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Performance of Four International Diabetes Risk Assessment Tools in Predicting Type 2 Diabetes Risk Among Young Adult Nigerians: A Cross-Sectional Study in Abia State

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Abstract

Background

Type 2 diabetes mellitus (T2DM) is increasingly affecting young adult populations in sub-Saharan Africa, yet validated risk assessment tools for Nigerian populations remain lacking.

Methods

A cross-sectional study was conducted among 567 young adults (18–45 years) recruited from urban (n = 328), rural (n = 202), and control (n = 37) populations in Abia State, Nigeria. Anthropometric measurements, fasting blood glucose, and lipid profiles were assessed. The four risk assessment tools (FINDRISC, AUSDRISK, ADART, and IDRS) were administered and evaluated against confirmed T2DM (FBS ≥ 126 mg/dL) using ROC curve analysis, sensitivity, specificity, and predictive values.

Results

The study population comprised 201 males (35.4%) and 366 females (64.6%), mean age 28.4 ± 8.7 years. The overall prevalence of T2DM was 7.2%, with urban (0.7%) and rural (2.9%) populations showing a significant difference ($p < 0.001$). All four tools demonstrated poor discriminatory ability (AUC < 0.60) for identifying confirmed T2DM. ADART showed the highest sensitivity (32.4%) but lowest specificity (75.9%) and PPV (9.4%), misclassifying 127 participants as high-risk. FINDRISC achieved the highest specificity (99.2%) and accuracy (92.6%) but minimal sensitivity (8.1%). AUSDRISK (AUC = 0.481) and IDRS (AUC = 0.537) showed moderate performance. Optimal cut-off analysis suggested lower thresholds for Nigerian populations: FINDRISC ≥ 6.5, AUSDRISK ≥ 6.5, ADART ≥ 20.5, and IDRS ≥ 35.

Conclusions

International diabetes risk assessment tools demonstrate poor diagnostic performance in young adult Nigerian populations, necessitating the development and validation of population-specific risk assessment instruments.

Introduction

Type 2 diabetes mellitus (T2DM) has emerged as a significant public health challenge globally, with prevalence escalating dramatically across all age groups and regions. The International Diabetes Federation estimates that 589 million adults aged between 20 and 79 years (11.1% prevalence) currently live with diabetes [1]. This is projected to reach 852.5 million by 2050 [2]. In Nigeria, estimates show over 3 million adult cases (approximately 3.0% prevalence), while Africa is expected to have the fastest projected growth of 142% in diabetes prevalence by 2050 [1]. Nigeria, as Africa's most populous nation,

harbors a substantial portion of the continent's diabetes burden, with diagnosed cases estimated at 1.7 million [1].

There is a worrisome rise in the incidence of type 2 diabetes in young adults globally. A recent report from a study in Asia indicates that while the incidence of type 2 diabetes among adults in Asia has been stable, rates in youth and young adults have increased [3]. Similar trends have been observed in Africa in general, and Nigeria in particular [4, 5].

In Nigeria, studies examining urban-rural diabetes differentials within southeastern Nigeria consistently demonstrate expected gradients, though with some suggestion of narrowing gaps. Ejike and Nwachukwu found urban prevalence approximately double rural prevalence (8% vs. 4%), a smaller differential than observed in some other African settings, potentially reflecting lifestyle diffusion into rural areas [6]. Ubani et al. reported that the prevalence of diabetes mellitus is rising in Abia State with no significant urban-rural difference [7]. This convergence likely reflects the diffusion of Westernized lifestyles into rural areas through improved transportation, market integration, and media exposure [8, 9].

Early identification of individuals at high risk of developing T2DM is essential for implementing preventive interventions and reducing the risk of complications. Diabetes risk scoring techniques are cost-effective methods for identifying susceptible individuals and predicting their risk of developing the disease. Several international risk assessment tools have been developed and validated in specific populations, including the Finnish Diabetes Risk Score (FINDRISC), Australian Diabetes Risk Score (AUSDRISK), Indian Diabetes Risk Score (IDRS), and the American Diabetes Association Risk Test (ADART).

FINDRISC is a non-invasive, cost-effective tool using eight components: age, body mass index (BMI), physical activity, dietary habits (fruit/vegetable intake), history of hypertension treatment, hyperglycemia, and family history of diabetes [10]. AUSDRISK was developed in Australia and assesses 10 parameters, including age, sex, ethnicity, family history, previous high blood glucose, use of antihypertensive medications, smoking status, physical activity, BMI, and waist circumference [11]. IDRS is a simplified risk score tailored to the Indian population, comprising only four parameters: age, abdominal obesity, physical activity, and family history of diabetes [12]. ADART, developed by the American Diabetes Association, includes seven items: age, gender, family history, gestational diabetes, hypertension, physical activity, and BMI [13].

