

## Original Research Article

# Prevalence and determinants of type 2 diabetes mellitus among adults in rural communities of Rivers State, Nigeria

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## ABSTRACT

**Background:** Type 2 diabetes mellitus (T2DM) is increasingly recognized in rural populations, yet data on prevalence and determinants in rural communities in Rivers State, Nigeria, remain limited. Understanding these factors is essential for planning targeted interventions. This study determined the prevalence and independent determinants of T2DM among adults.

**Methods:** A community-based cross-sectional study was conducted between March and September 2025 among 602 adults aged  $\geq 18$  years in nine rural communities across three rural Local Government Areas. Multistage probability sampling selected households and one eligible adult per household. Data on sociodemographic characteristics, lifestyle behaviours, and family history were collected using a pretested WHO STEPwise questionnaire. Anthropometry, blood pressure, and fasting blood glucose were measured using standard protocols. Internal consistency was assessed using Cronbach's alpha. Descriptive statistics, bivariate analysis, and multivariable logistic regression were performed. Model diagnostics included multicollinearity assessment, Hosmer-Lemeshow goodness-of-fit, and receiver operating characteristic curve analysis.

**Results:** Prevalence of T2DM was 9.3%, with 41.1% previously undiagnosed. Age  $\geq 45$  years (AOR=3.12; 95% CI: 1.68–5.78), obesity (AOR=2.84; 95% CI: 1.49–5.42), physical inactivity (AOR=2.17; 95% CI: 1.16–4.05), hypertension (AOR=2.63; 95% CI: 1.38–5.02), and family history of diabetes (AOR=3.41; 95% CI: 1.72–6.78) were independently associated with T2DM. The model demonstrated good fit (Hosmer-Lemeshow  $p=0.64$ ) and discrimination (ROC=0.78).

**Conclusions:** T2DM is prevalent in rural communities of Rivers State, with undiagnosed cases common. Modifiable and non-modifiable factors predict T2DM, supporting screening and lifestyle interventions.

**Keywords:** Determinants, Prevalence, Rivers State, Rural communities, Type 2 diabetes mellitus

## INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a major non-communicable disease that significantly contributes to morbidity and mortality worldwide, with prevalence steadily rising in both urban and rural populations.<sup>1</sup> Globally, over 537 million adults were estimated to be living with diabetes in 2021, and projections suggest this number could surpass 640 million by 2030 if current trends continue.<sup>2</sup> T2DM represents not only a clinical

concern but also a substantial public health and socioeconomic burden, as it is associated with complications such as cardiovascular disease, nephropathy, retinopathy, and neuropathy, which can severely affect quality of life.

In sub-Saharan Africa, the prevalence of T2DM has increased markedly over the past two decades. This rise is driven by a combination of demographic changes, including population growth and ageing, urbanisation, dietary transitions, and increasing physical inactivity.<sup>3</sup>

While urban centres have traditionally been the focus of diabetes research, there is mounting evidence that rural populations are not immune to these trends. In fact, rural communities often face unique challenges, including limited access to health services, lower health literacy, and socio-economic constraints that can delay diagnosis and effective management.<sup>4</sup>

In Nigeria, T2DM has historically been considered a largely urban disease; however, rural populations are increasingly affected. Studies have shown that a significant proportion of adults in rural areas have undiagnosed diabetes, which raises concerns about late presentation and the risk of complications.<sup>5</sup> These communities are often underserved, with limited availability of specialised non-communicable disease services, inadequate screening programs, and health facilities that are geographically inaccessible. Cultural beliefs and misconceptions about diabetes further compound the problem, resulting in delayed healthcare seeking and reliance on alternative treatments.<sup>6</sup>

Understanding the prevalence and determinants of T2DM in rural settings is therefore crucial for planning targeted interventions and allocating resources efficiently. Knowledge of local risk factors can inform health education campaigns, community screening initiatives, and the development of context-appropriate management strategies. Previous studies have highlighted factors such as advancing age, obesity, hypertension, family history of diabetes, and sedentary lifestyles as key contributors to the development of T2DM.<sup>7-9</sup>

