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Diabetes Risk Susceptibility and Predictive Ability of the Finnish Diabetes Risk Scoring Tool in a Rural Young Adult Nigerian Population

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ABSTRACT

Background: The burden of diabetes mellitus is increasing across the globe.

Objective: This study was aimed at identifying at-risk individuals and determine the performance of the Finnish diabetes risk scoring (FINDRISC) tool in a rural Nigerian setting.

Methods: A prospective cross-sectional study was conducted amongst 200 young adults (aged 15–35 years) in a rural community in Delta State, Nigeria. Participants filled the FINDRISC questionnaire and underwent fasting blood glucose and anthropometric measurements following standard protocols.

Results: We found a high prevalence of elevated waist circumference (21.0%), overweight/obesity by BMI (19.0%), physical inactivity (49.5%) and a family history of diabetes (28.0%) with a female preponderance. Risk factors increased with increasing FINDRISC scores. Slightly elevated and moderate risk was found in 16.0% (24.1% females and 7.3% males) of the population. The AUC for predicting prediabetes was 0.49, 0.54 and 0.40 with optimal cut points 5.5 (sensitivity = 71.9%; specificity = 59.2%), 5.5 (sensitivity = 60.0%; specificity = 76.4%) and 6.5 (sensitivity = 63.6%; specificity = 60.5%) in the overall population, males and females, respectively.

Conclusion: FINDRISC performed poorly in this rural population with a female preponderance of risk factors and risk status for diabetes mellitus.

Keywords: FINDRISC, Diabetes risk, Young adult, Rural, Nigeria

INTRODUCTION

Diabetes mellitus can be described as a silent killer because the disease usually remains undiagnosed for a long time. It has been reported that over 50% of those living with diabetes are undiagnosed [1]. The implication of this is that until major complications of the disease arise, these persons who are living with the disease remain unaware of their status. Nephropathy, neuropathy and retinopathy are some of the long-term macrovascular and microvascular complications that are commonly associated with the disease thus making diabetes management quite challenging [2].

Generally, health care and routine testing is not prioritized in most developing nations of the world. This explains why the burden of diabetes is quite enigmatic in these nations, as the disease is currently ravaging menacingly and stretching their already dysfunctional health care systems. Sadly, Nigeria is badly affected by what can be considered as a multiple tragedy of increasing prevalence of diabetes, increasing number of undiagnosed cases, lack of awareness and poor health care. This, in addition to a low quality of life amongst patients amply justifies the need to stem the tide of the disease.

Uncontrolled diabetes commonly manifests as elevated blood glucose level leading to significant damages to vital organs [3]. This is often preceded by prediabetes which may be considered as an incipient stage of type 2 diabetes

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mellitus that may be reversible with necessary lifestyle modifications, thus making it a potential target of efforts aimed at reducing the burden of diabetes. Additionally, the identification of individuals at risk for diabetes can be achieved via risk scoring. Diabetes risk scores are cheap, non-invasive tools for assessing the likelihood of developing type 2 diabetes mellitus over a defined period of time [2]. One of such risk scores is the Finnish Diabetes Risk Score (FINDRISC) that was developed in Finnish cohorts for the identification of individuals at high risk for type 2 diabetes mellitus based on a 10-year prospective data [4].

We have recently used the tool to assess the risk of developing diabetes mellitus in an urban-based young adult Nigerian population with significant findings [2]. We intend to follow up that study by examining risk predisposition and performance of the FINDRISC tool in predicting the risk of developing future diabetes in a rural setting. Despite the use of the FINDRISC tool in other Nigerian populations [5,6] studies aimed at the validation of the diagnostic accuracy of this tool are scarce. Therefore, in this present study, we sought to determine the diabetes risk susceptibility and performance of the FINDRISC tool in a rural young adult Nigerian population.

METHODS

Study Design: This was a cross-sectional community-based study carried out amongst young adults (aged 15-35 years) in Igbodo, Delta State, Nigeria to determine the diabetes risk susceptibility and performance of the FINDRISC tool in young adult Nigerian populations.

