.3	341	Married	**Marital Status**
20.7	89	Not Married	
14	60	No family history of DM or HTN	**Family History**
7.2	31	F.H of DM	
29.8	128	F.H. of HTN	
49	211	F.H of DM & HTN	
3.7	16	Poor and Supported	**Social Status**
96.3	414	Not poor	
81.9	352	No	**Smoking**
6.5	28	Ex-smoker	
6.3	27	Smoking for <10 years	
5.3	23	Smoking for 10 or more years	
69.5	299	No	**Snuff**
4	17	Ex-snuffer	
9.1	39	<10 years	
17.4	75	≥10years	
17.9	77	Yes	**Regular Exercise**
82.1	353	No	
3.7	16	Underweight	**BMI**
24.9	107	Normal	
30.2	130	Overweight	
21.6	93	Obese class I	
9.3	40	Obese class II	
10.3	44	Obese class III	
29.3	126	Normal	**Blood pressure finding**
50	215	Pre-hypertension	
15.6	67	Stage 1 HIN	
5.1	22	Stage 2 HIN	
34.2	147	Diabetic	**Personal history of DM**
65.8	283	Non –diabetic	
82.3	121	Diabetic	**High RBG >140 in diabetic and non-diabetic**
20.5	58	Non –diabetic	

FH: Family History; DM: Diabetes Mellitus; HTN: Systemic Hypertension

number of diabetic patients was estimated to be 35.4 million in Middle East and North Africa region in 2015. The prevalence of diabetes is 7.7% in adults (20-79 years) in Sudan in 2015 [3]. Previous studies showed the highest prevalence rates of diabetes in the Northern State compared to other parts of Sudan [4,5]. The aim of this study was to determine the prevalence of diabetes, its associated risk factors, and the proportion of undiagnosed DM in a rural population in the northern part of Sudan.

Material and Methods

It was descriptive cross-sectional community-based study carried out at Alkhannag Village during the period June-November, 2016. The study was conducted in two stages. The first stage was a house-to-house survey of the whole village when all the adults (18 or more years) present at the village at the time of survey were registered in data sheets, including the name, age and whether they had DM or hypertension or both. The total number of participants at this stage was 1491. In the second stage, a sample of 430 was selected from those who agreed to come to the village's health center and who were willing to provide blood samples. Those who were seriously ill or had recent history of hospitalization due to any ailments were excluded from the study. Demographic data, past history or family history and treatment history of DM or hypertension as well as smoking habits and regular exercise were obtained from the participants by a structured questionnaire. The arterial blood pressure was measured using mercury sphygmomanometers. The American Heart Association Guidelines for In-Clinic Blood Pressure Measurement [6] were applied for the participants. Capillary blood glucose was obtained by a finger puncture under aseptic conditions to measure a random blood glucose using a portable electronic glucose monitor *(CERA-CHEK1070®, Ceragem Medisys, Korea)*.

The Body Mass Index (BMI) is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2). The BMI was determined by using World Health Organization (WHO) classification for obesity [7,8]. The Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7) classification of hypertension [9], was used for this study. For the purpose of this study, participants with random capillary blood glucose of 140mg/dl (7.8mmol/L) or more were considered as having hyperglycemia or uncontrolled DM if they are known to be diabetic.

Statistical analysis was performed *via* SPSS software (SPSS, Chicago, IL, USA). Continuous variables were compared using student's t test (for paired data) or Mann–Whitney U test for non-parametric data. For categorical data, comparison was done using Chi-square test (X^2) or Fisher's exact test when appropriate. A *P* value of <0.05 was considered statistically significant.

Ethical clearance and approval for conducting this research was obtained from the State Ministry of Health and informed verbal consent was obtained from every respondent who agreed to participate in the study. Of course, the respondents informed that the study is not associated with experimental or therapeutic intervention while information was collected from them.