Despite the growing recognition of the diabetes burden in rural Nigeria, there remains a paucity of data specifically from Rivers State. Most available studies focus on urban populations or the general Nigerian population, limiting the ability to develop interventions tailored to rural communities with distinct socioeconomic and cultural characteristics.<sup>7-9</sup>

By assessing T2DM in rural communities of Rivers State, this study seeks to provide evidence that is not only epidemiologically relevant but also practical, considering the lived experiences, daily routines, and health-seeking behaviours of rural adults. Such evidence is essential for designing culturally sensitive, sustainable interventions that reduce both the prevalence and the impact of diabetes in these communities.

## METHODS

### *Study design and setting*

This study was a community-based analytical cross-sectional study conducted in selected rural communities of Rivers State, Nigeria, between March and September 2025. Rivers State is located in the South-South geopolitical zone and comprises both urban and rural populations, including riverine and mainland settlements.

It has 23 Local Government Areas (LGAs). The study was conducted in three rural LGAs, namely Ahoada East LGA, Emohua LGA and Oyigbo LGA. In each LGA, three communities were selected, giving a total of nine communities. The rural communities are characterised by dispersed settlements, predominantly agrarian and fishing livelihoods, and limited access to specialised non-communicable disease services.<sup>10</sup>

### *Study population*

The study population consisted of adults aged 18 years and older who had resided in the selected communities for at least 6 months before the study. This residency criterion was applied to ensure adequate exposure to local environmental and lifestyle factors relevant to the aim of the study.

### *Inclusion criteria*

Adults aged  $\geq 18$  years who provided written informed consent.

### *Exclusion criteria*

Pregnant women (due to altered glucose metabolism), critically ill individuals unable to participate, and persons with known type 1 diabetes mellitus.

### *Sample size determination*

Sample size was determined using the single population proportion formula for cross-sectional studies:

$$n = \frac{Z^2 pq}{d^2}$$

Where;  $n$ = minimum sample size,  $Z$ = standard normal deviate at 95% confidence level (1.96),  $p$ = estimated prevalence of type 2 diabetes mellitus,  $q$ =  $1 - p$ ,  $d$ = margin of error (0.05).

An estimated prevalence of 8% was assumed based on previous community-based studies in Nigeria<sup>7</sup>.

$$n_0 = \frac{3.84 \times 0.0736}{0.0025}$$

$$n_0 = 113.1$$

### *Adjustment for multistage cluster sampling*

Because communities were sampled, the design effect (DEFF = 2.0) was applied to account for intra-cluster correlation and loss of statistical efficiency. This approach is consistent with WHO STEPwise survey recommendations and similar population-based studies where intra-cluster correlation coefficients are not readily available.<sup>11</sup>

So,  $n_1 = 113 \times 2 = 226$

### **Adjustment for non-response (10%)**

$n_2 = 226 / 0.90 = 251$ . So, the minimum statistically adjusted sample size is  $\approx 251$ .

### **Adjustment for multivariable logistic regression requirements**

The study performed multivariable logistic regression with 5 key predictors: Age, obesity, hypertension, physical inactivity, and family history of diabetes.

A conservative epidemiological rule is  $\geq 10$  outcome events per variable (EPV). In this case, a minimum of 11-12 EPV was used. The 5 predictors gave:  $5 \times 12 = 60$  cases of diabetes.

With expected prevalence  $\approx 9\%$ :  $n_3 = 60 / 0.09 \approx 667$ . So, the final sample size was 667, but 602 respondents completed the study.