Recruitment of Participants: Male and female participants were recruited by convenience sampling and the study protocol was thoroughly explained to them. They participated willingly in the study and filled the FINDRISC questionnaire after signing the informed consent form which was designed in accordance with the guidelines of the research ethics review committee of World Health Organization.

Exclusion Criteria: Potential participants were excluded from the study based on any of the following conditions: a prior diagnosis of diabetes, a fasting blood glucose ≥ 126 mg/dl (≥ 7.0 mmol/L), current use of prescribed drugs or diets for the control and management of diabetes, pregnancy, drug addiction, physical disability that impedes anthropometric measurements as well as a decline of consent.

Sample Size: The sample size was determined using the formula of Vaughan and Morrow [7].

$$N = \frac{PQ}{(E/1.96)^2}$$

N is sample size

P is maximum expected prevalence rate of diabetes mellitus

Q is $100 - P$

E is margin of sample error tolerated in percentage (5% being the maximum accepted value)

With a 4.5% error margin and a diabetes prevalence rate of 5.4% in Delta State, Nigeria [8] a minimum sample size of 97 participants was recommended. However, the sample size was increased to 200.

FINDRISC calculation

The scoring of the FINDRISC tool has been exhaustively described in our previous paper [2]. In the FINDRISC tool, eight variable components that are linked with anthropometric and lifestyle patterns are scored. These components include age; BMI; waist circumference; physical activity; consumption of vegetables, fruits or berries; blood pressure medication; previous diagnosis of high blood sugar; family history of diabetes. For clarity and emphasis, a participant scored 0, 2, 3 or 4 points in the "age" component if he/she was under 45 years, 45–54 years, 55-64 years or over 64 years, respectively. A participant scored 0, 1 or 3 points in the "BMI" component if he/she had a BMI <25 kg/m^2, 25 kg/m^2 - 30 kg/m^2 or >30 kg/m^2, respectively. A participant scored 0, 3 or 4 points in the "waist circumference" component if he/she had a waist circumference <94 cm for men or <80 cm, 94 cm-102 cm for men or 80 cm-88 cm for women or >102 cm for men or >88 cm for women, respectively. A participant scored 0 or 2 points in the "physical activity" component if he/she had a physical activity of at least 30 min on a daily basis or less, respectively. A participant scored 0 or 1 point in the "consumption of vegetables, fruits or berries" component if he/she had a daily consumption of vegetables, fruits or berries or if not on a daily basis, respectively. A participant scored 2 or 0 points in the "use of anti-hypertensive" component if he/she was on a regular use of anti-hypertensive or if not, respectively. A participant scored 5 or 0 points in the "previous diagnosis of high blood sugar" component if he/she had been diagnosed of high blood glucose in the past or if not, respectively. A participant scored 5, 3 or 0 points in the "family history of diabetes" component if he/she had a first degree relative (a parent, brother, sister or own child) with diabetes, a second degree relative (a grandparent, aunt, uncle or first cousin) with diabetes or if none of these relatives have diabetes, respectively.

We determined participants' total risk score as the sum of the respective scores of the different components and classified them as follows: <7 (Low risk-an estimated 1 in 100 will develop disease); 7-11 (Slightly elevated risk-an estimated 1 in 25 will develop disease); 12-14 (Moderate risk-an estimated 1 in 6 will develop disease); 15-20 (High risk-an estimated 1 in 3 will develop disease); >20 (Very high risk-an estimated 1 in 2 will develop disease).

