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ORIGINAL ARTICLE

PREVALENCE OF DIABETES MELLITUS AND IMPAIRED FASTING GLUCOSE AMONG RESIDENTS IN A RURAL COMMUNITY IN SOUTH-SOUTH NIGERIA

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Keywords

Diabetes Mellitus,
Impaired Glucose,
Rural
Community,
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Abstract

Background: Diabetes mellitus and impaired glucose tolerance have become significant global health issues. This study aimed to determine the prevalence of diabetes mellitus (DM) and impaired glucose tolerance (IGT) in a rural community in Edo State.

Methods: This cross-sectional study was conducted on 310 residents of Irrua, Esan Central Local Government Area, Edo State, from February to October 2023. The respondents were selected using a multi-stage sampling method. Using the modified WHO STEPS tool for chronic diseases, anthropometric measurements and standard glucose level assessments were performed in stages, and data were analyzed with IBM SPSS version 22.0. Logistic regression was used to identify predictors of glucose intolerance, with a p-value of <0.05 indicating statistical significance. Ethical approval was obtained for the study.

Results: Out of 310 recruited for the study, 206 (66.5%) were females. The mean (SD) age of the participants was 58.9 ($\pm$ 13.5) years. The prevalence of impaired fasting glucose was 1.3% (Males, 1.0%; females, 1.4%). The overall prevalence of diabetes mellitus (DM) was 10.3%. Females had a higher rate of DM than males (13.6% vs. 3.8%), a statistically significant difference ($p = 0.008$). Factors associated with glucose intolerance included increased weight (OR=0.929, CI=0.883-0.978), body mass index (OR=1.195, CI=1.064-0.343), waist circumference (OR=2.401, CI=1.025-5.622), and alcohol consumption (OR=0.399, CI=0.183-0.870).

Conclusion: A greater number of females were diagnosed with DM in the study. Health authorities should promote health-promoting and disease prevention initiatives that focus on healthy lifestyles and dietary habits, with particular emphasis on women.

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INTRODUCTION

Diabetes Mellitus (DM) has become one of the most critical chronic conditions of public health importance in the world.¹ This condition is preceded by impaired fasting glucose (IFG) or impaired glucose tolerance (IGT), commonly referred to as the pre-diabetic states.² The global DM prevalence increased from 4.3% in 1980 to 9.0% in 2014 in men and from 5.0% to 7.9% in women.³ Current global estimates by the International Diabetes Federation (IDF) reveal a prevalence of 10.5% in 2021 and a projected figure as high as 12.2% in 2045. Up to 46.5% of persons with DM remain undiagnosed, and most of them live in low and middle-income countries.⁴ The global cost of DM was estimated to be \$ 1.31 trillion, or 1.8% of the global gross domestic product (GDP), in 2015.⁵ Socioeconomic difficulties and a reduction in life expectancy are associated with the worsening health conditions of DM and the effect of DM is notably worse in low and middle-income countries.⁶ There is indeed increasing evidence to show variations in the prevalence of DM between urban and rural populations, and between the higher and lower socioeconomic groups. Whereas DM is higher in the lower socioeconomic group in the developed countries, it is apparently higher among the top socioeconomic group in developing countries. These differences are often attributed to varying lifestyles.^{7,8} In addition, epidemiological research shows that DM and all other conditions of glucose intolerance and hypertension are interrelated, with each predisposing to atherosclerotic cardiovascular disease, and that approximately 15 – 18% of hypertensive patients are said to have impaired glucose tolerance.⁹ Nigeria is one of the 48 countries in the IDF African region, and 25 million people within this region have been reported to have diabetes, out of 589 million people with the condition worldwide.⁴ Furthermore, in Nigeria, up to 3.9 million adults lived with diabetes in 2019, and this has been projected to almost double