### **Sampling technique**

A four-stage multistage probability sampling technique was used: Stage 1: Three rural Local Government Areas (Ahoada East, Emohua, and Oyigbo LGAs) were selected by simple random sampling from the list of rural LGAs in Rivers State, Stage 2: In each selected LGA, three rural communities were selected by simple random sampling from official community lists, to give a total of nine communities, Stage 3: In the third stage, households within each selected community were sampled using systematic random sampling. The sampling interval for each community was determined by dividing the total number of households by the allocated sample size for that community. A random starting point was selected, after which every 4<sup>th</sup> household was visited for data collection, Stage 4: To minimise intra-household clustering, only one eligible adult was selected per household. Where multiple eligible adults were present, simple random sampling (balloting) was used.

Sample allocation across LGAs and communities was done proportionately to the estimated population size to ensure representativeness.

### **Data collection instrument and procedure**

Data were collected using a pretested, interviewer-administered structured questionnaire adapted from the WHO STEPwise approach to non-communicable disease surveillance.<sup>11</sup> The questionnaire captured sociodemographic characteristics, lifestyle behaviours (diet, physical activity, etc.), family history of diabetes, and health-seeking behaviour. Anthropometric measurements, blood pressure, and fasting blood glucose were collected using standard protocols.<sup>12,13</sup> T2DM was defined as fasting plasma glucose  $\geq 7.0$  mmol/L or self-reported use of antidiabetic medication.<sup>12</sup> Body mass index (BMI) was calculated as weight (kg)/height<sup>2</sup> (m<sup>2</sup>),

and hypertension was defined as systolic BP  $\geq 140$  mmHg and/or diastolic BP  $\geq 90$  mmHg.<sup>13</sup> Data collection was conducted by trained research assistants fluent in English and local languages. Standard operating procedures were followed to ensure uniformity.

### **Validity and reliability**

**Content validity:** The questionnaires were reviewed by two experts on T2DM and epidemiology for clarity and relevance. The dataset was further validated using the validation function of SPSS version 27.

**Internal reliability** was assessed using Cronbach's alpha, with  $\alpha \geq 0.70$  considered acceptable for internal consistency. The questionnaire was pre-tested on 60 adults in a rural community outside the study area, and necessary adjustments were made for clarity and cultural appropriateness.

### **Data management, storage, and statistical analysis**

Each participant was assigned a unique identifier code to ensure anonymity. No personal identifiers (e.g., names, contact details) were entered into the dataset. Electronic data files were protected and stored on a secure, encrypted computer accessible only to the principal investigator and data analysts.

Physical documents, including consent forms and questionnaires, were stored in a locked cabinet in the office of the corresponding author within the Department of Community Medicine, Faculty of Clinical Sciences, Rivers State University. These will be retained for a minimum of five years in compliance with institutional data retention policies.

Data were entered, cleaned, and analysed using the Statistical Product and Service Solution (SPSS) Version 27 (Armonk, NY: IBM Corporation).

**Normality testing:** Normality of continuous variables was assessed using the Shapiro-Wilk test, supplemented by visual inspection of histograms and Q-Q plots. Variables approximating a normal distribution were summarised using means and standard deviations.

### **Descriptive and bivariate analysis**

Categorical variables were summarised using frequencies and percentages. Associations between type 2 diabetes mellitus and independent variables were assessed using Chi-square tests for categorical variables. Variables with  $p < 0.20$  at bivariate analysis were considered for multivariable modelling to reduce residual confounding.

### **Multivariable analysis and model diagnostics**

Binary logistic regression was used to identify independent determinants of type 2 diabetes mellitus.

Adjusted odds ratios (AORs) with 95% confidence intervals were reported.

Multicollinearity among independent variables was assessed using the variance inflation factor (VIF), with values of VIF  $\geq 2.5$  considered significant multicollinearity.

Model adequacy was assessed using the Hosmer-Lemeshow goodness-of-fit test, classification accuracy, and receiver operating characteristic (ROC) curve analysis.

Although clustering occurred at the community level, the study design minimised clustering effects by selecting only one respondent per household and distributing respondents across multiple communities. In addition, a design effect was applied at the sample size estimation stage to account for the clustering inherent in the multistage design. Statistical significance was set at  $p < 0.05$ .