Results

1491 people were registered during the initial house-to-house survey at the village. The age distribution ranged from 18 to 95 years with a mean (standard deviation) age of 38.87 years. A male of 120

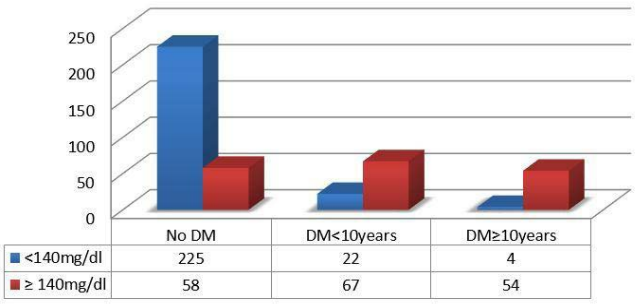

Figure 1: Distribution of the random blood glucose level among diabetic and non-diabetic participants.

years of age was excluded because he was bed-ridden and was not eligible for the second stage of the study. 176 of the 1491 participants (11.8%) had diabetes mellitus, 141 (9.5%) had hypertension and 60 (4%) had both DM and hypertension.

In the second stage of this study, the random blood glucose ranged from 65 to 478mg/dl with a mean (SD) of 160.83 mg/dl. Table 1 shows the demographic and clinical characteristics of the 430 participants studied. It was observed that 241 (56.1%) participants were female and 44.7% were in the age group of 18-40 years. Most of participants 231 (53.7%) were secondary school, 211 (49.0%) had family history of DM and HIN. Majority of participants 352 (81.9%) not smoker and only 77 (17.9%) had regular exercise. Obesity was detected in 41.1% of the participants. Pre hypertension and hypertension were found in 50% and 20.7% respectively.

High random blood glucose of 140mg/dl or more was detected in a hundred and seventy nine out of the four hundred and thirty participants (41.6%), 32.4% of them were not diabetic, 20.5% of the non-diabetic and 82.3% of the diabetic participants had a random blood glucose of ≥140mg/dl (Figure 1). The study finds strong association between the following risk factors and hyperglycemia *P* value >0.05 (age, six, tribe, education, marital status, and family history of DM or HIN, smoking, BMI and high blood pressure) (Table 2).

Table 2: Risk factors associated with high random capillary blood glucose (RCBG) levels (hyperglycemia) among 179 participants.

Parameter		RCBG≥140mg/dl	P value
		Frequency (Percent)	
Age (years)	<40	48 (25)	0.001*
	40-<60	83 (48.5)	
	≥60	48 (71.6)	
Sex	Female	162 (47.5)	0.001*
	Male	17 (19.1)	
Tribe	Arakeiyeen	117 (46.4)	0.01*
	Other tribes	62 (34.8)	
Occupation	Farmer	19 (32.2)	*0.076*
	Laborer or housewife	144 (44.7)	
	Employee	16 (32.7)	
Education	Illiterate	70 (48.6)	0.002*
	Pre-university	97 (42.0)	
	University & above	12 (21.8)	
Marital Status	Married	162 (47.5)	0.001*
	Not married	17 (19.1)	
Social status	Poor or Supported	7 (43.8)	*0.527*
	Not poor	172 (41.5)	
Family History	No	58 (20.5)	0.001*
	HTN	67 (75.3)	
	DM	52 (92.9)	
	DM & HTN	2 (100)	
Smoking	No	156 (44.3)	0.001*
	Ex-smoker	15 (53.6)	
	Smoker < 10 years	2 (7.4)	
	Smoker≥10years	6 (26.1)	
Snuff use	No	128 (42.8)	*0.338*
	Ex-snuffer	7 (41.2)	
	Snuffer<10years	11(28.2)	
	Snuffer≥10years	33(44.0)	
Regular Exercise	No	146 (41.4)	*0.453*
	Yes	33 (42.9)	
Blood Pressure	Normal	41 (32.5)	0.01*
	Pre hypertension	95 (44.2)	
	Stage 1 hypertension	30 (44.8)	
	Stage 2 hypertension	13 (59.1)	
Body mass index	Underweight	5 (31.2)	**0.02***
	Normal weight	38 (35.5)	
	Overweight	58 (44.6)	
	Obese class I	42 (45.2)	
	Obese class II	18 (45.0)	
	Obese class III	18 (40.9)	

