Diabetes Mellitus and its Risk Factors Among a Suburban Population of Northwestern Nigerians: A Community-Based Survey

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Abstract

Background: Diabetes mellitus is a serious public health problem, and its prevalence is increasing globally. However, there are scanty reports of the scope and burden of the disease among suburban populations of Nigeria. This study aims to determine the prevalence of diabetes mellitus and to determine the associated risk factors of the disease among the suburban population of Northern Nigeria.

Methodology: A community-based descriptive cross-sectional study was conducted in which 1100 subjects were recruited using a multistage random cluster sampling technique. They were screened for diabetes by fasting plasma glucose (FPG) or casual plasma glucose (CPG) estimation. Individuals with FOG >7mmol//l or CPG >7.8mmol/l abnormal glucose levels had a 75 g oral glucose tolerance test (OGTT) and HbA1c done. The prevalence of diabetes was computed with a 95% confidence interval.

Result: The crude prevalence of diabetes from this study is 4.1% (95% CI = 3.3 – 4.9%) and standardized rate of 6.4%. Male gender OR 0.74, (95% CI = 0.569 – 1.982), age >40yrs OR 1.12 (95% CI = 0.851 – 1.463), physical inactivity OR 3.78 (95% CI = 2.881 - 12.726), Hypertension (SBP OR 10.28 (95% CI = 6.319– 29.369), (DBP OR 7.52 (95% CI = 3.928 – 36.914), and family history of DM OR 9.34 (95% CI = 3.890 – 23.481), showed significant independent association with diabetes.

Conclusion: The prevalence of diabetes in the suburban population of Northwestern Nigeria is high and the associated risk factors include overweight and obesity, physical inactivity, family history of diabetes and age.

Keywords: Prevalence; Diabetes mellitus; Risk factors; Suburban; Community Survey.

Introduction

The prevalence of diabetes mellitus (DM) is increasing rapidly worldwide and is now recognized as a global public health problem. In addition, various complications of diabetes are at an epidemic level and thus have now become an important health-threatening condition[1]. Epidemiological evidence suggests that, without effective prevention and control programmes, the burden of diabetes will continue to increase globally. The International Diabetes Federation (IDF) estimated in 2017, that there are 451 million adults with diabetes globally and the figure was projected to rise to a 693million by 2045[2]. Of those expected to have diabetes, almost half are undiagnosed and living with the disease. These figures are expected to rise more in sub-Saharan Africa than in any part of the world[2].

The burden of DM in Sub-Saharan Africa and Nigeria is not fully known owing to the paucity of population-

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based studies[1], for instance, IDF estimates for the prevalence of diabetes in Nigeria has been fluctuating declining from 4.6% in 2014[3] to 3.1% in 2019. A recent meta-analysis on the prevalence of diabetes in Nigeria was reported as 5.77% by Uloko et al[4].

Nigeria's DM prevalence based on the 1997 National Expert Committee report on Non-communicable Disease (NCD) was 2.2% with a male: female ratio of 1.1:1, while the crude prevalence of DM in urban Kano was put at 1.8%[5]. Despite the lack of adequate data, studies have shown that diabetes is a major cause of morbidity and mortality among the adult population accounting for more than 40% of hospital admissions[6-8]. Several studies have demonstrated that the prevalence of diabetes mellitus in Nigeria has been increasing since the 1960s from 1% [9-11] to about 4% in the 2000s[3,11].

Strong evidence exists in the literature to suggest that interventions that prevent type 2 diabetes mellitus (T2DM) in individuals with dysglycaemia [Impaired glucose tolerance (IGT)) and impaired fasting glucose (IFG)] have been effective[12,13]. There is also evidence in the literature to support the screening of T2DM and IGT combined than screening for T2DM alone.

Several risks factors like Overweight, family history and sedentary lifestyle have been reported to be the most important risk factors for diabetes in Nigeria[3].

