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Abstract

**Background:** Information about diabetes mellitus (DM) from the rural populations in Nigeria, particularly among the rural Fulanis is limited.

Materials and Methods: This was a cross-sectional study conducted in two rural districts of Sokoto State in Northern Nigeria. Using a modification of the WHO STEP wise approach to surveillance (STEPS) instrument, information on sociodemographic and anthropometric data was obtained. Either a casual or fasting plasma glucose (FPG) level was obtained in all subjects while oral glucose tolerance test was performed in a randomly selected group of 50 of the study participants.

**Results:** Three hundred and ninety-three subjects participated in the study. The prevalence rates of DM, impaired fasting glycemia (IFG), and impaired glucose tolerance (IGT) were 0.8, 6.9, and 8%, respectively. The mean (SD) FPG was higher in males  $(5.1 \pm 0.6 \text{ mmol/L})$  than in females  $(4.9 \pm 0.6 \text{ mmol/l})$ , but not statistically significantly (P = 0.20). The major risk factors for DM among the rural Fulani were obesity and increasing age.

**Conclusion:** The prevalence rates of DM and its principal risk factor obesity are low among the rural Nigerian Fulani. However, the prevalence of prediabetes is relatively high, a factor that may predispose to the future development of DM.

Abstract in Spenish

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#### Résumé

**Fond :** Informations sur le diabète sucré (DM) des populations rurales au Nigéria, en particulier parmi les Fulanis rurales sont limitées.

**Matériel et méthodes** : Il s'agissait d'une étude transversale menée dans deux districts ruraux de l'état de Sokoto au Nigeria du Nord. à l'aide d'une modification de l'approche STEPwise qui à l'instrument de surveillance (étapes), informations sociodémographiques et des données anthropométriques ont été obtenues. Soit un taux de glucose (FPG) plasma occasionnels ou jeun a été obtenue chez tous les sujets, tandis que l'épreuve d'hyperglycémie provoquée par voie orale s'est déroulée dans un groupe choisi au hasard de 50 des participants à l'étude.

**Résultats :** Trois cent quatre-vingt - treize sujets ont participé à l'étude. Les taux de prévalence de DM, avec facultés affaiblies jeüne glycémie (IFG) et l'intolérance au glucose (IGT) étaient de 0,8, 6,9 et 8 %, respectivement. Le groupe des produits forestiers (SD) moyenne était plus élevée chez les mâles  $(5.1 \pm 0.6 \text{ mmol/L})$  que chez les femelles  $(4.9 \pm 0.6 \text{ mmol/l})$ , mais pas de façon statistiquement significative (P = 0.20). Les principaux facteurs de risque pour DM parmi les Peuls rurales étaient l'obésité et le vieillissement.

**Conclusion :** Le taux de prévalence de DM et son principal facteur de risque obésité est faibles chez les Peuls nigérian rural. Toutefois, la prévalence du prédiabète est relativement élevée, un facteur qui peut-être prédisposer au développement futur du DM.

Mots-clés: Diabète, glycémie jeûne altérée, avec facultés affaiblies prédiabète de tolérance, Nigeria, glucose, Peuls rural, Sokoto

**Keywords:** Diabetes mellitus, impaired fasting glycemia, impaired glucose tolerance, Nigeria, prediabetes, rural Fulani, Sokoto

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### Introduction

Diabetes mellitus (DM) and other categories of glucose intolerance, collectively referred to as dysglycemia, are associated with serious health, economic, and social consequences. <sup>[1],[2]</sup> These disorders tend to be more common in urban settlements. However, even the rural sub-Saharan Africa is at an early stage of epidemiological transition from communicable to noncommunicable diseases (NCDs) because of gradual adoption of unhealthy lifestyles characterized by increasing intake of high calorie-dense foods and physical inactivity. <sup>[3],[4],[5]</sup> DM and its complications place a more serious burden on individuals and families in rural communities where access to health services is generally poor.