## RESULTS

### *Sociodemographic characteristics of respondents*

A total of 602 adults participated in the study. The mean age was  $44.6 \pm 13.8$  years, with nearly half (48.0%) aged  $\geq 45$  years. Females constituted 58.3% of respondents, while males accounted for 41.7%. Most participants were married (65.8%), and the majority had attained at least secondary education (60.5%). Regarding occupation, 38.7% were engaged in farming or fishing, 32.6% were traders or artisans, 14.8% were civil servants, and 13.9% were unemployed. These characteristics reflect a typical rural adult population in Rivers State, ensuring representativeness of the study sample (Table 1).

### *Prevalence of type 2 diabetes mellitus and associations with selected risk factors*

Table 2 shows that the overall prevalence of type 2 diabetes mellitus was 9.3% (56/602), with a substantial proportion previously undiagnosed (41.1%). Prevalence increased markedly with age, from 3.9% among participants  $< 45$  years to 14.5% among those  $\geq 45$  years ( $\chi^2 = 21.8$ ;  $p < 0.001$ ). Obesity was strongly associated with T2DM: prevalence was 19.4% among obese participants, compared with 3.4% among those with normal or underweight BMI ( $\chi^2 = 24.6$ ;  $p < 0.001$ ). Similarly, inadequate physical activity, hypertension, and a family history of diabetes were significantly associated with T2DM.

### *Multivariable logistic regression analysis of determinants of type 2 diabetes mellitus*

In multivariable logistic regression, age  $\geq 45$  years was associated with a threefold increased odds of T2DM (AOR=3.12; 95% CI: 1.68-5.78;  $p < 0.001$ ). Obesity

(AOR=2.84; 95% CI: 1.49-5.42;  $p = 0.002$ ), physical inactivity (AOR=2.17; 95% CI: 1.16-4.05;  $p = 0.015$ ), hypertension (AOR=2.63; 95% CI: 1.38-5.02;  $p = 0.003$ ), and family history of diabetes (AOR=3.41; 95% CI: 1.72-6.78;  $p < 0.001$ ) remained independent predictors of T2DM after adjustment for potential confounders (Table 3). These findings confirm that both non-modifiable (age, family history) and modifiable (obesity, physical inactivity, hypertension) factors independently increase the risk of T2DM in rural adults.

**Table 1: Socio-demographic characteristics of respondents (n=602).**

Variable	Frequency	Percentage (%)
<b>Age group (years)</b>		
18-29	112	18.6
30-44	201	33.4
$\geq 45$	289	48.0
Mean age $\pm$ SD	44.6 $\pm$ 13.8	
<b>Sex</b>		
Male	251	41.7
Female	351	58.3
<b>Marital status</b>		
Single	146	24.3
Married	396	65.8
Widowed/separated	60	10.0
<b>Educational level</b>		
No formal education	97	16.1
Primary	141	23.4
Secondary	151	25.1
Tertiary	213	35.4
<b>Occupation</b>		
Farming/fishing	233	38.7
Trading/Artisan	196	32.6
Civil servant	89	14.8
Unemployed	84	13.9

SD = standard deviation

### *Receiver Operating Characteristic (ROC) curve*

Figure 1 illustrates the ROC curve for the multivariable logistic regression model, which assessed the predictive accuracy for T2DM among rural adults. The area under the curve (AUC=0.78) indicates good discrimination, confirming that the model reliably distinguishes between individuals with and without type 2 diabetes mellitus (T2DM). This supports the utility of the identified risk factors for predicting T2DM in rural populations and suggests that community-level risk screening using these variables could be effective for early identification.

### *Notes*

The Cronbach's alpha ranged from 0.81 to 0.86 for the sections of the questionnaire, indicating good internal reliability of the data set. The Shapiro-Wilk test for normality reported a normal distribution ( $W = 0.92$ ,

p=0.07). As such, parametric summaries were used. Hosmer-Lemeshow goodness-of-fit test:  $\chi^2=6.12$ , p=0.63,

indicated a good model fit. Variance inflation factor range = 1.21-2.43, indicating no multicollinearity.