Anthropometric Measurements

Anthropometric measurements were done by trained research assistants. Participants' body weight was measured (in kilograms) using a standard weighing scale (Hana model, China) with light clothing and without shoes. Height was measured (in centimeters) using a stadiometer in an erect posture and without shoes. Waist circumference was measured (to the nearest 0.1 cm) in a horizontal plane, midway between the lowest rib and the iliac crest using a non-stretchable measuring tape. Hip circumference was measured (to the nearest 0.1 cm) in a horizontal plane, around the pelvis at the point of maximum protrusion of the buttocks using a non-stretchable measuring tape with participant in an erect posture. From these measurements;

Waist-to-hip ratio (WHR) was calculated as $\text{WHR} = \frac{\text{Waist Circumference (cm)}}{\text{Hip Circumference (cm)}}$

Waist-to-height ratio (WHtR) was calculated as $\text{WHtR} = \frac{\text{Waist Circumference (cm)}}{\text{Height (cm)}}$

Body-mass-index (BMI) was calculated as $\text{BMI} = \frac{\text{Weight (Kg)}}{\text{Height (m)}^2}$

Body-adiposity-index (BAI) was calculated as $\text{BAI} = \frac{\text{Hip Circumference (cm)}}{\text{Height (m)}^{1.5}} - 18$ [9]

Blood Pressure Measurement: Blood pressure measurement was done by trained personnel using a blood pressure measuring device (Omron M2 Eco, Hoofddorp, The Netherlands). The participant was made to relax without any distractions, for at least 5 min and remained in a sitting position. Participants had three separate measurements after an interval of 2 min and the average of the last two measurements was eventually recorded.

Blood Sugar Measurement: Fasting blood sugar measurement was preceded by an overnight fast of 10-12 h. On confirmation that the fasting period has been accomplished, the participant was thumb-pricked using a sterilized lancet. A drop of blood was tested on the glucose test strip using a standard glucometer (Accu-Chek Active, Roche Mannheim, Germany).

Outcome: The outcome of interest was prediabetes; an intermediate state of hyperglycemia that signals diabetes susceptibility. Prediabetes was defined according to the latest American Diabetes Association (ADA) criteria [10] but slightly modified such that the lower cut-off value was lower than the ADA recommended cut-off. Participants with impaired fasting glucose, i.e., FBG ≥ 90 mg/dl (5.0 mmol/L) and < 126 mg/dl (7.0 mmol/L) were considered to have prediabetes. Thus, hypoglycemia, normoglycemia and hyperglycemia were defined according to the definitions adopted in a previous study [2].

Definition of overweight and obesity: Overweight and obesity were defined according to different indices: BMI ≥ 25 kg/m^2 but < 30 kg/m^2 and BMI ≥ 30 kg/m^2 respectively [11]; BAI (21 %-26 %; in males, and 33 %-39 %; in females) and BAI (> 26 %; in males, and > 39 %; in females) respectively [12]; WC (94 cm-102 cm; in males, and 80 cm-88 cm; in females) and WC (> 102 cm; in males and > 88 cm; in females) respectively [13].

Statistical Analysis: Statistical analysis was done using Statistical Package for the Social Sciences (SPSS) version 23.0 (SPSS Inc Chicago IL). Descriptive statistics were expressed as Means (Standard Deviation) for continuous variables and as proportions for categorical variables. Chi-square (for categorical variables), t-test or one-way ANOVA followed by Duncan test (for continuous variables) was used for comparison. The receiver operating characteristic (ROC) curve was obtained by plotting sensitivity and 1-specificity on the y-axis and x-axis, respectively. The area under curve (AUC) and optimal FINDRISC cut points were determined.

RESULTS

Males had significantly higher mean values of systolic blood pressure ($p < 0.001$), height ($p < 0.001$) and weight ($p < 0.05$) while females had significantly higher mean values of waist-to-height ratio ($p < 0.05$), body adiposity index ($p < 0.001$) and FINDRISC score ($p < 0.001$) in the rural population **(Table 1).**

There was a significant ($p < 0.001$) difference in the prevalence of elevated waist circumference with more females attaining the threshold values for overweight and obesity (by waist circumference) relative to males. Males had a significantly ($p < 0.05$) higher level of physical activity (≥ 30 min/day) relative to females **(Table 2).**

