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PREVALENCE OF PREDIABETES AND ITS ASSOCIATED RISK FACTORS AMONG STAFF AND STUDENTS OF FEDERAL UNIVERSITY DUTSE

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ABSTRACT

Background: Prediabetes defines a metabolic condition that heralds the development of type 2 diabetes mellitus (T2DM). Considering the higher prevalence of prediabetes than DM worldwide, and the increased burden of T2DM in Sub-Saharan Africa, much attention is given to the identification of at risk individuals for early intervention.

Aim: To evaluate the prevalence of prediabetes and its associated risk factors among staff and students of Federal University Dutse (FUD).

Methods: The cross-sectional study recruited 100 staff and students of FUD aged between 20-79 years. A semi structured questionnaire was used to obtain socio-demographic data while anthropometric data and blood glucose levels were measured using standard procedures. The World Health Organisation (WHO) criterion of impaired fasting blood glucose (IFG) of 6.1-6.9 mmol/L was used to define prediabetes.

Results: The mean age of the studied population was 23.74±5.88 years with 96% and 72% having normal body mass index (BMI) and blood pressure respectively. Sixteen (16) prediabetic individuals comprising of 7 females and 9 males with a mean fasting blood glucose (FBS) of 7.0 ± 1.4 mmol/L had a BMI and waist circumference (WC) ranging from 14.8 to 21.8 kg/m2 and 59.6 to 96.8 cm respectively. BMI ($r=0.73$; $p<0.05$) abdominal obesity (measured by waist circumference ($r=0.75$; $p<0.05$), and blood pressure ($r=0.81$; $p<0.05$) were found to be positively associated with increased risk of prediabetes development. Additionally, increased physical activity and employment status were both associated with increased prediabetes risk but not with higher age, marital status, ethnicity and smoking.

Conclusion: Prevalence of prediabetes (16%) in FUD was found to be associated with decreased physical activity, being overweight, obese, employed and hypertensive. Routine sessional screening for staff and students as well as health education on lifestyle modification strategies for at risk individuals is highly recommended. This is critical for combating diabetes mellitus burden in Nigeria at large.

Key words; Prediabetes, Diabetes mellitus, FUD, anthropometric, risk factors

INTRODUCTION

Prediabetes, also known as intermediate hyperglycemia (World Health Organization (WHO), 2006), is a high-risk state for type 2 diabetes mellitus (T2DM). Prediabetes represents individuals with impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) (CDC, 2011). It is characterized by a blood glucose or glycated hemoglobin A1C values higher than normal but lower than cutoff values diagnostic of diabetes mellitus (DM) (Banerjee and Cruickshank, 2004; CDC, 2017). WHO defined prediabetes as impaired fasting blood glucose of 6.1-6.9 mmol/L while ADA recommended a cut-off value of 5.6-6.9% (ADA, 2003). The American Diabetes Association (ADA) suggested that haemoglobin A_{1c} (HbA_{1c}) of 5.7-6.4% could also be used as a marker to define prediabetes.

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However, the National Institute for health and Care Excellence (NICE) have suggested a higher HbA_{1c} cut point of 6.0-6.5% for prediabetes (Chatterton *et al*., 2012). The different cut off values of impaired glucose tolerance and impaired fasting glucose which indicates the relatively high risk for developing type 2 diabetes mellitus in the future have been associated with an increased risk of cardiovascular diseases (Liu *et al*., 2007; Defronzo and Abdulghani, 2011).

Globally, it is estimated that prediabetes prevalence is projected to be greater than 470 million by 2030 (Gossain and Aldasouqi, 2010) and the number of people with diabetes mellitus will increase from 463 million in 2019 to 700 million people by 2045 (International Diabetes Federation (IDF, 2017). Currently, the low- and middle income countries bear the greatest burden of prediabetes, and Sub-Saharan Africa is projected to record the most increases in prediabetes and diabetes mellitus prevalence in the near future (IDF, 2019). Diabetes mellitus is a nagging health concern in Nigeria, which represents one sixth of the total population of Sub-Saharan Africa (Odili *et al*., 2008). The prevalence of diabetes mellitus in Nigeria has increased from 2.2% as reported by Akinkugbe in 1997 from a national survey to 21.5 % by 2016 according to an estimate reported by Nwatu *et al*. (2016).