(6.0million) by 2045.¹⁰ In addition, the prevalence of DM and IGT in Nigeria varies by ethnicity and geographical location, being higher in the Southern urban region than in the predominantly rural northern region.⁷ Generally, the nation's rapid urbanization, which promotes more sedentary lifestyles and poor eating habits, is one of the main risk factors for DM. This risk is significantly increased by the higher intake of processed foods, sugary drinks, and high-calorie meals among Nigerians who migrate to cities.¹¹ This issue is further worsened by the transition from traditional diets high in fruits, vegetables, and whole grains to more westernised diets that are low in nutrients.¹¹ The prevalence of obesity in the nation has been steadily increasing as a result of bad eating habits, restricted access to physical activity, especially in cities, and a lack of knowledge about the dangers of obesity. Other risk factors include smoking and high alcohol intake, lack of recreation and sports, as well as air and noise pollution.^{6,11,12} This study assessed the prevalence of impaired fasting glucose and DM, along with the associated risk factors, among residents of the Esan Central Local Government Area in Edo State.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted in the Esan Central Local Government Area of Edo State between February and October 2023. The local government area is divided into ten administrative wards, with each ward comprising between three and four villages. This population is currently projected to be approximately 130,584 persons, based on an annual growth rate of 3.18%.¹³ Three hundred ten (310) rural dwellers, aged between 18 and 75 years and residing in the study area for at least 6 months, were included in the study. Pregnant women, non-consenting subjects, and breastfeeding mothers were excluded. The minimum sample size for this study was determined using Cochran's formula,¹⁴ for the determination of minimum sample size in a cross-sectional study when the sample population is greater than 10000:

Table 1: Socio-Demographic Characteristics of Respondents

Variables	Frequency (n=310)	Percentage (%)
Age Group (Years)		
20-29	4	(1.3)
30-39	21	(6.8)
40-49	44	(14.2)
50-59	78	(25.2)
60-69	89	(28.7)
≥70	74	(23.8)
Total	310	(100.0)
Mean age	58.9±13.5	
Sex		
Male	104	(33.5)
Female	206	(66.5)
Total	310	(100.0)
Tribe		
Ishan	307	(99.0)
Igbo	3	(1.0)
Total	310	(100.0)
Occupation		
Civil servant	19	(6.1)
Farming	191	(61.6)
Pensioner	13	(4.2)
Trader	41	(13.2)
Unemployed	25	(8.1)
Others (doctors, driving etc)	21	(6.8)
Total	310	(100.0)

Thus: $N = Z^2pq/d^2$

Using a prevalence of 23.6% from a previous study¹⁵

$n = 276.8$.

Considering an attrition rate of 10%, a minimum sample size of 310 was calculated.

Multi-stage sampling was used to select participants during this study. The first stage involved selecting five wards from the ten wards that comprise the local government area using simple random sampling. The second stage also involved selecting two communities from each ward using simple random sampling.

Then, two quarters were selected from each community as clusters, using simple random sampling. Thus, at least thirty-one households were selected from each community.

DATA COLLECTION

Trained Medical doctors and medical students from Ambrose Alli University, Ekpoma were responsible for data collection. The research procedure was based on the modified WHO STEPS instrument. This involves a simple, standardised method for collecting, analysing, and disseminating data on chronic disease risk factors in member

countries. The information obtained using the WHO STEPS questionnaire included demographic characteristics, diet, lifestyle, and family history of diabetes and hypertension.¹⁶ Anthropometric measurements, such as weight, height, waist circumference (WC), and hip circumference (HC), were recorded for all participants. The body mass index (BMI) and waist-to-hip ratio (WHR) were derived from the measured variables. Weight was measured and recorded in kilograms to the nearest 0.1kg, and height was measured while the subject was standing upright and recorded to the nearest 0.01m.¹⁷ The waist circumference was measured at a point midway between the inferior border of the rib cage and the iliac crest. The hip circumference was measured at the level of the maximal gluteal circumference. All participants underwent both fasting plasma glucose and oral glucose tolerance tests; while fasting plasma insulin was measured for 155 participants who were selected using a systematic sampling method.