The participants in the moderate risk group had significantly higher mean values of body mass index ($p < 0.001$), waist circumference ($p < 0.001$), hip circumference ($p < 0.001$), weight ($p < 0.001$), waist-to-height ratio ($p < 0.001$), body adiposity index ($p < 0.001$) and FINDRISC score ($p < 0.001$) relative to the lower FINDRISC score groups in the rural population **(Table 3).**

There was a significant ($p < 0.001$) FINDRISC score-dependent increase in the prevalence of overweight and obesity (by BMI) as participants in the moderate risk (FINDRISC score = 12-14) group had the highest prevalence of overweight and obesity. There was a significant ($p < 0.001$) difference in the prevalence of elevated waist circumference with more participants in the moderate risk group attaining the threshold values for overweight and obesity (by waist circumference) relative to the lower FINDRISC score groups. The moderate risk group had a higher occurrence of a lack of physical activity ($p = 0.006$) and a family history of diabetes ($p < 0.001$) **(Table 4).**

Table 1. Mean values of participants' characteristics stratified by gender.

	Total; (n = 200)	Male; (n = 96)	Female; (n = 104)	T-test	P value
BMI (kg/m^2); Mean ± SD	21.89 ± 3.97	21.64 ± 3.34	22.13 ± 4.48	- 0.881	0.379
WC (cm); Mean ± SD	77.58 ± 8.28	78.04 ± 8.24	77.15 ± 8.32	0.757	0.450
Systolic BP (mmhg); Mean ± SD	122.65 ± 12.70	127.31 ± 12.60	118.35 ± 11.24	5.310	< 0.001
Diastolic BP (mmhg); Mean ± SD	75.55 ± 9.27	75.51 ± 9.91	75.59 ± 8.68	- 0.065	0.948
Pulse (beat/min); Mean ± SD	75.59 ± 11.95	73.71 ± 10.58	77.31 ± 12.90	- 2.146	0.033
Hip Circumference (cm); Mean ± SD	90.30 ± 8.68	90.45 ± 8.68	90.15 ± 8.73	- 0.247	0.805
Height (cm); Mean ± SD	164.43 ± 8.92	169.09 ± 8.59	160.12 ± 6.83	8.194	< 0.001
Weight (kg); Mean ± SD	59.28 ± 11.59	62.20 ± 11.25	56.57 ± 11.29	3.528	0.001
Waist-to-hip ratio (WHR); Mean ± SD	0.85 ± 0.04	0.85 ± 0.04	0.85 ± 0.04	0.723	0.471
Waist-to-height ratio (WHtR); Mean ± SD	0.46 ± 0.05	0.45 ± 0.05	0.47 ± 0.05	- 2.753	0.006
Body Adiposity Index (BAI); Mean ± SD	25.00 ± 5.07	23.26 ± 4.50	26.61 ± 5.05	- 4.934	< 0.001
Fasting Blood Sugar (mg/dl); Mean ± SD	76.09 ± 11.65	75.55 ± 10.56	76.58 ± 12.60	- 0.626	0.532
FINDRISC Score; Mean ± SD	3.80 ± 2.62	2.98 ± 2.12	4.55 ± 2.81	- 4.419	< 0.001

Table 2. Prevalence of participants' characteristics stratified by gender.

	Total; (n = 200)	**Male; (n = 96)**	**Female; (n = 104)**	**x^2**	**P value**
Body Mass Index (BMI)					
BMI (25-30 kg/m^2) n (%)	31 (15.5)	15 (15.6)	16 (15.4)	3.314[a]	0.191
BMI (> 30 kg/m^2) n (%)	7 (3.5)	1 (1.0)	6 (5.8)		
Waist Circumference (WC)					
WC: 94-102 cm (M); 80-88 cm (F) n (%)	32 (16.0)	8 (8.3)	24 (23.1)	19.762[a]	< 0.001
WC: > 102 cm (M); > 88 cm (F) n (%)	10 (5.0)	0 (0.0)	10 (9.6)		
Daily Physical Activity					
< 30 min/day n (%)	99 (49.5)	30 (31.3)	69 (66.3)	24.598[a]	< 0.001
Consumption of Fruits/Vegetables/Berries					
No daily consumption n (%)	156 (78.0)	75 (78.1)	81 (77.9)	0.002[a]	0.967
Blood Pressure (BP) Medication					
Use of BP Medication n (%)	4 (2.0)	3 (3.1)	1 (1.0)	1.192[a]	0.275
Family History of Diabetes					
Second Degree Relatives n (%)	35 (17.5)	16 (16.7)	19 (18.3)	0.235[a]	0.889
First Degree Relatives n (%)	21 (10.5)	11 (11.5)	10 (9.6)		
Hypertension n (%)	23 (11.5)	13 (13.5)	10 (9.6)	0.756[a]	0.385