*Significant

Discussion

This study was carried out by using random capillary blood glucose, which has the advantage of being performed at any time of the day, does not require fasting, simple and relatively cheap. Random capillary blood glucose of ≥140mg/dl (7.7mmol/L) was found to correspond to post-prandial blood glucose of ≥200mg/dl (11.1mmol/L) with a sensitivity of 86.5%, specificity of 80.7% and accuracy of 81.5% in a previous study in India [9]. Lower cutoff levels of RCBG were used in different studies to detect diabetes and pre-diabetes [10-12].

Our study showed that 20.5% of the non-diabetic participants had high RCBG levels, which corresponds to 32.4% of all participants with high RCBG. A study on the prevalence of diabetes in North Sudan about two decades ago showed that new cases were almost twice as common as known cases [5]. This may be explained by improvement in the awareness of the community about diabetes. Our results also showed that most of the diabetic participants had high RCBG, which necessitates better health education and regular

follow up. On the same point of view, the study showed that more prolong diabetes duration associated with bad control rate this may be due to appearance of diabetic complications. Inadequate glycemic control in the study population was consistent with the probable lack of awareness, and scarcity of health care facilities in the village.

Our data demonstrate a prevalence rate of hyperglycemia higher than that reported from most countries in the region [13-15]. A comparison of our data with these reports is difficult because of the different criteria used, the different age groups studied, and the different methodologies adopted.

In the present study, females were more likely to have high random blood glucose than males. Previous reports were variable regarding gender differences in the prevalence of hyperglycemia. Our data are consistent with those reported from Iraq [16] and Abu-Dhabi [17].

The present study finds that (82.1%) of our study, population has no regular exercise program, as the majority of them are females in addition to cultural aspect. This is in keeping with other studies [5,9].

It is very interesting to notice that (81.9%) are nonsmoker and this again may be due to high female percentage in this study.

As we are going through the other risk factors we find that (71.3%) of our populations have high body mass index ranging from overweight to obese class III and the study demonstrate strong association between BMI and hyperglycemia p value 0.02. Our finding correlates with previous studies which states that (Obesity, mainly central obesity has long been considered a risk factor for DM and other cardiovascular diseases) [13,14]. Lack of regular exercise and bad dietary habit can be others risk factors for insulin resistance.

It is not surprising to notice that abnormal blood pressure (pre hypertension& hypertension) are found in about (45.4%) of hyperglycemic patients. Finding already confirmed by Mohamed Berraho and his colleagues as they found (70.4%) prevalence rate of hypertension among 525 diabetic patients [13]. A French study reported hypertension in about one third of diabetic patients [14].

The current study is not without limitation; one of the limitations of the present study was using random capillary blood glucose rather than twelve-hours fasting and 2 hrs. Post–prandial blood glucose. Further studies should be done by using twelve-hours fasting and 2 hrs. Post-prandial blood glucose to determine the prevalence of DM and pre-diabetes in our population.

Other limitation of the present study was confounded by inadequate sample size or selection bias. Small sample size is open to a beta-II type error: a failure to accurately identify a true difference (i.e., a false negative result). In spite of limitations like small sample size and unicenter model, this study takes an important step towards exploring the inter-relationship of various predictors for Diabetes and impaired glucose tolerance.

Conclusion

Our study demonstrated a high prevalence of hyperglycemia among diabetic and non-diabetic rural population in rural area of Sudan. Our results also showed that most of the diabetic participants had high RCBG, and poor control, which necessitates better health education.

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