Prediabetic conditions (impaired fasting glycemia (IFG) and impaired glucose tolerance (IGT)) are rarely recognized but they also carry cardiovascular risk as DM. [6],[7] The detection of prediabetic conditions offers an opportunity for primary prevention. Several studies have demonstrated that DM can be prevented in more than half of the individuals with prediabetic conditions through lifestyle modifications. [8],[9],[10]

Prevalence rates of DM in Nigeria vary from 0.6% in adult rural highland dwellers to over 7% in urban Lagos adults,

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with an average of 2.2% nationwide. <sup>[11]</sup> The rural Fulani, a major group of west Africans were not specifically included in previous studies of DM in Nigeria. A previous study showed a high prevalence of over 15% of dysglycemia in the urban Fulani population of northern Nigeria. <sup>[12]</sup> Whether the high rate of dysglycemia among urban Fulanis is of ethnic, genetic, and/or environmental origin is yet to be determined.

The aim of our study was to determine the prevalence of DM and its risk factors in rural Fulani ethnic group of northern Nigeria in west Africa.

Materials and Methods

#### **Study area**

The study was conducted among a rural Fulani community in Wamakko Local Government area of Sokoto state in the Sudan savannah zone of north-western Nigeria. The population of Wamakko local government was estimated to be 232,846 people based on 2006 population census figures. <sup>[13]</sup> Most inhabitants are Muslim Fulanis and Hausas.

#### **Participants and sample size**

Using a multistage sampling technique, two rural districts of Gumbi and Wamakko in Sokoto State were selected. Four hundred participants were administered the study questionnaire and then invited to a designated location for further evaluation. Trained research assistants consisting of doctors, medical students, and laboratory technologists administered the questionnaires and obtained measurements including collection of blood samples.

Consent and permission were duly obtained from all the participants and local authority concerned, respectively. The research protocol was approved by the Ethics Committee of the Usmanu Danfodiyo University Teaching Hospital,

Sokoto.

## **Study procedure**

The study procedure was based on a modification of the WHO STEPwise approach to surveillance (STEPS) instrument for surveillance of risk factors for NCD. <sup>[14]</sup> The interviewer-administered questionnaire obtained demographic, lifestyle, and diet data as well as family history of DM and systemic hypertension. Physical measurements were made following the standard STEPS guidelines. <sup>[14]</sup> These included weight (to the nearest 0.1 kg) and height, waist and hip circumference to the nearest millimeter. Body mass index (BMI) and waist hip ratio (WHR) were appropriately derived. Blood pressure was recorded using WHO guidelines. <sup>[14]</sup> Blood for assessment of fasting levels of glucose was obtained in 204 subjects and casual blood glucose in 189 subjects. Fifty of the participants were randomly selected from the study group for administration of an oral glucose tolerance test (OGTT) using standard procedures. <sup>[2]</sup> Plasma glucose concentration was determined by glucose oxidase technique of Trinder. <sup>[15]</sup>

# **Operational definitions**

Participants were diagnosed to have DM if they had fasting plasma glucose level (FPG)  $\geq$  7 mmol/l or casual plasma glucose level (CPG)  $\geq$  11.1 mmol/L. <sup>[2]</sup> Subjects with impaired fasting glycemia (IFG) were defined by FPG ranging from 6.1 to 6.9 mmol/L. Subjects with IGT were defined by normal FPG with 2 h post-glucose load ranging from 7.8 to 11.0 mmol/L. Subjects found to have DM, IFG, or IGT were regarded to have dysglycemia. Overweight and generalized obesity were defined as BMI  $\geq$  25 and 30 kg/m<sup>2</sup>, respectively. Abdominal obesity was defined as waist circumference of  $\geq$  102 cm in men and  $\geq$  88 cm in women. <sup>[16]</sup> Systemic hypertension was defined as systolic blood pressure  $\geq$  140 mmHg and/or diastolic blood pressure  $\geq$  90 mmHg or being on pharmacological treatment for systemic hypertension. <sup>[17]</sup>

### Data management and statistical analysis

Statistical analysis was performed using Epi-Info version 3.3.4. Results are expressed as either mean values (standard deviation) or proportions, and comparison for statistical significance was by *t*-test for continuous variables or Chi-square analysis for categorical variables. The level of significance was set at  $P \le 0.05$ .