Table 3. Mean values of participants' characteristics stratified by FINDRISC score.

	Total; (n = 200)	< 7; (n = 168)	7-11; (n = 31)	12-14; (n = 1)	P value
BMI (kg/m^2); Mean ± SD	21.89 ± 3.97	21.00 ± 2.98	26.34 ± 5.00	34.55 ± 0.00	< 0.001
WC (cm); Mean ± SD	77.58 ± 8.28	76.03 ± 6.84	85.45 ± 10.44	93.00 ± 0.00	< 0.001
Systolic BP (mmhg); Mean ± SD	122.65 ± 12.70	123.13 ± 13.19	120.83 ± 8.73	98.00 ± 0.00	0.098
Diastolic BP (mmhg); Mean ± SD	75.55 ± 9.27	75.41 ± 9.33	76.54 ± 9.11	69.00 ± 0.00	0.641
Pulse (beat/min); Mean ± SD	75.59 ± 11.95	75.76 ± 12.08	75.00 ± 11.36	64.00 ± 0.00	0.593
Hip Circumference (cm); Mean ± SD	90.30 ± 8.68	88.62 ± 7.21	99.00 ± 10.63	102.00 ± 0.00	< 0.001
Height (cm); Mean ± SD	164.43 ± 8.92	165.02 ± 8.91	161.51 ± 8.52	155.00 ± 0.00	0.075
Weight (kg) Mean ± SD	59.28 ± 11.59	57.43 ± 10.42	68.51 ± 12.68	83.00 ± 0.00	< 0.001
Waist-to-hip ratio (WHR); Mean ± SD	0.85 ± 0.04	0.85 ± 0.04	0.85 ± 0.03	0.91 ± 0.00	0.406
Waist-to-height ratio (WHtR); Mean ± SD	0.46 ± 0.05	0.45 ± 0.04	0.52 ± 0.07	0.60 ± 0.00	< 0.001
Body Adiposity Index (BAI); Mean ± SD	25.00 ± 5.07	23.93 ± 3.87	30.50 ± 6.81	34.86 ± 0.00	< 0.001
Fasting Blood Sugar (mg/dl); Mean ± SD	76.09 ± 11.65	76.45 ± 11.67	74.41 ± 11.66	67.00 ± 0.00	0.497
FINDRISC Score; Mean ± SD	3.80 ± 2.62	2.91 ± 1.68	8.35 ± 1.27	12.00 ± 0.00 [c]	< 0.001

Post hoc tests were not performed because at least one group (FINDRISC score 12-14 group) had fewer than two cases.

None of the participants had a high-risk score (15-20) for diabetes.

Table 4. Prevalence of participants' characteristics stratified by FINDRISC score.