Oral Glucose Tolerance Test: Participants were instructed to fast for 8-14 hours before testing. Baseline fasting venous blood was collected from

Table 1b: Socio-Demographic Characteristics of Respondents

Variables	Frequency (n=310)	Percentage (%)
Level Of Education		
None	83	(26.8)
Primary	162	(52.3)
Secondary	48	(15.4)
Post sec	8	(2.6)
University	9	(2.9)
Total	310	(100.0)
Marital Status		
Married	216	(69.7)
Separated	4	(1.3)
Single	6	(1.9)
Widow	76	(24.5)
Widower	8	(2.6)
Total	310	(100.0)

the subject's cubital fossa and put into a fluoride oxalate bottle. Seventy-five grams of anhydrous glucose was dissolved in 250 mL of water and administered to the participants. Another blood sample was taken two hours later for the assessment of plasma glucose using the glucose oxidase method. Plasma glucose measurement was also carried out using the glucose oxidase method.¹⁷ The data obtained from this study were analysed with IBM SPSS version 22.0. The student's t-test was used to compare the means of two groups, while the association between categorical variables was done using the Chi-square test. The test of association between quantitative variables was determined using Pearson's correlation coefficient, and the association of risk factors for glucose intolerance was tested using logistic regression. A p-value of <0.05 was taken as statistically significant.

ETHICAL APPROVAL

The Research and Ethics Committee of the Irrua Specialist Teaching Hospital, Irrua, granted ethical approval (ADM/PERS/4/VOL.1/76). Respondents provided written informed consent, and their participation was voluntary. They were assured of confidentiality by using initials rather than names

during data collection. The study protocol conformed to the Helsinki Declaration.

RESULTS

There were 310 participants in the study. This comprised 104 (33.5%) males and 206 (66.5%) females, with a female-to-male ratio of 2:1. Most of the respondents (28.7%) were between the ages of 60 and 69 years, with a mean (SD) age of 58.9 (13.5) years. The mean (SD) ages for males and females were 59.1 (12.3) and 58.1 (14.1) years, respectively, with no statistically significant difference ($p = 0.8$). Two hundred sixteen participants (69.7%) were married, while 114 (36.1%) were single. Most subjects (99%) belonged to the local Ishan ethnic group. Most of the subjects [189 (61.6%)] were farmers. Most respondents (52.3%) had a primary level of education, while a small number (2.9%) had a university level of education. Respondents above 70 years of age had the highest frequency of both components of glucose intolerance. None of the respondents between the ages of 20 and 29 years had DM. (Figure 1). Tale 2 shows the frequency and sex distribution of the glucose intolerance spectrum. The prevalence of impaired fasting glucose 9IFG) was 1.3% (Males 1% ; females 1.4%). Impaired glucose tolerance was more frequently observed in males (15.4% vs. 12.6% in

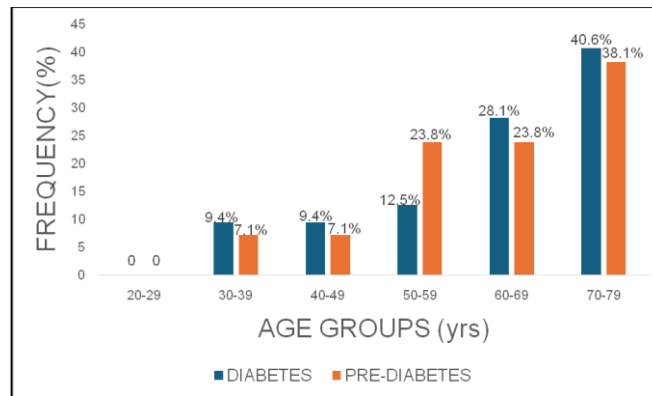


Figure 1: Age Distribution of Glucose Intolerance.