The two intermediate categories of glucose intolerance, IFG and IGT, have been shown in several studies to be strongly associated with cardiovascular disease risk;[13-15], Yet population-based studies on the prevalence and risk factors for diabetes, and other forms of glucose dysregulation in Nigeria is scanty. This paper seeks to provide some information on the prevalence of DM in Kano and Nigeria at large. It will help in planning intervention and prevention strategies that have been shown to work well in other countries.

Method

This was a descriptive cross-sectional community-based study that was conducted in the Kumbotso local Government area of Kano state Nigeria which is about 22km from Kano city. It has a total land area of 20,760sq kilometres and a population of 9,383,682 based on the official 2006 National Population and Housing Census and almost equal distribution of male (51%) and female (49%)with a predominant occupation of subsistence farming[16].

Ethical approval was obtained from Aminu Kano Teaching Hospital Kano and the Kano state ministry of health. Pregnant women, persons who are known to have diabetes mellitus, very ill persons and persons who declined consent were excluded from the study.

The sample size for the study was determined using the following formula was used: $n = z^2 pq / d^2$
Based on the prevalence of diabetes mellitus in a Nigerian urban city similar to Kano (Lagos mainland = 7.4%) as reported by the expert committee on non-communicable disease survey of 1997[5].
n=Minimum sample size
z = standard normal deviate at 95% confidence level = 1.96
p= prevalence of Diabetes mellitus obtained from previous study (7.4% = 0.074)
q= Complementary probability to p = 1-p = 1-0.074 = 0.0926
d= absolute precision limit required (2%) 0.02
Thus $\mathbf{n} = (1.96)^2 (0.074)(0.926)/(0.02)^2 = 658 + 10\% = 658 + 68 = 718$
1100 persons were recruited to accommodate non-responders.

Study Population

The Subjects included adult males and females aged 18years and above resident within the study area who meets the inclusion criteria were enrolled on the study.

Study Procedure

Permission and cooperation for the study were obtained from the village and ward heads of the respective communities.

Research assistants who speak English, as well as the local languages (Hausa), were recruited and trained to assist in data collection and anthropometric measurements.

An interviewer-administered questionnaire based on a modification of the WHO STEPS Instrument was used for data collection. Anthropometric measurements were carried out on each subject as follows;

Weight was measured to the nearest 0.1kg with subjects in light clothing and without shoes, while standing on a calibrated bathroom scale, positioned on a flat even surface[17]. Height was measured to the nearest 0.1cm using a height stand with subjects barefooted and without headgear while standing

erect[17]. Body mass index (BMI) was calculated as weight in kg divided by the square of height in meters (m^2) i.e. kg/m using the Quetelet formula BMI = weight (kg)/height $(m)^{2.}$ [17]Waist circumference (WC) was measured to the nearest 0.1cm using a non-stretchable dressmaker's tape at a point mid-way between the margin of the lowest rib and the iliac crest in the horizontal level. This was done with the subject standing erect at an expiratory phase of respiration[17] Hip circumference (HC) was measured to the nearest 0.1cm at the horizontal level of the maximum circumference around the gluteal region (posteriorly) and the pubic symphysis (anteriorly) with the tape parallel to the floor. This was done with the subject standing erect at the end of a normal expiration[16] Waist to hip ratio (WHR) was calculated as the waist circumference in centimetre (cm) divided by hip circumference in centimetre (cm)[17].

Biochemical Measurement.

After 10-12 hours of overnight fast, venous samples were collected from the subjects. The blood samples were immediately centrifuged and separated. The sera were analyzed for glucose, lipids and fasting plasma insulin. Subjects who had fasting plasma glucose in the pre-diabetes range had OGTT done.

Serum Glucose was determined using the glucose oxidase method of Trinder. Total Cholesterol; this was determined using the cholesterol oxidase and cholesterol ester method. High-Density Lipoprotein (HDL) was estimated by the precipitation method. Triglyceride was determined using the lipoprotein lipase enzymatic procedure. Glycated Hemoglobin was measured using the HPLC technique with Bio-Rad 10 analyzer.