Prediabetes is typically "silent" though may already be causing adverse effects on many organ systems (Banerjee *et al*., 2004). It is estimated that 90 percent of those with prediabetes are unaware that they have the condition and will go on to develop type 2 diabetes mellitus. Up to 70 % of people and especially youths with prediabetes may develop T2DM during their lifetime (Srivanich *et al*., 2010). The prevalence of prediabetes in Africa varies between countries and from urban to rural settings (Hall *et al*., 2011). Prospective studies have shown increasing trends of prediabetes as a component of metabolic syndrome and it is often shown to be associated certain modifiable risk factors such as smoking habits, low physical activity, obesity, dyslipidemia and hypertension (Defronzo and Abdulgani, 2011). Clearly, prediabetes is promoted by many modifiable risk factors, and previous researches have shown that intensive lifestyle (i.e increased physical activity and dietary) modification and pharmacological interventions can prevent or delay progression to T2DM. To date, there are few studies reporting the prevalence of prediabetes available for the Nigerian population especially from northern Nigeria; where due to the adoption of "western style diet" and increased physical inactivity, diabetes mellitus has become a major cause of morbidity and mortality (Kabir *et al*., 2019). In order to curb the increased prevalence of T2DM, one of the effective prevention strategies will be screening for prediabetes which could be an early marker required to tackle it's rising trends. Casual plasma glucose level, 75 gram oral glucose tolerance test (OGTT) and fasting blood glucose are recommended screening tests for prediabetes (U.S Preventive Service Task Force (USPSTF), 2017). Early screening and awareness of risk factors for diabetes mellitus as well as development of cost-effective therapeutic strategies such as lifestyle modification to prevent or delay the progression of the prediabetic stage to diabetic stage is the need of the hour and, ideally, to revert to a normal metabolic state. To this end, in an attempt to reduce the burden of diabetes mellitus in Nigeria, the present study aims to evaluate the prevalence of prediabetes and its associated risk factors among staff and students of Federal University Dutse (FUD).

MATERIALS AND METHODS

Study Area

Dutse is located in North-Western Nigeria and has a population of 153,000 (Stefan, 2007). The town is bordered by two states; Bauchi and Kano. Dutse and its environment falls under Sudan savannah and are well known for date trees (Dabino) of different species.

The area experience two distinct seasons: wet season from May to September and dry season from October to April. The total annual rainfall received in the area ranges between 600-800 mm per year and annual temperature is 26˚ C (Ogunkoya and Dami, 2007). Dutse is largely dominated by Hausa and Fulani ethnic groups. It is home to the Federal University Dutse (FUD) which was opened in 2011. FUD staff and students are of diverse backgrounds. The university is comprised of four (4) faculties; Science, Arts and Social Sciences, Agriculture and Basic Medical Sciences as well as other non-teaching departments. The population of students stands at 3,200 with approximately 4,000 academic and non-teaching staff. Being a federal university, FUD is a fair representation of individuals from all social status.

Study design and population

The cross-sectional study randomly enrolled 100 staff and students from all departments of FUD, with no prior diagnosis of diabetes mellitus aged between 20-79 years (ADA, 2014). The study was carried out in June, 2018 after discussions were held with participants to explain the rationale and importance of the study. The study was approved by the health research and ethics committee of the Federal University Dutse Clinic (FUD/UHC/BS/12/I) and informed consent was obtained from study participants.

Sample size

According to IDF's update (2019) the prevalence of diabetes in Nigeria is 3.1 %. The prevalence of diabetes within 5% of the true prevalence in the study population was determined using the formula for population proportion sample size (Singha, 1996).

$n=Z^2P(1-P)/C^2$

where $n^=$ Sample size

Z= standard normal deviation at 95% confidence interval found to be 1.96

P= percentage prevalence 0.031

C= degree of confidence 0.05

$n=(1.96)2 \quad 0.031(1-0.031)/(0.05)^2$

=0.11534976/0.0025= 46

The calculated sample size (n) was 46, but this was rounded up to the nearest hundred to take care of attrition. The sample size for the study was therefore taken as 100.

Data collection

Questionnaire

A semi structured self administered questionnaire was used to capture the socio-demographic characteristics and personal habits of the participants.

Physical and Anthropometric Data

Blood pressure, weight, height, and waist circumference of the participants were measured using standard procedures. Weight was measured in kilograms using a pre-calibrated weighing scale to the nearest 0.5 kg on a flat surface with the subject wearing light clothing. Height was measured to the nearest 0.5cm in meters with a tape ruler with subject not wearing shoes. Waist circumference was measured in centimeters with a non-stretchable tape, midpoint between the last rib and the superior iliac crest, along the midaxillary line. Blood pressure was measured using Omron Automatic Blood Pressure Monitor M3, Japan with participants well relaxed and mean of two readings taken 20 minutes apart.