females), with a total prevalence of 13.5%. More females had diabetes mellitus than males (13.6% vs. 3.8%), a statistically significant difference ($p = 0.008$). The overall prevalence of DM was 10.3%. The prevalence of dysglycemia was 23.5%, with frequencies of 18.3% and 26.2% in males and females, respectively. Table 3 shows the risk factors for glucose intolerance. Increasing weight [Odd ratio (OR)=0.929, CI=0.883-0.978], body mass index (OR=1.195, CI=1.064-0.343), waist circumference (OR=2.401, CI=1.025-5.622), and alcohol consumption (OR=0.399, CI=0.183-0.870) were found to be predictors/risk factors for glucose intolerance. Table 4 presents the frequency of risk factors associated with glucose intolerance. The frequency of glucose intolerance increased with age, with those above seventy years of age having the highest frequency. None of the respondents in the 20-29 age group had glucose intolerance.

Half of the respondents with glucose intolerance had normal BMI, while 31% were overweight. Central obesity, assessed using waist circumference, was present in 50% of respondents. Sixteen (38.1%) of respondents drank alcohol. A respondent with glucose intolerance smoked a cigarette. A female respondent with glucose intolerance had a family history of diabetes.

DISCUSSION

Glucose intolerance is associated with serious health, economic and social consequences. This

cross-sectional analytical study assessed the prevalence of impaired glucose tolerance and DM and the risk factors among residents of the Esan Central Local Government Area of Edo State. The prevalence of IFG in this study was 1.3%, similar to the 1.7% reported by researchers from Northern Nigeria.¹⁸ It was, however, lower than the 8.8% and 9.2% reported in Southeast and Southwest Nigeria, respectively.^{7, 19}

Additionally, it was less than 7.6%, as reported by researchers from China.²⁰ The low prevalence of IGF obtained in this study may not be unrelated to the rural nature of the study setting. This, no doubt, may have influenced the adoption of non-sedentary lifestyles, and the intake of traditional complex carbohydrates and high-energy diets is common among inhabitants in rural settings.^{6, 21} This study also revealed a slight female preponderance (1.4% vs 1.0%) in terms of IFG. This finding is similar to a previous report from Northwest Nigeria.²² Where the IFG for females was (5.9 ± 1.2 mmol/L) compared to (5.8 ± 2.5 mmol/L) for males. It also corroborates another report from Southeast Nigeria,²³ with an IFG of 1.6% for females compared to 0.6% for males. However, it was at variance with another report from Calabar, with a male preponderance (9.8% in men and 6.7% in females).⁷ This observation may be due to hormonal differences between males and females.²⁴

Table 2- Sex Distribution of Prevalence of Glucose Intolerance

	SEX			χ^2	p-value	
	Male n (%)	Female n (%)	Total n (%)			
Impaired Fasting Glucose						
Absent	103(99.0)	205(99.5)	308	(99.4)	0.244	0.621
Present	1 (1.0)	1 (5.0)	2 (6)			
Total	104 (100.0)	206 (100.0)	310	(100.0)		
Impaired Glucose Tolerance						
Absent	88(84.6)	180 (87.4)	268	(86.5)	0.451	0.502
Present	16(15.4)	26 (12.6)	42	(13.5)		
Total	104 (100.0)	206 (100.0)	310	(100.0)		
Isolated IFG						
Absent	102(98.1)	205 (99.5)	307	(99.0)	0.338	0.561
Present	2 (1.9)	1 (0.5)	3	(1.0)		
Total	104 (100.0)	206 (100.0)	310	(100.0)		
Isolated IGT						
Absent	89 (85.6)	181(87.9)	270	(87.1)	0.322	0.571
Present	15 (14.4)	25 (12.1)	40	(12.9)		
Total	104 (100.0)	206 (100.0)	310	(100.0)		
Combined IFG/IGT						
Absent	103 (99.0)	205 (99.5)	308	(99.4)	0.244	0.621
Present	1(1.0)	1 (0.5)	2	(.6)		
Total	104(100.0)	206 (100.0)	310	(100.0)		
Diabetes Mellitus						
Absent	100 (96.2)	178 (86.4)	278	(89.7)	7.091	0.008*
Present	4 (3.8)	28 (13.6)	32	(10.3)		
Total	104 (100.0)	206 (100.0)	310	(100.0)		