Ethical Clearance and Ethical consideration

Approval was sought for and obtained from the AKTH Ethical Committee (Ref No. NHREC/21/08/2008/AKTH/EC/1105). Informed consent was also obtained from all the participants before enlisting in the study. Participants that were found to be diabetic or had abnormal blood glucose were counselled and referred to a health facility of their choice for further management after the study. Ethical considerations were observed following the provisions of the Helsinki declaration on research in human subjects.

Statistical Methods

Data were was analyzed using SPSS version 16.0. P values <0.05 were considered statistically significant. The validity (specificity sensitivity, positive predictive values, negative predictive values, likelihood ratios and accuracy) of $HbA_{1C,}$ FPG, and 2-hour PG load was determined. In all statistical comparisons, a p-value of $\leqslant 0.05$ was considered to be statistically significant.

Results

One thousand one hundred (1100) subjects were recruited into the study, 1024 subjects completed the study, giving a response rate of 93.1 %. Of those who completed the study, there were 419 (40.9%) males and 605 (59.1%) females giving a sex ratio of 1:1.5 in favour of females.

The mean ±SD age of the subjects was 41.9±17.6 years, with a range of 18 – 94 years. The mean ±SD age of the females and males was 43.4±18.7 and 39.7±16.2 respectively, with the latter being younger. The majority of the subjects were in their second and third decade of life. The distribution of the study subjects by age and gender is as shown in table 1.

The mean ±SD BMI of the study subjects was 23.3 ±SD 4.6 Kg/m^2 and in males and females was 22.7 ±3.7 Kg/m^2 23.7 ± 5.1 Kg/m^2 respectively in females (p=0.001), while mean±SD WHR of male subjects was 0.9 ± 0.6 and that of the females was 0.9± 0.7. Table 2.

The crude prevalence of diabetes from this study is 4.1% (95% CI = 3.3 – 4.9%) and standardized rate of 6.4%, and 27 patients (2.6%) were undiagnosed to have DM. Table 2 and 3. Male gender, diastolic blood pressure, systolic blood pressure, age >40, physical inactivity and family history of diabetes showed a significant independent association with diabetes. Table 4. The prevalence of dysglycaemia in this study was 4.3% for IFG, 1.91% for IGT

Male gender OR 0.74, (95% CI = 0.569 – 1.982), age >40yrs OR 1.12 (95% CI = 0.851 – 1.463), physical inactivity OR 3.78 (95% CI = 2.881 - 12.726), Hypertension (SBP OR 10.28 (95% CI = 6.319–29.369), (DBP OR 7.52 (95% CI = 3.928 – 36.914), and family history of DM OR 9.34 (95% CI = 3.890 – 23.481), showed significant independent association with diabetes.

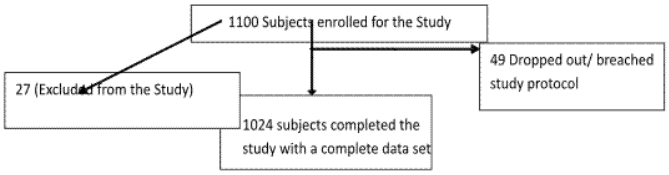

Figure 1: A flow chart showing subjects enrolment

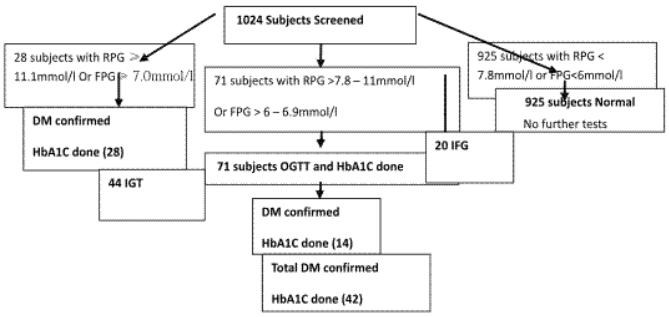

Figure 2: Flow Chart of Subjects showing the schema for validity calculation.