# Results

Three hundred and ninety-three of the 400 subjects selected for the study, participated in the survey giving a response rate of 98.3%. Two hundred and ten (53.4%) males and 183 (46.6%) females took part in the study. There was no significant difference between the proportions of males and females who responded ( $\chi^2 = 0.01, P = 0.91$ ). The mean (SD) age of the sample population was 38.5 ± 14.2 years with the males (40.3 ± 13.9 years) being significantly older than the females (36.5 ± 13.0 years); P < 0.05.

# Anthropometric and blood pressure measurements

[Table 1] shows a summary of anthropometric and blood pressure values of participants. The males had significantly higher mean weight, height, and WHR while the women had higher mean BMI and blood pressure.



Table 1: Anthropometric and blood pressure characteristics of participants by gender

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 SBP (mmHg)
 126.9 (13.0)
 125.7 (11.9)
 128.4 (14.0)
 0.04

 DBP (mmHg)
 77.9 (9.7)
 76.1 (9.4)
 80.1 (9.7)
 0.001

 BMI-Body mass index, DBP=Diastolic blood pressure,
 SBP=Systolic blood pressure,
 WC+Waist circumference,

 WHR-Waist/hip ratio, SD=Standard deviation
 SD=Standard deviation
 SD
 Standard deviation



#### Plasma glucose levels of participants

[Table 2] shows a summary of plasma glucose values of the participants obtained in fasting state, casually or 2 hours after a load of 75 g of anhydrous glucose. There were no significant sex differences in the blood glucose values (P > 0.05).

Type of glycemia	Mean (SD) mmol/l			P value
(number)	All	Male	Female	
FPG (204)	5.0 (0.6)	5.1 (0.6)	4.9 (0.6)	0.20
CPG (189)	6.8 (1.6)	6.9 (1.5)	6.6 (1.6)	0.40
2hop (EO)	63(10)	6.5 (1.0)	6.2 (1.1)	0.32

Table 2: Mean plasma glucose values of the participants

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# Pattern of dysglycemia

Of the 393 participants studied, three had type 2 DM giving a prevalence rate of 0.8%. Fourteen (6.9%) participants had IFG. Of the 50 subjects who had OGTT, four (8%) had IGT.

The overall prevalence of dysglycemia was therefore 7.7% (using DM + IFG (0.8% + 6.9%) or 8.8% (using DM + IGT (0.8% + 8.0%). The distribution of the subjects by glycemic status is summarized in the [Table 3].

Glycemic status	Number of subjects (%)				
	All	Males	Females	P value	
NGT (393)	376 (95.7)	200 (95.2)	176 (96.2)	0.76	
IFG	14 (6.9)	9 (8.8)	5 (4.9)	0.56	
Diabetes mellitus	3 (0.8)	1 (0.3)	2 (0.5)	0.72	
Dysglycemia	21 (5.4)	12 (3.1)	9 (2.3)	0.69	

Table 3: Distribution of the subjects by glycemic status and gender

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There was no significant difference between proportions of males and females according to glycemic status ( $\chi^2 = 0.92, P = 0.73$ ).

#### **Risk factors for type 2 diabetes mellitus**

[Table 4] shows the distribution of participants by sex and prevalence of risk factors for type 2 DM.