*Significant

It may also be due to the disproportionately larger visceral adipose tissue among females.²⁵ In this study, slightly over one-tenth of the respondents were shown to have DM. This value includes 9.7% of undiagnosed cases, revealing a significantly high number of undiagnosed diabetes cases. This prevalence is consistent with a previous report by the IDF that two-thirds of persons with DM in developing countries are undiagnosed.⁴ In terms of the overall prevalence of DM, it was higher than the national average figure of 5.77% in Nigeria.²⁶ This value may be a reflection of the poor health-seeking behaviour of people in the study area. The prevalence of DM obtained in this study is higher than previous reports from Southeast Nigeria.^{19, 27} However, significantly higher values have been reported from South Africa.²⁸

From this study, the determinants of glucose intolerance included: increasing body weight, BMI, WC and alcohol consumption. Increasing body weight, which is closely associated with rising BMI, appears to be on the rise in developing countries.²⁹ This study has revealed that increasing BMI is one of the predictors of DM (OR = 1.195, CI = 1.064-0.343). Similar findings had been reported in previous studies in Nigeria, where BMI and age were reported as predictors for DM;²² and Sub-Saharan Africa,²⁸ where BMI, waist circumference and waist-hip ratio were identified as significant predictors for DM. However, contrasting reports by scientists from Northern Germany suggest that underweight individuals were significantly at a higher risk of glucose intolerance.³⁰

Table 3: Risk Factors for Glucose Intolerance

Variable		OR (95% CI)	p-value
AGE	1.014	(0.986 - 1.042)	0.337
WT	0.929	(0.883 - 0.978)	0.005
BMI	1.195	(1.064 - 0.343)	0.003
WC	2.401	(1.025 - 5.622)	0.044
WHR	0.050	(0.000 -183.83)	0.474
SMOKING	0.683	(0.133 - 3.518)	0.649
ALCOHOL	0.399	(0.183 - 0.870)	0.021
FAMHXDM (1)	1.416	(0.127 - 15.81)	0.777
HTN	0.000	(0.000 - 0.000)	0.999
SED	1.446	(0.645 - 3.25)	0.371
LIFESTYLE			

WT: weight, BMI: body mass index, WC: waist circumference, WHR: waist-hip ratio, FHXDM: family history of diabetes mellitus, HTN: hypertension, SED: sedentary.

Moreover, this study revealed that WC was also a determinant of increased glucose intolerance (OR = 2.401, CI = 1.025-5.622). This is particularly important because of the increasing use of WC as an anthropometric measure. Indeed, this finding is corroborated by a previous result in Nigeria, where age, BMI, WC and systolic hypertension were shown to be significantly associated with DM and another report from the Republic of Nauru, where WC was stated as a predictor of diabetes (OR: 1.04, 95% CI: 1.02, 1.07).^{11, 31} However, this was not in keeping with reports from Addis Ababa, where hypertension, BMI and waist-hip ratio were found to be associated with impaired fasting glucose.³² One possible explanation for this finding on the link between WC and glucose intolerance is that abdominal obesity is closely tied to glucose intolerance, and WC is a key indicator of abdominal obesity.²⁵ Furthermore, this study demonstrates that an increase in alcohol consumption was significantly associated with glucose intolerance (OR = 0.399, CI = 0.183-0.870). This is in keeping with a previous report by researchers in China, who reported that high intake of alcohol was significantly associated with type 2 DM (OR=1.29,

CI=1.06-1.57).³³ However, a study conducted in Cameroon found no link between alcohol and glucose levels intolerance.²⁴ The identified determinants of glucose intolerance in this study are modifiable risk factors that could be mitigated through health education and health promotion.

CONCLUSION

Impaired glucose tolerance and DM values were lower than those from other parts of Nigeria. The risk factors for glucose intolerance were increasing weight, body mass index, waist circumference and high alcohol consumption. Health authorities should actively encourage health-promoting and disease-preventing initiatives that focus on lifestyles and dietary habits, with particular emphasis on females.