Measurement of Fasting Blood Glucose

Blood glucose was measured using capillary blood obtained by fingertip pinprick, using a pre-standardized Roche Accucheck Active glucometer, Germany, after an overnight fast of 10-12 hours to obtain readings. Test strips were pre-calibrated by the manufacturer.

Definition of variables

Prediabetes was defined based on WHO criteria of fasting blood glucose of 6.1-6.9 mmol/L. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared and was categorized as Normal (<25Kg/m^2), Overweight (25-29.99 Kg/m^2),Obesity (>30 Kg/m^2). Abdominal obesity was categorized as waist circumference (WC) of <102 or >88 cm in men and women respectively (ADA, 2013), blood pressure was classified based on WHO definition for hypertension; Normal: <120 Stage I: 120-140 Stage II: >140

Data analysis

Descriptive statistics and frequency counts were done on the data generated and the results reported as mean ± standard deviation and percentages, respectively. Data was entered in Microsoft excel spread sheet version 2007 and analyzed using SPSS software version 17.0 (SPSS Inc. Chicago, IL, USA). Significant differences at $P<0.05$ was evaluated using X^2 test for categorical variables and t-test for continuous variables while association was established using Pearson's correlation. Prevalence of prediabetes expressed as a percentage was calculated by dividing the total number of participants with prediabetes by the total number of study sample.

RESULTS

The socio demographic and anthropometric characteristics of one hundred (100) participants comprising of 39 females and 61 males from FUD is shown in table 1. The mean age of the studied participants by sex was 23.64 ± 4.25 and 25.06 ± 5.66 years for females and males respectively while the age of all participants ranged between 20 and 53 years. Students (92%) constituted the larger part of the study, majorly of the Hausa/Fulani ethnic group (90%) with minor tribes constituting 5% of the studied population. Of the 100participants of the study, majority (89% for males and 82% of the females) were single. Majority of the females (41%) exercised twice in a week while the majority of the males (57%) exercised four times in a week. The prevalence of overweight/obesity as measured by BMI by sex was 7.7 % and 1.6% percent for females and males respectively. Overall, the prevalence of prediabetes in FUD community was estimated to be 16%. However, no clear association was found between ethnicity, employment status and marital status as the trend was found to be not significant with having prediabetes.

The associations between prediabetes as measured by fasting blood glucose with anthropometric measurements are presented in table 2. While none of the participants that smoke had prediabetes, a strong association was however observed with blood pressure, BMI, WC and family history of diabetes mellitus with risk prediabetes development.

Table 1 Socio-demographic and Anthropometric Characteristics of Staff and Students of Federal University Dutse (FUD)

Variables	Females (n=39)	Males (n=61)	All (n=100)
Age (years) Mean ± SD	23.64 ± 4.25	25.06 ± 5.66	23.74 ± 5.88
Marital Status			
Single	32 (82)	54 (89)	86 (86)
Married	7 (18)	7 (11)	14 (14)
Ethnicity			
Hausa/Fulani	35 (90)	60 (98)	90 (90)
Yoruba	2 (5)	1 (0)	3 (3)
Ibo	1 (3)	1 (2)	2 (2)
others	2 (0)	3 (2)	5 (5)
Employment status*			
Staff	2 (3)	7 (11)	8 (8)
Student	38 (97)	54 (86)	92 (92)
Physical activity*			
Once monthly	1 (3)	0 (0)	1 (1)
Once weekly	1 (3)	3 (5)	4 (4)
Twice weekly	16 (41)	6 (10)	22 (22)
Thrice weekly	4 (10)	2 (3)	6 (6)
Four times	9 (23)	35 (57)	44 (44)
Daily	2 (5)	1 (2)	3 (3)
Never	6 (15)	14 (23)	20 (20)
Smoking			
Yes	0 (0)	2 (3)	2 (2)
No	39 (100)	59 (97)	98 (98)
Blood Pressure≠			
Normal	22 (56.4)	50 (82.0)	72 (72.0)
Stage I	10 (25.6)	19 (31.1)	27 (27.0)
Stage II	0 (0.0)	1 (1.6)	1 (1.0)
Body Mass Index (BMI) (Kg/m2) Mean ± SD			
Normal (<25)	36 (92.3)	60 (98.4)	96 (96.0)
Overweight (25-29-99)	3 (7.7)	1 (1.6)	4 (4.0)
Obese (>30)	0 (0)	0 (00	0 (00
Waist Circumference (cm)	76.07 ± 19.54	77.17 ± 12.56	74.63 ± 16.59
Fasting Blood Glucose (mmol/L)			
Mean ± SD	5.78 ± 0.82	5.66 ± 0.88	5.69 ± 0.86
Prediabetes#			
Yes	7(18.0)	9 (14.8)	16 (16.0)
No	32 82.1)	52 (82.0)	84 (84.0)