**Table 2: Prevalence of type 2 diabetes mellitus and Bivariate association with selected risk factors.**

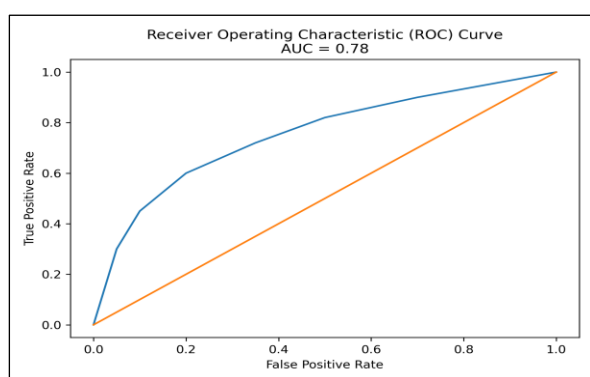
Variable	T2DM present, N (%)	T2DM absent, N (%)	$\chi^2$	P value
<b>Overall prevalence</b>	56 (9.3)	546 (90.7)	-	-
<b>Age group (years)</b>				
<45	14 (3.9)	344 (96.1)	21.8	<0.001*
≥45	42 (14.5)	248 (85.5)		
<b>Body mass index</b>				
Normal/underweight	11 (3.4)	314 (96.6)	24.6	<0.001*
Overweight	19 (8.7)	199 (91.3)		
Obese	26 (19.4)	108 (80.6)		
<b>Physical activity</b>				
Adequate	18 (5.1)	334 (94.9)	10.9	0.001*
Inadequate	38 (14.6)	222 (85.4)		
<b>Hypertension</b>				
Yes	31 (18.1)	140 (81.9)	18.4	<0.001*
No	25 (5.8)	406 (94.2)		
<b>Family history of diabetes</b>				
Yes	22 (21.6)	80 (78.4)	22.1	<0.001*
No	34 (6.8)	466 (93.2)		

$\chi^2$  = Chi-square test; T2DM = Type 2 diabetes mellitus; \* Statistical significance set at p<0.05

**Table 3: Multivariable logistic regression analysis of determinants of type 2 diabetes mellitus.**

Variable	Adjusted odds ratio (AOR)	95% CI	P value
<b>Age ≥45 years</b>	3.12	1.68-5.78	<0.001*
<b>Obesity</b>	2.84	1.49-5.42	0.002*
<b>Physical inactivity</b>	2.17	1.16-4.05	0.015*
<b>Hypertension</b>	2.63	1.38-5.02	0.003*
<b>Family history of diabetes</b>	3.41	1.72-6.78	<0.001*

CI = Confidence interval. \*Statistical significance set at p<0.05



**Figure 1: Receiver Operating Characteristic (ROC) curve.**

## DISCUSSION

This community-based study demonstrates that type 2 diabetes mellitus (T2DM) is an increasingly important public health problem among adults residing in rural communities of Rivers State, Nigeria. The prevalence observed in this study, together with the substantial

proportion of undiagnosed cases, reflects the expanding burden of diabetes beyond urban populations and supports global evidence indicating that diabetes prevalence continues to rise worldwide.<sup>1</sup> This shift underscores the growing vulnerability of rural populations in low- and middle-income countries, where demographic ageing, lifestyle modification, and socioeconomic transitions are reshaping disease patterns.<sup>2</sup>

The prevalence of T2DM recorded in this study exceeds earlier national estimates and is higher than pooled prevalence figures reported in some Nigerian meta-analyses.<sup>4</sup> This finding may be attributable to temporal increases in diabetes burden, regional variation in risk factor distribution, and improved community-level case detection. Similar prevalence estimates have been reported in more recent studies conducted in Southern Nigeria, including rural and semi-rural communities, where prevalence rates approaching 9-10% have been documented.<sup>5,10</sup> In contrast, older Nigerian studies reported substantially lower prevalence rates, often below 6%, suggesting that diabetes burden in rural communities has increased over time.<sup>14,21</sup> Comparable trends have been documented across sub-Saharan Africa, where rural

diabetes prevalence has risen alongside economic development and lifestyle transitions.<sup>3</sup>