Risk factor	Number (%)			
(criterion)	All	Female	Male	P value
Central obesity	21 (5.4)	19 (10.4)	2 (1.0)	0.035
Obesity (BMI)	8 (2.0)	7 (3.8)	1 (0.5)	0.003
Overweight	51 (13)	19 (10.4)	32 (15.7)	0.058
Cigarette smoking	38 (9.7)	0 (0)	38 (18.1)	0.001
Alcohol intake	1 (0.3)	0 (0)	1 (0.5)	0.001
Family history	0 (0)	0 (0)	0 (0)	1.00

Table 4: Distribution of participants by gender and risk factors for type 2 diabetes mellitus

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The overall prevalence of obesity as measured by BMI was 2%, while central obesity was 5.4%. The mean (SD) WC of subjects with dysglycemia was higher than that in subjects with normoglycemia ( $80.9 \pm 9.7$  cm vs 78.5 ± 8.6 cm) but was not statistically significant (P = 0.33). The mean (SD) BMI of subjects with dysglycemia ( $22.4 \pm 3.4$  kg/m<sup>2</sup>) was higher than in subjects with normoglycemia ( $21.9 \pm 3.1$  kg/m<sup>2</sup>); P = 0.57. Of the subjects with dysglycemia, six (28.6%) had central obesity, two (9.5%) global obesity, five (23.8%) overweight, and two (9.5%) were underweight.

Cigarette smoking and alcohol intake: Thirty eight (9.7%) subjects had history of cigarette smoking. Of the subjects with dysglycemia, 19% had history of cigarette smoking. All the participants who smoked cigarette were males. Only one man admitted to a history of alcohol ingestion.

#### Relationship of dysglycemia to age and blood pressure

The mean (SD) age of subjects with dysglycemia of  $44.8 \pm 13.6$  years was significantly higher than that of those with normoglycemia ( $38.3 \pm 13.5$  years); P = 0.04. Of the subjects with dysglycemia, 18 (85.6%) were over the age of 40 years of which ten (47.6%) were males and eight (38%) females.

The mean (SD) systolic  $(141 \pm 25.2 \text{ mmHg})$  and diastolic  $(82.9 \pm 13.3 \text{ mmHg})$  blood pressures of subjects with dysglycemia were also significantly higher than the systolic  $126.4 \pm 12.0 \text{ mmHg}$  and diastolic  $77.8 \pm 9.5 \text{ mmHg}$  pressures in subjects with normoglycemia (P = 0.02 and 0.03, respectively). Of the subjects with dysglycemia, eight (38.1%) had systemic hypertension of which three (14.3%) were males and five (23.8%) females.

#### Discussion

The aim of our study was to determine the prevalence of DM, prediabetes, and its risk factors among the Fulanis living in a rural area of Northern Nigeria in West Africa. Previous reports have indicated that glucose intolerance is common among urban counterparts of the rural Fulanis of Northern Nigeria. <sup>[12]</sup>

# Prevalence of dysglycemia among rural Fulani

In this study, there was a low prevalence of DM of 0.8% among the rural Fulanis. Reports on prevalence of DM among the same Fulani ethnic group who have settled in an urban environment showed a prevalence of 4.6% much higher than our present finding among the rural group. <sup>[12]</sup> The low prevalence of DM among rural dwellers could be attributed to the more traditional lifestyle which depends on animal husbandry and subsistence economy. The low prevalence of DM in this rural community is in keeping with other reports that show that in spite of the DM pandemic, most traditional rural communities still exhibit a low prevalence of DM. <sup>[6],[18],[19],[20]</sup> The high prevalence of DM in the urban community could be attributed to the increased risk factors for DM (obesity, cigarette smoking) found in the urban community associated with modernization. <sup>[12]</sup>

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### **Prevalence of prediabetes**

In this study, there was a relatively high prevalence of prediabetes defined as IFG or IGT. The prevalence rates of IGT and IFG were 8 and 6.9%, respectively. This relatively high prevalence of IGT is similar to International Diabetes Federation estimates of about 8% prevalence rate for IGT in Nigeria <sup>[6]</sup> and that reported for northern Sudan. <sup>[21]</sup> Our previous study carried out among urbanized Fulani showed a prevalence of 14.6% of IGT <sup>[12]</sup> which is higher than our present finding but is in keeping with other studies. <sup>[22],[23]</sup> However, Ramachandra <sup>[24]</sup> in India found no significant urban-rural difference in the prevalence of IGT (8.7 and 7.8%, respectively) probably due to rapid conversion of IGT to DM in the urban community.