	Total; (n = 200)	**< 7; (n = 168)**	**7-11; (n = 31)**	**12-14; (n = 1)**	**x^2**	**P value**
Body Mass Index (BMI)						
BMI (25-30 kg/m^2) n (%)	31 (15.5)	14 (8.3)	17 (54.8)	0 (0.0)	94.705[a]	< 0.001
BMI (> 30 kg/m^2) n (%)	7 (3.5)	1 (0.6)	5 (16.1)	1 (100.0)		
Waist Circumference (WC)						
WC: 94-102 cm (M); 80-88 cm (F) n (%)	32 (16.0)	20 (11.9)	12 (38.7)	0 (0.0)	85.294[a]	< 0.001
WC: > 102 cm (M); > 88 cm (F) n (%)	10 (5.0)	0 (0.0)	9 (29.0)	1 (100.0)		
Daily Physical Activity						
< 30 min/day n (%)	99 (49.5)	75 (44.6)	23 (74.2)	1 (100.0)	10.168[a]	0.006
Consumption of Fruits/Vegetables/Berries						
No daily consumption n (%)	156 (78.0)	130 (77.4)	26 (83.9)	0 (0.0)	4.206[a]	0.122
Blood Pressure (BP) Medication						
Use of BP Medication n (%)	4 (2.0)	4 (2.4)	0 (0.0)	0 (0.0)	0.777[a]	0.678
Family History of Diabetes						
Second Degree Relatives n (%)	35 (17.5)	28 (16.7)	6 (19.4)	1 (100.0)	45.064[a]	< 0.001
First Degree Relatives n (%)	21 (10.5)	8 (4.8)	13 (41.9)	0 (0.0)		
Hypertension n (%)	23 (11.5)	19 (11.3)	4 (12.9)	0 (0.0)	0.196[a]	0.907

Post hoc tests were not performed because at least one group (FINDRISC score 12-14 group) had fewer than two cases.

None of the participants had a high-risk score (15-20) for diabetes.

A total of 2.0 % of the participants (1.0 % males, 2.9 % females) had hypoglycemia (FBS < 54 mg/dl), 89.5 % of the participants (93.8 % males, 85.6 % females) were normoglycemic (FBS = 54-90 mg/dl) while 8.5 % of the participants (5.2 % males, 11.5 % females) were hyperglycemic (FBS > 90 mg/dl but < 126 mg/dl) **(Figure 1).**

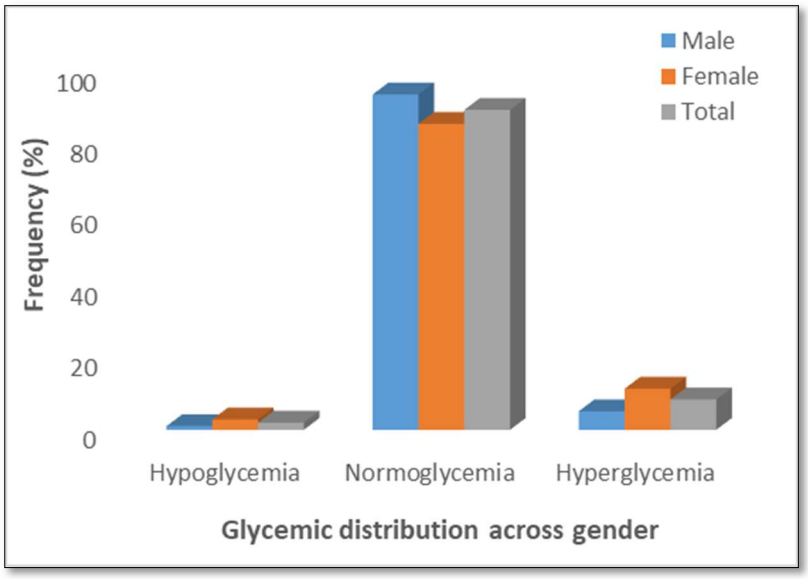

Figure 1. Gender distribution of fasting blood sugar in the population.