STRENGTHS AND LIMITATIONS OF THE STUDY

The study used standard measurement procedures to obtain data from participants. The sample size for the study was reasonably large, which enhanced the study's power. Although some participants were uncooperative during the invasive procedures, the projected 10% attrition may compensate for this deficit.

Table 4A: Frequency Distribution of Risk Factors for Pre-Diabetes

GLUCOSE INTOLERANCE						
Variable	Yes		No		Total	
	n	(%)	N	(%)	n	(%)
Age Group						
20-29	0	(.0)	4	(1.5)	4	(1.3)
30-39	3	(7.1)	18	(6.7)	21	(6.8)
40-49	3	(7.1)	41	(15.3)	44	(14.2)
50-59	10	(23.8)	68	(25.4)	78	(25.2)
60-69	10	(23.8)	79	(29.5)	89	(28.7)
≥70	16	(38.1)	58	(21.6)	74	(23.9)
BMI						
<18.5	2	(4.8)	6	(2.2)	8	(2.6)
18.5-24.9	21	(50.0)	154	(57.5)	175	(56.5)
25-29.9	13	(31.0)	70	(26.1)	83	(26.8)
≥30	6	(14.3)	38	(14.2)	44	(14.2)
Central Obesity						
Present	21	(50.0)	87	(32.5)	108	(34.8)
Absent	21	(50.0)	181	(67.5)	202	(65.2)
Waist-Hip Ratio						
Present	6	(14.3)	28	(10.4)	34	(11.0)
Absent	36	(85.7)	240	(89.6)	276	(89.0)
HHTN						
Yes	0	(.0)	13	(4.9)	13	(4.2)
No	42	(100.0)	255	(95.1)	297	(95.8)

IMPLICATIONS FOR POLICY AND FUTURE RESEARCH

The rising prevalence of DM calls for urgent policies for the prevention and control of DM, especially among the middle-aged and elderly in society. Future research should focus on understanding the underlying factors contributing to the disease burden and evaluating the effectiveness of interventions in this specific context.

DATA AVAILABILITY

The data supporting this study's findings are available from the Department of Internal Medicine, Ambrose Alli University, Ekpoma, Edo State, Nigeria. The data are also available from the authors upon reasonable request, provided the

permission of the Department of Internal Medicine, Ambrose Alli University, Ekpoma, Edo State, Nigeria has been obtained.

CONFLICT OF INTEREST

No conflicts of interest

ACKNOWLEDGMENT

We are grateful to the respondents who voluntarily participated in this study.

SPECIFIC AUTHOR CONTRIBUTIONS

AP and FA conceived and designed the study proposal; AI, AE and AP supervised the data collection; AP collected the data; AI analysed the data; and AP, FA, and AI interpreted the data, drafted the manuscript, substantively revised it, and approved the submitted version.

Table 4B: Frequency Distribution of Risk Factors for Pre-Diabetes

GLUCOSE INTOLERANCE						
Variable	Yes		No		Total	
	n	(%)	N	(%)	n	(%)
Alcohol						
No	26	(61.9)	192	(71.6)	218	(70.3)
Yes	16	(38.1)	76	(28.4)	92	(29.7)
Smoking						
No	40	(95.2)	258	(96.3)	298	(96.1)
Yes	2	(4.8)	10	(3.7)	12	(3.9)
FHDM						
Yes	1	(2.4)	6	(2.2)	7	(2.3)
No	41	(97.6)	262	(97.8)	303	(97.7)
Physical Activity						
Yes	32	(76.2)	194	(72.4)	226	(72.9)
No	10	(23.8)	74	(27.6)	84	(27.1)
Fruit Consumption						
Low	37	(97.4)	222	(95.3)	259	(95.6)
High	1	(2.6)	11	(4.7)	12	(4.4)
Vegetable Consumption						
Low	38	(100.0)	234	(99.6)	272	(99.6)
High	0	(.0)	1	(.4)	1	(.4)

χ^2 : Chi-square.

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