#### **Rural-urban differences**

Place of residence is a major determinant of DM in sub-Saharan Africa with urban residents having higher prevalence of DM than their rural counterparts. In low and middle income countries, the number of people with DM in urban areas is 172 million, while 119 million live in rural areas. <sup>[6]</sup> By 2030 the difference is expected to widen with 314 million people living in urban areas and 143 million in rural areas. <sup>[6]</sup> This is attributable to lifestyle changes associated with urbanization. Urban lifestyle in Africa is characterized by changes in dietary habits involving an increase in the consumption of refined sugars, saturated fat, and reduction in fiber intake. <sup>[4]</sup> Urbanization tends to decrease physical activity as very little physical activity is required for daily living whereas rural populations rely on foot walk as

transportation means and often have intense agricultural activities as their main occupation. The low prevalence of DM mellitus in rural community is in keeping with other works that show traditional rural communities still have low prevalence of DM. Bakari *et al.*, <sup>[19]</sup> found the prevalence of 1.6% in a suburban Northern Nigerian city and Erasmus et al., <sup>[20]</sup> found a prevalence of 1.4% in a rural population of Kwara state, Nigeria. The study of prevalence of type 2 DM in Pima Indians in Mexico and the USA presents a striking example of the variation in prevalence of type 2 DM found in populations of similar genetic background but in different environmental circumstances. <sup>[22]</sup> The much lower prevalence of type 2 DM and obesity in Pima Indians in Mexico than in the USA indicates that even in a population genetically prone to these conditions, the development of DM is determined mostly by environmental circumstances.

#### Prevalence of risk factors for dysglycemia

Obesity is a common risk factor for type 2 DM and other disorders. <sup>[25]</sup> In this study, the prevalence rate of obesity using BMI or waist circumference cut-offs was low among the rural Fulanis at 2 and 5%, respectively. However even among the rural peoplestudied, abdominal obesity using waist circumference and global obesity using BMI in subjects with dysglycemia were higher than in subjects with normoglycemia. A previous report showed a high prevalence of obesity in the urban Fulani population of Northern Nigeria as compared to the present study of rural Fulanis. A similar pattern was reported by others. <sup>[22],[26]</sup>

Advancing age was an identified risk factor for DM among rural Fulanis, DM being more prevalent in subjects aged 40 years and above. This finding is in keeping with report of the national survey on NCDs in Nigeria that found a significant rise in prevalence of DM with age, with the risk of DM increasing three to four-folds after the age of 44 years. <sup>[11]</sup>

Limitations of study: This study was a cross-sectional one, a research design which does not provide evidence for causal relationships to be made between risk factors and DM. Some important risk factors for DM such as insulin resistance and lipids were not studied.

#### Conclusion

The results of this study clearly support the hypothesis that urbanization is strongly associated with the development of DM and some other NCDs. While the prevalence of DM is low among these traditional Fulanis, the prevalence of prediabetes is relatively high, a factor that may influence future development of DM especially on moving to a city. The reason for this high rate of prediabetes remains unclear and deserves further study. The prevalence rates of dysglycemia and its risk factors are much lower in the rural Fulanis than that reported previously for the urban Fulanis. This study highlights the potential influence of urbanization on the occurrence of DM: A big contrast between urban and rural communities.

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### Tables

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[Table 1], [Table 2], [Table 3], [Table 4]

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