However, these tools may not be directly applicable to Nigerian populations due to differences in lifestyle, diet, genetic factors, and the prevalence and distribution of other risk factors. A study in Cross River State, Nigeria, found that FINDRISC, AUSDRISK, IDRS, and ADART had limited efficacy in detecting glycaemic abnormalities in young adults, with AUSDRISK presenting the best balance with an AUC of 0.61 [4]. Similarly, research in Delta State revealed that FINDRISC scores correlated with anthropometric parameters but demonstrated varying predictive utility [14]. Nnamudi *et al*. assessed the FINDRISC tool in a young adult Nigerian population, finding that 38.4% had high-risk scores; though the study did not validate these risk scores against glucose measurements [14].

The South-East geopolitical zone of Nigeria, including Abia State, has been the site of several diabetes studies, though comprehensive evaluations of multiple risk assessment tools in young adult populations remain scarce. This study, therefore, aimed to evaluate the sensitivity, specificity, and predictive values of four diabetes risk score tools (FINDRISC, AUSDRISK, ADART, and IDRS) in predicting T2DM risk among young adults in urban and rural populations in Abia State, Nigeria.

Methods

Study Design and Setting

A cross-sectional study was conducted among young adults aged 18-45 years in Abia State, Nigeria. Participants were recruited from urban (Umuahia, n=328), rural (Okpuala Ngwa, Nsulu, and Ikwuano, n=202), and control (confirmed diabetes patients, n=37) populations.

Inclusion and Exclusion Criteria

Inclusion criteria: age 18-45 years; resident in the study community for at least six months; provision of written informed consent.

Exclusion criteria: diagnosis of diabetes at baseline; previous diagnosis of diabetes; use of prescribed drugs or diets for diabetes management; pregnancy; drug addiction; physical disability impeding anthropometric measurements; decline of consent.

Sample Size Determination

The sample size was determined using the formula of Vaughan and Morrow [15]:

$N = PQ / E^2$

Where:

- N = sample size
- P = maximum expected prevalence rate of diabetes mellitus (8.1% in Abia State, Nigeria) [7]
- Q = 100 – P
- E = margin of sample error tolerated in percentage (4%)

However, to account for design effect and potential data loss, the minimum sample size was increased to 400 participants, with 200 participants in each location. A total of 567 participants were eventually recruited.

Data Collection Tools and Procedures

Data were collected using a structured questionnaire capturing demographic details, lifestyle factors, and items required for the four diabetes risk tools. The questionnaire was developed specifically for this

study, incorporating validated items from the original risk assessment tools to compute FINDRISC, AUSDRISK, ADART, and IDRS scores. An English language version of the questionnaire is provided as Supplementary File S1.

Age, Anthropometric and Clinical Measurements

Self-reported age of each subject was recorded. Height and weight were measured (to the nearest 0.1 cm and 0.1 kg, respectively) using a stadiometer (2M Retractable Stature Meter Measuring Tool; No.26SM) and a digital scale (Salter glass electronic weighing scale), respectively. BMI was calculated as weight (kg)/[height (m)]^2. Waist and hip circumferences were measured using non-stretchable tape, at the plane passing through the navel and directly below the last rib bone, and the widest circumference around the buttocks, respectively. The values obtained were used to compute waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR). Blood pressures were measured after 5 minutes rest using an oscillometric blood pressure monitor (Omron M2 Eco) and appropriate cuffs, with the subject seated in an upright position. The average of two blood pressure readings taken at 5-minute intervals was recorded for each subject.

Biochemical Analysis

Fasting blood glucose (FBG) concentration was measured using a glucometer (Accu-Chek Active, Roche Mannheim, Germany) which measures the quantity of electrons released in the production of gluconolactone by glucose dehydrogenase; a factor which is proportional to the amount of glucose consumed in the reaction. Participants were required to fast for at least 8 hours prior to the test. A finger-prick blood sample was taken by trained personnel and placed on the test strip where it spreads into the analytical chamber by capillary action. Once placed into the glucometer, results were displayed in a few seconds and recorded immediately.

Screen-detected Type 2 diabetes mellitus was defined primarily using fasting blood sugar ≥126 mg/dL (7.0 mmol/L), following American Diabetes Association and World Health Organization diagnostic criteria [16,17]. HbA1c ≥6.5% was used in sensitivity analysis due to its smaller valid sample size.