A notable finding of this study is the high proportion of undiagnosed T2DM, with a significant number of individuals unaware of their diabetic status before the survey. This pattern is consistent with findings from other rural Nigerian populations, where undiagnosed diabetes has ranged from approximately one-third to nearly half of all cases.<sup>5,25</sup> Similar trends have been reported across low- and middle-income countries, reflecting persistent challenges related to limited screening coverage, poor awareness, and inadequate access to diagnostic services.<sup>7</sup> Undiagnosed diabetes poses serious public health concerns, as delayed diagnosis is associated with increased risk of chronic complications, including cardiovascular disease, renal impairment, neuropathy, and visual loss.<sup>23</sup>

Increasing age was a strong independent determinant of T2DM in this study, with adults aged 45 years and above exhibiting significantly higher odds of diabetes. This finding is consistent with evidence from Nigerian and international studies demonstrating a progressive rise in diabetes prevalence with advancing age.<sup>12,20</sup> Age-related physiological changes, including increased insulin resistance, reduced beta-cell reserve, and prolonged exposure to metabolic risk factors, provide plausible explanations for this association.<sup>8</sup> Similar age-related patterns have been observed in rural African populations, reinforcing the need for age-prioritised diabetes screening strategies.<sup>21</sup>

Obesity emerged as a major predictor of T2DM, with obese individuals having substantially increased odds of diabetes. This finding aligns with extensive evidence linking excess adiposity to impaired glucose metabolism and diabetes risk.<sup>22</sup> Nigerian studies have consistently demonstrated strong associations between obesity and T2DM across both urban and rural populations.<sup>14,23</sup> Although rural communities were previously thought to be protected against obesity, recent data indicate rising levels of overweight and obesity in rural Nigeria due to changing dietary practices, reduced physical activity, and increasing availability of energy-dense foods.<sup>24</sup> The strong association observed in this study confirms that obesity is now a critical driver of diabetes risk in rural settings.

Physical inactivity was also independently associated with T2DM. While rural populations are often assumed to be physically active due to occupational demands, evidence increasingly suggests declining activity levels resulting from the mechanisation of farming, increased motorised transport use, and more sedentary lifestyles.<sup>25</sup> The observed association is consistent with systematic reviews demonstrating an inverse relationship between physical activity and diabetes risk.<sup>26</sup> Similar findings have been reported in Nigerian rural populations, indicating

that physical inactivity is an emerging risk factor irrespective of place of residence.<sup>27</sup>

Hypertension showed a strong association with T2DM in this study, highlighting the clustering of cardiometabolic risk factors in rural populations. This coexistence has been widely documented in Nigeria and other sub-Saharan African countries, where diabetes and hypertension frequently occur together, particularly among older adults and those with obesity.<sup>28</sup> Shared pathophysiological mechanisms, including insulin resistance, endothelial dysfunction, chronic inflammation, and neurohormonal dysregulation, are believed to underlie this association.<sup>29</sup> The coexistence of these conditions substantially increases cardiovascular risk and complicates disease management, particularly in rural settings with limited access to comprehensive care.<sup>30</sup>

Family history of diabetes was identified as a significant determinant of T2DM, reflecting the combined influence of genetic predisposition and shared environmental and behavioural factors. This finding is consistent with evidence from Nigerian and international studies demonstrating that individuals with a positive family history have a markedly increased risk of developing diabetes.<sup>20,31</sup> Shared dietary habits, physical activity patterns, and health-seeking behaviours within families may further amplify genetic susceptibility. The strength of this association supports recommendations for targeted screening among individuals with a family history of diabetes, particularly in resource-constrained settings.<sup>31</sup>