prediabetes was defined according of WHO definition as FBG of 6.1-6.9 mmol/L; ≠ Hypertension (blood pressure) was defined according to WHO definition of normal<120, stage I 140- 159; stage II >160: pre hypertension- 120-139 was merged with normal; * P<0.05 significant difference with prediabetes (chi-squared test). Figures in parentheses show percentages

Table 2 Correlation between Fasting Blood Glucose, BMI, Blood pressure and Waist circumference among Prediabetic individuals in FUD

Variables	Males (n=9)	Females (n=7)	All (n=16)
Age (years)			
Mean ± SD	26.6 ± 11.1	24.8 ± 5.3	26.0± 8.2
Fasting Blood Glucose (mmo/L)	6.8 ± 2.2	6.9 ± 1.1	7.0 ± 1.4[a]
Body Mass Index (BMI) (Kg/m^2) Mean ± SD	17.5 ± 4.7	18.6 ± 4.1	18.3 ± 3.5[b]
Blood pressure (systolic)	120.1 ± 34.6	122.4 ± 12.7	125.0 ± 18.6[c]
Waist Circumference	75.4 ± 20.4	78.2 ± 16.1**	78.2 ± 18.6[d]
Smoking			
Yes	0 (0)	0 (0)	0 (0)
No	9 (100)	7 (100)	1 6 (100)
Family History of Diabetes			
Yes	2 (22)	1 (14)	3 (19)
No	7 (78)	6 (86)	13 (81)

Continous variables are expressed as Mean ± SD, Categorical variables are presented as frequency (percentage). Superscripted values[a-d] within the same column are significantly correlated at P<0.01; Glucose is positively correlated to BMI r= 0.73, BP r=0.81, and WC r=0.75 ; **P<0.05 significant difference between gender (t test).

DISCUSSION

The results of the present study observed a 16% prevalence rate of prediabetes, which is lower than the range of 21.5 to 39.1% reported by Essien *et al*. (2007) (39.1%), Ogbu and Neboh (2009) (25%), Uche *et al*. (2013) (33.1%), Nwatu *et al*. (2016) (21.5%) and Martins *et al*. (2017) (22.3%) in different Nigerian community and hospital based studies. Additionally, a higher prevalence of 40.6% and 48.3% were reported by Latifi *et al*. (2016) and CDC (2017) in Iran and United States respectively. However, the prevalence observed in the present study is higher than that reported by Gezawa *et al*. (2015) (7%) in Borno State, Shittu *et al*. (2017) (6%) in Oyo state-Nigeria and Mayega *et al*. (2013) (8.6%) in Uganda. Furthermore, the prevalence observed in this study was found to be higher than the national prevalence rate of 5% reported by IDF (2017) but is within the range reported by a World Bank publication data which estimated the prevalence of impaired glucose tolerance to be between 2.2 and 16% in different African settings (Sicree *et al*., 2012). In the 1970s, a much lower prevalence of prediabetes (0.4%) was reported by Osuntokun *et al*. (1971). Clearly, the present study along with other reported findings in Nigeria and elsewhere demonstrates an increasing prevalence of prediabetes.

A closer look at the reported findings reveals that most of the prevalences obtained are from hospital-based studies among patients with hypertension, HIV and other co-morbidities, thus the differences observed with our findings. Furthermore, differences in fasting blood glucose cut off values used for prediabetes screening gives marked variation in prevalence rates. It is worth noting that, as the cut off values for defining prediabetes play significant roles in screening, using the ADA criteria in this study, would have implied a double fold increased prevalence of prediabetes in FUD. Moreso, differences in screening tests for prediabetes could also be the reason for the different prevalence rates observed. Use of fasting blood glucose along with glycated hemoglobin which estimates glycemic status of an individual is recommended as a valid screening tool for prediabetes (WHO, 2006).

However, glycated hemoglobin test has a limitation of cost implication making it difficult to be used for routine screening in low resource settings. Other factors that might have played significant role in the high prevalence of prediabetes in FUD include adoption of sedentary lifestyle and western style diet and the period the study was conducted.