Data Analysis

Field data were collected and entered on a Microsoft Excel spreadsheet a priori formatted to accommodate the diabetes risk calculators used in the study, and the biochemical data generated. Data were analyzed using SPSS version 25, with charts and tables generated using Microsoft Excel 2016. Descriptive statistics were computed for demographic variables and risk scores. Chi-square tests assessed associations between categorical variables. Pearson's correlation was used to examine relationships between risk scores, FBG, and BMI. Diagnostic accuracy for each risk tool was evaluated by calculating sensitivity, specificity and area under the ROC curve (AUC). A significance threshold of $p < 0.05$ was adopted for all analyses.

Results

Demographic Characteristics

A total of 567 participants were recruited, comprising 201 males (35.4%) and 366 females (64.6%). The mean age was 28.4 ± 8.7 years. The distribution across locations was: urban 328 (57.8%), rural 202 (35.6%), and control 37 (6.5%).

The demographic, anthropometric, and clinical characteristics of study participants by location and sex is presented in Table 1.

Table 1
Demographic and Anthropometric Characteristics of Study Participants

Variable	Urban (n = 328)		Rural (n = 202)		Control (n = 37)		p-value*
	Male (n = 104)	Female (n = 224)	Male (n = 72)	Female (n = 130)	Male (n = 25)	Female (n = 12)	
Age (years)	27.8 ± 7.2	29.6 ± 6.8	25.4 ± 8.6	27.9 ± 7.9	41.2 ± 9.3	39.8 ± 8.7	0.083
Height (m)	1.72 ± 0.07	1.62 ± 0.06	1.70 ± 0.08	1.60 ± 0.07	1.68 ± 0.09	1.59 ± 0.07	0.041
Weight (kg)	72.4 ± 11.2	65.8 ± 12.4	68.6 ± 10.8	62.3 ± 11.9	76.8 ± 13.5	70.2 ± 12.8	0.038
BMI (kg/m²)	24.5 ± 4.2	25.1 ± 5.1	23.7 ± 3.9	24.3 ± 4.8	27.2 ± 5.6	27.8 ± 5.9	0.042
WC (cm)	84.2 ± 10.8	82.4 ± 11.2	80.6 ± 9.8	78.9 ± 10.5	92.4 ± 12.6	88.6 ± 11.9	0.018
HC (cm)	94.6 ± 8.4	98.2 ± 9.6	92.3 ± 8.1	96.8 ± 9.2	96.8 ± 10.2	100.4 ± 10.8	0.215
WHpR	0.89 ± 0.07	0.84 ± 0.08	0.87 ± 0.07	0.82 ± 0.08	0.95 ± 0.09	0.88 ± 0.08	0.035
WHtR	0.49 ± 0.06	0.51 ± 0.07	0.47 ± 0.06	0.49 ± 0.07	0.55 ± 0.08	0.56 ± 0.08	0.047
FBG (mg/dL)	82.4 ± 14.2	79.6 ± 12.8	80.8 ± 15.6	77.4 ± 13.2	232.5 ± 118.4	258.6 ± 115.2	0.211

*All values are presented as Mean ± Standard Deviation. WC = Waist Circumference; HC = Hip Circumference; WHpR = Waist-to-Hip Ratio; WHtR = Waist-to-Height Ratio; FBG = Fasting Blood Glucose. *p-value from one-way ANOVA comparing urban, rural, and control groups.*

Prevalence of Type 2 Diabetes Mellitus

Fasting blood glucose measurements were available for 514 participants. The overall prevalence of T2DM was 7.2% (37 participants). When urban and rural populations were combined (excluding controls), the prevalence was 1.46%, with rural areas showing higher prevalence (2.92%) compared to urban areas (0.65%). This difference was statistically significant ($\chi^2 = 336.750$, $p < 0.001$). The glycaemic status distribution was: normal FBS in 457 participants (88.9%), prediabetes in 20 participants (3.9%), and diabetes in 37 participants (7.2%).

Risk Category Distribution

The distribution of participants across risk categories for each tool is presented in Table 2.