Abbreviations: FPG= Fasting Plasma Glucose; RPG=Random Plasma Glucose; OGTT=Oral Glucose Tolerance Test; IGT=Impaired Glucose Tolerance; DM= Diabetes Mellitus; HbA1c= Haemoglobin A1c.
Foot Notes: Test A- OGTT, Test B- HbA1c

Table 1: Sociodemographic variables

Socio-Demographic Variable	Total N	Frequency (%)
Age (Years)		
<20	48	4.69
20-29	227	22.17
30-39	237	23.14
40-49	152	14.84
50-59	162	15.82
60-69	82	8.01
70-79	61	5.96
≥80	55	5.37
-	1024	100.00
Educational Status		
Quranic Education	109	24.60
Primary Education	221	49.89
Secondary Education	104	23.48
Others	8	1.81
Tertiary	1	0.23
Total	443	100.00
Marital Status		
Single	171	16.70
Married	774	75.59
Separated	74	7.23
Widowed	5	0.49
Total	1024	100.00
Occupation		
Unemployed	171	16.70
Business	575	56.15
Housewife	193	18.85
Teaching	11	1.07
Farming	74	7.23
Total	1024	100.00

Table 2::Prevalence and variables in the study population

Variable	Male (n=419)	Female (n=605)	P-Value	Sample Population
Age (years), mean ± SD	43.4±18.7	39.7±16.2	<0.001	41.9±17.16
BMI (Kg/M^2), mean ± SD	22.7±3.7	23.7±5.1	<0.001	23.3±4.6
WHR, mean ± SD	0.9±0.6	0.9±0.7	<0.001	0.9±0.6
FPG (mmol/l) mean, ± SD	5.1±0.3	4.5±0.2	<0.001	4.7±0.2
CPG (mmol/l) mean, ± SD	6.5±0.6	6.1±0.7	<0.01	6.2±0.8
HbA1c (%) mean, ± SD	6.0±0.5	4.9±0.4	<0.001	5.3±0.3
FPI (ui/l) mean, ± SD	6.0±0.4	4.8±0.5	<0.001	5.5±0.4
Crude prevalence of DM (%)	6.2	2.6	-	4.1
Standardized Prevalence (%)	5.2 (4.1 - 5.9)	2.8 (1.8 - 3.2)	-	6.4
Undiscovered DM (%)	3.3	2.1	-	2.6

*= Significant $p \leqslant 0.05$

Table 3: Modifiable Risk Factors for Diabetes Mellitus in the study population

Risk Factor	Diabetes Yes (42)	No (982)	P-Value
BMI (Kg/M^2)			
<25	15	860	<0.0001*
⩾25	27	122	
WHR			
<0.85	29	112	<0.0001*
⩾0.85	13	870	
Physical Activity			
Active	18	114	<0.0001*
Not active	24	868	
Alcohol			
<21 units/week	2	192	0.238
⩾21units/week	-	830	
Cigarette smoking			
Yes	2	9	<0.0001*
No	-	1013	
Frequent fruits and vegetables			
>5 days per week	31	98	0.0031*
⩽5 days per week	11	884	
SBP			
Hypertensive	25	337	<0.0001*
Normotensive	17	645	
DBP			
Hypertensive	26	329	<0.0001*
Normotensive	16	653	

*= Significant $p \leqslant 0.05$; BMI= Body Mass Index; WHR= Waist – Hip ratio; SBP = Systolic Blood pressure; DBP= Diastolic Blood Pressure.

Table 4: Non-modifiable risk factors for Diabetes Mellitus in the study population

Risk Factor		Diabetes Yes (42)	No (982)	P-Value
Age				
	<40	10	502	<0.0001*
	⩾40	32	482	
Gender				
	Male	26	393	<0.0001*
	Female	16	589	
Diabetes in first-degree relatives				
	Yes	7	61	<0.0001*
	No	35	921	
Social Class				
	Upper	16	611	<0.01
	Middle	18	342	
	Lower	8	71	

*= Significant $p \leqslant 0.05$

Table 5: Logistic regression analysis Risk factors for Diabetes Mellitus in the study population