The findings of this study reflect a broader epidemiological transition occurring in rural Rivers State, characterised by a shift from communicable to non-communicable diseases. Similar transitions have been documented across sub-Saharan Africa, where rural populations are increasingly affected by diabetes and other chronic conditions.<sup>3,7</sup> However, health systems in many rural areas remain poorly equipped to address chronic disease prevention and management.<sup>19</sup>

Persistent health system weaknesses likely contribute to the high burden of undiagnosed diabetes observed in this study. Primary healthcare services in rural Nigeria continue to focus predominantly on acute and infectious conditions, with limited integration of routine non-communicable disease screening.<sup>19</sup> Evidence suggests that health system readiness for diabetes prevention and control at the primary care level remains inadequate in many low-resource settings.<sup>30,31</sup> Strengthening primary healthcare capacity, improving access to diagnostic tools, and integrating lifestyle counselling into routine services are essential steps toward addressing this gap.<sup>11</sup>

The multivariable model used in this study demonstrated good discriminatory performance, indicating that the identified risk factors effectively differentiate individuals with and without T2DM in this population. This finding supports the feasibility of implementing simple, risk-

based screening approaches incorporating age, body mass index, blood pressure status, physical activity, and family history in rural settings where laboratory resources are limited.<sup>7</sup> Evidence suggests that community-based screening interventions can improve early detection, linkage to care, and long-term outcomes among underserved populations.<sup>31,32</sup>

This study provides important epidemiological evidence on the burden and determinants of T2DM among adults in rural communities of Rivers State, a population that is often underrepresented in non-communicable disease research. The use of a community-based design and multistage sampling across multiple rural communities enhances the representativeness of the findings and supports their relevance for similar rural settings. Standardised data collection instruments and objective measurements of fasting blood glucose, anthropometry, and blood pressure strengthen the internal validity of the study, while multivariable analysis allowed for adjustment of potential confounders and identification of independent determinants.

The findings should be interpreted in light of certain limitations. The cross-sectional design limits causal inference between identified risk factors and T2DM. Although fasting blood glucose was used to define diabetes status, repeat measurements and glycated haemoglobin assessments were not performed, which may have resulted in some misclassification. Self-reported behavioural factors, including physical activity and dietary practices, are subject to recall and social desirability bias. In addition, while a design effect was applied during sample size calculation to account for clustering, residual intra-community correlation may still be present. Despite these limitations, the study provides valuable insight into the emerging burden of diabetes in rural populations.

## CONCLUSION

This study provides evidence that T2DM prevalence in rural Rivers State is high, with a substantial proportion of previously undiagnosed cases. Independent determinants include age  $\geq 45$  years, obesity, hypertension, physical inactivity, and family history. The findings underscore the need for strengthened rural health systems, regular community screening, and targeted interventions to address modifiable risk factors.

## Recommendations

Given the observed prevalence of T2DM and the pattern of associated risk factors identified among adults in rural communities of Rivers State, there is a clear need to strengthen community-based diabetes screening, particularly among older adults and those with obesity, hypertension, or a family history of diabetes. Early detection strategies integrated into routine primary healthcare services will be critical in reducing the

substantial proportion of undiagnosed cases observed in this study.

In line with the identified modifiable determinants, health education interventions should prioritise lifestyle modification, including promotion of healthy dietary practices, regular physical activity, and weight control, using culturally appropriate approaches tailored to rural settings. The coexistence of hypertension and obesity with diabetes in this population underscores the importance of integrated management of cardiometabolic risk factors within primary healthcare facilities.

Improving the availability of essential diagnostic tools and medications at rural health facilities is necessary to support timely diagnosis, initiation of treatment, and continuity of care. Finally, sustained surveillance and further research focusing on non-communicable diseases in rural populations are recommended to monitor epidemiological trends, evaluate interventions, and inform evidence-based health planning and policy development.

## Implications of the study

The high proportion of undiagnosed T2DM cases and modifiable risk factors such as obesity and physical inactivity highlight the need for community-level interventions, including screening, lifestyle education, and integration into primary healthcare services.

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