Table 2
Risk Category Distribution of the Four Diabetes Risk Assessment Tools

Risk Category	FINDRISC n (%)	AUSDRISK n (%)	ADART n (%)	IDRS n (%)
Low Risk	512 (90.3)	457 (80.6)	406 (71.6)	549 (96.8)
Slightly Elevated Risk	33 (5.8)	–	–	–
Intermediate/Moderate Risk	15 (2.6)	81 (14.3)	–	–
High Risk	7 (1.2)	29 (5.1)	161 (28.4)	18 (3.2)
Total	567 (100.0)	567 (100.0)	567 (100.0)	567 (100.0)

Diagnostic Performance of Risk Assessment Tools

The comparative diagnostic performance of the four tools is shown in Table 3.

Table 3
Comparative Performance of the Four Diabetes Risk Score Tools

Tool	Sensitivity	Specificity	Accuracy	AUC	Implication
FINDRISC	Very Low (8.1%)	Highest (99.2%)	Highest (92.6%)	0.480	Best at ruling out diabetes; misses most true cases
AUSDRISK	Moderate (21.6%)	High (96.6%)	Third (91.2%)	0.481	Best balance between sensitivity and specificity; still performs poorly overall
IDRS	Low (16.2%)	High (98.3%)	Second (92.4%)	0.537	Marginally best overall discrimination, but still poor (< 0.60)
ADART	Highest (32.4%)	Lowest (75.9%)	Lowest (72.8%)	0.504	Finds most true cases but produces many false positives (PPV only 9.4%)

The ROC curve analysis summary is presented in Table 4.

Table 4
ROC Analysis Summary

Risk Tool	AUC	Std. Error	95% CI	p-value
FINDRISC	0.480	0.058	0.367–0.593	0.680
AUSDRISK	0.481	0.058	0.368–0.594	0.698
IDRS	0.537	0.057	0.425–0.648	0.457
ADART	0.504	0.056	0.394–0.614	0.931

Optimal Cut-off Analysis

The optimal cut-off values derived from Youden Index analysis are presented in Table 5.

Table 5
Optimal Cut-off Values

Tool	Optimal Cut-off	Sensitivity (%)	Specificity (%)	Youden Index
FINDRISC	≥ 6.5	24.3	89.5	0.692
AUSDRISK	≥ 6.5	24.3	88.7	0.661
ADART	≥ 20.5	32.4	86.2	0.601
IDRS	≥ 35	29.7	93.9	0.567

Discussion

The finding that all four diabetes risk assessment tools demonstrated poor discriminatory ability (AUC < 0.60) in identifying confirmed T2DM among this young adult Nigerian population echoes recent work from Cross River State, where FINDRISC, AUSDRISK, IDRS, and ADART similarly showed limited efficacy in detecting glycaemic abnormalities in young adults [4]. These findings align with the findings of Ekure *et al*., on risk assessment tools in sub-Saharan Africa [18]. The consistent underperformance of these tools, originally developed and validated in European, Australian, and Asian populations underscores a pressing need for context-specific risk assessment instruments adapted to the unique epidemiological, demographic, and metabolic realities of Nigerian communities.

FINDRISC demonstrated the highest specificity (99.2%) and overall accuracy (92.6%) among the four tools, meaning it was exceptionally good at correctly identifying individuals without diabetes. However, its sensitivity was abysmally low (8.1%), implying that it would miss approximately 92% of participants with confirmed diabetes. This poor sensitivity likely reflects the lower prevalence of traditional risk factors such as obesity and physical inactivity in young Nigerian adults compared to the middle-aged and older Finnish population for whom the tool was designed [10]. While the high specificity suggests FINDRISC might serve as a confirmatory tool to rule out diabetes in low-risk individuals, its utility as a primary screening instrument in this population is severely limited. Nnamudi *et al.* in an earlier report

observed the usefulness of the FINDRISC tool in risk prediction in young adult Nigerians living in the Delta region [14]. Their study also found some limitations associated with this tool and also buttressed the need for a more specific tool validated for the local population.

AUSDRISK performed with a sensitivity of 21.6% and specificity of 96.6%, yielding an overall accuracy of 91.2%. Notably, it identified a significantly higher proportion of males as high risk (9.0% vs. 3.0% for females; p = 0.002), reflecting the inclusion of sex as a risk factor in the original algorithm [11]. The slightly more favourable balance between sensitivity and specificity compared to FINDRISC suggests that AUSDRISK may be marginally more appropriate for the Nigerian context, but its performance remains poor, and it cannot be recommended as a standalone screening tool. The Australian Type 2 Diabetes Risk Assessment Tool has not been formally validated or broadly tested for effectiveness in native African populations. It was built specifically on Australian cohorts using demographic and ethnic weighting unadjusted for sub-Saharan genetics or localized metabolic profiles. Our findings suggest that an adjustment for demographic and ethnic peculiarities may create a tool suitable for the Nigerian population from a modified AUSDRISK.