Risk factor	p-Value	Odds ratio	95% Confidence Interval
Age	0.004	1.12	- -
Gender (Male)	0.000	0.74	0.569 – 1.982
WHR	0.000	3.53	1.932 – 8.325
BMI (Obese and Overweight)	0.002	4.26	1.872 – 6.182
Family History of Diabetes	0.000	9.34	3.890 – 23.481
Physical In Activity	0.098	3.78	2.881 - 12.726
SBP	0.000	10.28	6.319– 29.369
DBP	0.000	7.52	3.928 – 36.914
Fruit Intake	0.003	1.79	0.993 – 12.372
Tobacco use	0.438	0.19	0.30 – 0.836
Alcohol Use	0.389	0.27	0.40 – 0.991

*= Significant $p \leqslant 0.05$; BMI= Body Mass Index; WHR= Waist – Hip ratio; SBP = Systolic Blood pressure; DBP= Diastolic Blood Pressure.

Table 6: Prevalence of Dysglycaemia Diabetes Mellitus in the study

Parameter	DM	IFG	IGT	Undiagnosed DM
n	42	44	20	27
%	4.1%	4.3	1.9	2.8

Diabetes Mellitus; IFG= Impaired Fasting Glycaemia; IGT= Impaired Glucose Tolerance;

Discussion

This study was conducted to determine the prevalence of undiagnosed diabetes mellitus and its associated risk factors. It represents a survey of a Sub-urban population of the Northwestern part of Nigeria.

From this study, the crude prevalence of diabetes was 4.1%, in the general population and 6.2% and 2.4%, and males and females respectively. The rate obtained from this study is similar to that reported from metanalysis Adeloye et al[18], and other studies from other parts of the country by (4.0%)[19], 4.06% by Chuwark[20] in Jos,[21] (4.3%), in Sokoto and (4.7%) in Okeogun in Nigeria[22]. Elsewhere in Mexico and the United States[23] in-Prima Indians 4.7%.It is however lower than the 2.2% reported from the NCD national survey by Akinkugbe[24] NCD and 2.2% reported by Olatobosunin Ibadan. The WHO estimates for the prevalence of diabetes in Nigeria was 4.3%[15,25,26]. Higher rates have been reported from Calabar (7.0%)[3], Nyenwe et al[23] (6.8%), in Port Harcourt Nigeria. This difference may be accounted for by the higher socio-economic status of people of the oil-rich Niger Delta region of Nigeria, a systematic review and meta-analysis by Uloko et al[27] put Nigeria's DM prevalence at 5.77%. Among hospital patients in Addis Ababa, 14.8% was reported[10].

Undiagnosed diabetes in the study was 2.6%, similar to 2.8% reported by Nyenwe et al in Port Harcourt[28], but much higher than 1.7% reported by Owovhoriole[29] in urban Lagos in 1988.Comparison between studies is, of course, fraught with difficulties due to differences in the methodology for testing for glucose, diagnostic criteria and selection criteria which may differ substantially. The high prevalence of DM in this study may due to demographic transition and rapid urbanization.

Females constituted a larger proportion of the study participants. This was probably because the males were at their various places of work mostly in the farms, business premises or industries when the research team arrived and the women were more willing to participate in the study. In addition, most of the women are housewives and are therefore always at home[30,31]. This finding is similar to what has been reported by other scholars. In this study, the prevalence of DM is higher in males than females although gender differences in the prevalence of DM have been variably reported in the literature[30-32], [33,34]. Some others showed no gender difference[35-37].

Age is recognized as an independent risk factor for DM. In our study, DM was commoner among the middle-aged group with a steady increase with increasing age like in other studies[30,31]. The implication of this is that the bulk of our economic workforce or the economically active segment is the most affected by the disease. It, therefore, has a far-reaching socioeconomic implication in the sense that the economically viable part of society is the most affected. This is similar to reported figures from studies done in other parts of the country[9,29,30,368]. Therefore, employing aggressive measures to prevent the development of the disease will have a positive impact on the economy.