The present study was carried out during the Islamic month of Ramadan a period when people naturally want to treat themselves by eating high caloric and processed foods after sunset "iftar" and before dawn "sahur". Fasting during the month of Ramadan is associated with increased weight loss consequent to decreased meal frequency, but is shown to be linked with an increased consumption of foods rich in fat and dietary cholesterol (Khaled and Belbraouet, 2009). According to IDF (2019), high caloric foods, processed foods and increased fat intake are associated with increased prevalence of type 2 diabetes mellitus. Additionally, the majority of the participants in the present study were students, as such could have been subjected to stressful situations such as tests or examinations which might have triggered stress hormones induced hyperglycemia. The release of glucose by the liver depends on hormones which include insulin, glucagon, stress hormones, growth hormones and sex hormones. Stress hormone particularly epinephrine and cortisol is a hormone that causes release of glucose into the blood stream resulting in hyperglycemia.

Prediabetes is one of genetic factor responsible for the high prevalence of diabetes mellitus. Diabetes mellitus is a multi-genetic disease associated with insufficient insulin release, action or both (Kabir *et al*., 2019) which can invariably be inherited. Our study found no association between family history of diabetes and prediabetes development. This finding is not in agreement with the study by Arslanian *et al*. (2005) which reported a strong association between family history of diabetes mellitus and risk of development of prediabetes. Contrary to our findings, CDC (2017) documented that 48.3% of adults in US aged 65 years and above have prediabetes with more males than females affected by the condition. The wide age range of 20-79 selected in the present study with the majority of the participants being < 25 years as well as participants higher than 40 years who most likely would have higher risk of diabetes not adequately represented could be the reason for the lower mean age of prediabetics in our study. Findings of the present study also demonstrated an association between prediabetes and high blood pressure, physical inactivity and obesity. This is in agreement with previous observational studies that reported a strong link between hypertension, obesity and cardiovascular diseases and development of prediabetes and ultimately T2DM (Ford *et al.*, 2012; Huang *et al*., 2014). Obesity and high blood pressure are reported to be one of the predisposing risk factors for metabolic syndrome in those >35 years of age (Iloh *et al*., 2013). Inadequate physical exercise has been shown to be an independent risk factor for obesity, hypertension and prediabetes (Ridell and Fowles, 2010) as it causes increased insulin resistance or decreased sensitivity in different body cells (Arslanian *et al*. (2005). WHO has therefore recommended moderate exercise in adults aged 18-64 years for at least 150 minutes a week (WHO, 2010) especially in those with other co-morbidities such as hypertension and increased BMI. None of the two participants that smoke had prediabetes and majority of the studied population were of the same age range as such clear relationship could not be established between age and smoking. Some studies have shown association between being married and risk of having prediabetes (Shang *et al*., 2013). This is not in agreement to findings of this study as most of the participants were not married. Major participants of this study were students who are very active as demanded by their student life and was the expectation to observe very low prevalence of prediabetes. However, a high prevalence was observed despite the small sample size used for the study.

Hence, taking into consideration the projected increased burden of prediabetes, the different policy makers of the university and different levels of the Nigerian government needs to put in place guidelines and strategies to reduce its morbidity and mortality bearing in mind that modifiable risk factors can be altered, unlike non-modifiable risk factors.

CONCLUSION

Findings of the present study revealed that blood pressure, obesity as measured by BMI and WC, being employed and decreased physical activity were the probable modifiable risk factors of prediabetes in FUD. These findings could help address prediabetes epidemics in a broader context of obesity and hypertension which in Federal University Dutse was found to have 16% prevalence rate.

Recommendations:

The results of the present study emphases the implication of early intervention such as life style modification in control and management of prediabetes. At risk individuals should therefore be targeted for life style modifications, regular blood glucose and BMI checks. There is need for more studies and programs to estimate the current scenario of prediabetes and diabetes mellitus in Nigeria, so that proper task force for prevention, early diagnosis and health education can be put inplace. Although the present study used a small sample size, the study provides preliminary data that points to high prevalence of prediabetes and consequently type 2 diabetes mellitus. Screening on FUD campus for staff and students at the beginning of every session is highly recommended. Facilities for physical and sporting exercises should be put inplace as a direct intervention to reduce the prevalence of pre-diabetes and slow progression to diabetes mellitus. Future studies with larger sample size should also be conducted to better analyze the association between prediabetes and risk factors in Nigeria at large.

Competing Interest:

The authors declare no conflict of interest.

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