IDRS achieved the highest AUC (0.537) among the four tools, indicating marginally better overall discriminatory ability. With a sensitivity of 16.2% and specificity of 98.3%, IDRS demonstrated excellent specificity comparable to FINDRISC but similarly poor sensitivity. The relatively better performance of IDRS in the Nigerian cohort may be explained by shared genetic and metabolic susceptibilities between Indian and Nigerian populations, a hypothesis supported by earlier cross-ancestry genetic studies [19, 20]. Although Asian populations share genetic susceptibility to diabetes and rapid lifestyle transitions accompanying economic development (just like Africans especially Nigerians), they generally have lower bone density than people of African ancestry and thus have lower BMI thresholds [19, 20]. This fact may account for the lower sensitivity reported here, and also shows that BMI is a strong predisposing factor to the risk of developing type 2 diabetes mellitus in the population under study.

ADART demonstrated the highest sensitivity (32.4%) among the four tools, meaning it identified the greatest proportion of participants with confirmed diabetes. However, this came at a considerable cost: very low specificity (75.9%), a positive predictive value of just 9.4%, and an overall accuracy of only 72.8%. The high false-positive rate 127 participants were classified as high risk, of whom only 12 had confirmed diabetes renders ADART unsuitable as a screening tool in its current form. Such a performance profile would inevitably lead to unnecessary confirmatory testing, patient anxiety, and wasted healthcare resources [4].

The poor performance of all four tools can be attributed to several interconnected factors: **age-specific limitations** as these risk scores were originally developed and validated in older populations, typically those aged 40 years and above, while this study focused on young adults aged 18–45 years; **ethnic and genetic differences** in the genetic architecture of T2DM that varies substantially across populations; **cultural and lifestyle differences** including traditional versus Westernised dietary patterns and occupational versus recreational physical activity; and the **absence of biochemical markers** as none of

the four tools incorporate biochemical variables such as HDL cholesterol, triglycerides, or HbA1c that emerged as important predictors in recent predictive models for diabetes detection in Nigerian populations [4, 21].

Study Limitations

Several limitations should be acknowledged. First, the cross-sectional design precludes assessment of temporal relationships between risk factors and T2DM development. Second, the study relied on a single fasting blood glucose measurement for T2DM screening, rather than the more comprehensive oral glucose tolerance test, which may have resulted in underestimation of T2DM prevalence. Third, the study was conducted in a single state in Nigeria and may not be generalizable to other regions.

Conclusion

The four international diabetes risk assessment tools (FINDRISC, AUSDRISK, IDRS, ADART) demonstrated poor discriminatory ability (AUC < 0.60) in identifying confirmed Type 2 diabetes mellitus in this young adult Nigerian population. This finding compels a re-evaluation of current diabetes prediction tool approaches in young Nigerian adults. Rather than relying on externally derived risk scores, there is an urgent need to develop and validate locally adapted tools that incorporate population-specific risk factors, biochemical markers, and culturally appropriate lifestyle variables. Until such instruments are available, clinicians should exercise caution when using existing risk scores in this population and consider complementing them with direct metabolic assessment.

Abbreviations

- **ADART:** American Diabetes Association Risk Test
- **AUC:** Area Under the Curve
- **AUSDRISK:** Australian Diabetes Risk Score
- **BMI:** Body Mass Index
- **FBG:** Fasting Blood Glucose
- **FINDRISC:** Finnish Diabetes Risk Score
- **IDRS:** Indian Diabetes Risk Score
- **PPV:** Positive Predictive Value
- **ROC:** Receiver Operating Characteristic
- **T2DM:** Type 2 Diabetes Mellitus
- **WC:** Waist Circumference
- **HC:** Hip Circumference
- **WHpR:** Waist-to-Hip Ratio
- **WHtR:** Waist-to-Height Ratio

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki. Ethical approval for the study was obtained from Federal Medical Centre, Umuahia (FMC/QEH/G.596/Vol.10 /570). Written informed consent was obtained from all participants.

Consent for publication

Not applicable. This manuscript does not contain any individual person's data in any form (including individual details, images, or videos).

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available due to the sensitive nature of participant health data and privacy concerns but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

III and CECCE conceived and designed the study. All authors contributed to data collection. III and INN performed data analysis and manuscript preparation. III and CECCE critically reviewed the manuscript for intellectual content. All authors read and approved the final manuscript.

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Authors' information

Not applicable.

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Supplementary Files

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- SupplementaryFileS1.docx