Family history of diabetes is a strong predictor of DM in this study. The is sufficient literature to show that family history of DM is a strong risk factor for DM. This finding has been corroborated in previous studies[19,30,39-41]. There are however a few studies that didn't show any risk of developing DM with a positive family history of DM in first degree relatives. Strong Family history of type 2 DM among first-degree relatives have been demonstrated by Cederbeg et al to be associated with both increased risk of becoming overweight/obese and greater susceptibility to increasing body fat, probably as a consequence of an increased propensity to accumulate non-subcutaneous fat[42]. Several genes have been identified that confer susceptibility to the development of DM first- and second-degree relatives[42,43].

Modifiable risk factors for DM like lack of physical activity, overweight and obesity have been found in this study similar to that reported in the literature to be associated with a higher prevalence of the disease[28-31]. The prevalence of diabetes in this study was noted to be higher among individuals with higher BMI (overweight and obese) as compared to those with normal weight among individuals with a lack of physical activity. Several studies across the country have reported a higher prevalence of obesity among subjects with type 2 DM in Nigeria[44] [45] and other countries[45]. Weight loss has been one of the targets of diabetes prevention programs that seek to reduce the risk of the development of diabetes in populations. Lifestyle measures have been implemented in various clinical trials and have been shown to prevent diabetes and even enhance the remission of DM in the various population studied.[13,46] Strategies helping patients lose weight, increase moderate-intensity physical activity levels to at least 150 min/wk., and increase fibre intake has worked well in the prevention of DM[25,26,47]. Calorie restriction for instance in the Direct trial has shown that 46% of participants were in remission toa non-diabetic state after one year and off antidiabetic drugs. A year later, 70% of those participants are still in remission[13,46].

The link between physical inactivity, overweight and obesity is an established risk factor for type 2 DM, may be related to increased pro-inflammatory cytokines (tumour necrosis factor and interleukin-6), insulin resistance, deranged fatty acid metabolism, and cellular processes such as mitochondrial dysfunction and endoplasmic reticulum stress[41,48]. It is, therefore important, to prevent and control obesity in the population, as one of the modifiable risk factors for the development of diabetes, doing this will help the efforts to reduce the risk of development of T2DM. In addition to the effect of exercise on weight loss, it may also help to enhance glucose uptake in tissues through several mechanisms like increasing insulin sensitivity, through an increase in GLUT-4 receptors in the cell membrane, enhancing insulin signaling in tissues, and increasing the utilization of glucose in exercising tissues[13,46]. Given the epidemic of obesity and type 2 diabetes globally, the benefits of exercise and increased physical activity on carbohydrate metabolism underscore its importance in preventing diabetes[13,46].

Conclusion

The crude prevalence of diabetes mellitus in this study was found to be 4.1% using the WHO 1999 criteria and 4.9 % when adjusted for age and gender. Increasing Age, familial history of diabetes, and obesity are the main risk factors associated with the development of diabetes mellitus.

Limitations of this study

One of the limitations of this study like other epidemiological studies is its cross-sectional design which makes it impossible to identify the association between diabetes and other cardiovascular risk factors. Secondly, OGTT could not be done for the entire population.

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Ethical Approval and consent

Ethical clearance was obtained from the Aminu Kano Teaching Hospital and the Kano State Ministry of Health. Written informed consent was obtained from all the participants who participated in the study. All copies of the written consent and ethical clearance are available for review by the Editor-in-Chief of this journal.

Declaration

The authors have no conflicts of interest to declare.

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Author Contributions

MAR, RAH and MB wrote the manuscript, AEU, MAR and IDG edited the manuscript, RAH, and AUA edited and reviewed the manuscript. All authors contributed equally to the preparation of the paper.

Consent for publication

All the authors have agreed to consent to the publication of the article in this journal.

Abbreviations

CPG= Casual plasma glucose; DM= Diabetes Mellitus; FPG= Fasting Plasma Glucose; HbA1c= Haemoglobin A1c.; IGT=Impaired Glucose Tolerance; OGTT=Oral Glucose Tolerance; RPG =Random Plasma Glucose; Test; Type 2 diabetes Mellitus = T2DM

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