Low risk status was more prevalent in males (92.7 % vs 76.0 %) relative to females in the population. Although there were no high-risk participants in the rural population, females had a higher prevalence (24.1 % vs 7.3 %) of participants with either slightly elevated or moderate risk of developing diabetes relative to males. **(Figure 2).**

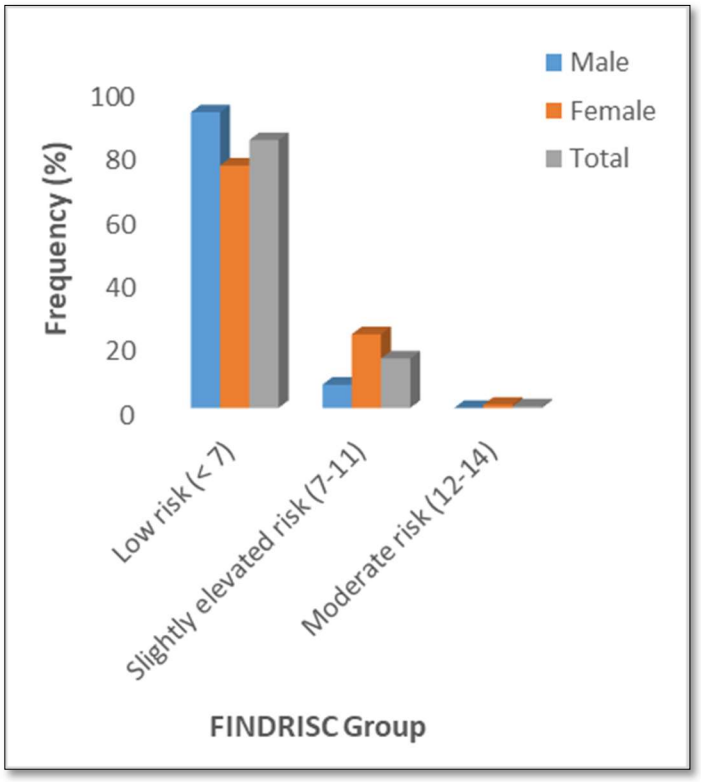

Figure 2. Distribution of FINDRISC score across gender in the population.

The FINDRISC tool performed poorly in the rural population (AUC = 0.49 with 95% CI: 0.28–0.69), male population (AUC = 0.54 with 95% CI: 0.04–1.00) and female population (AUC = 0.40 with 95% CI: 0.19–0.60) **(Figures 3-5).**

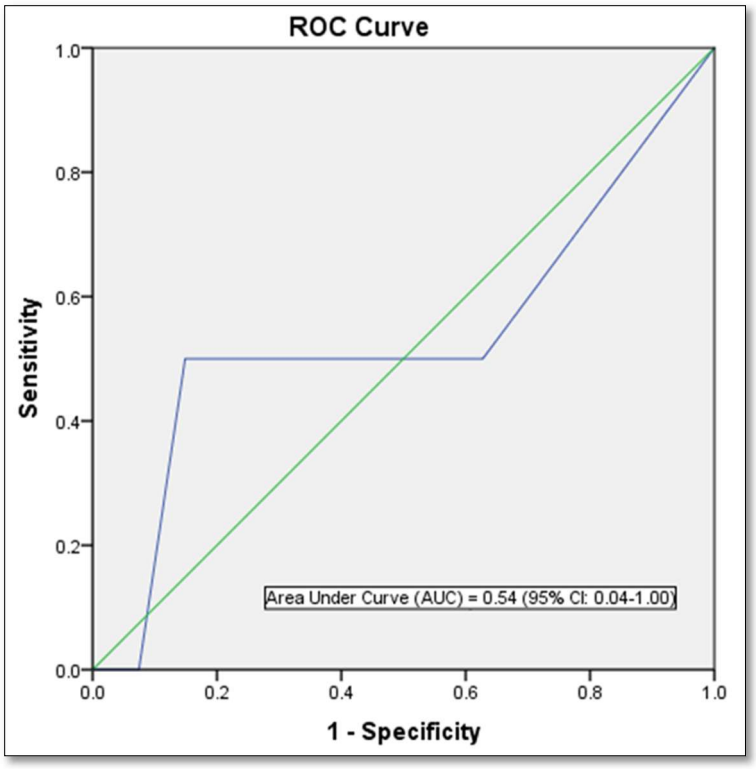

Figure 3. Receiver Operating Characteristic (ROC) curve for males in the population.

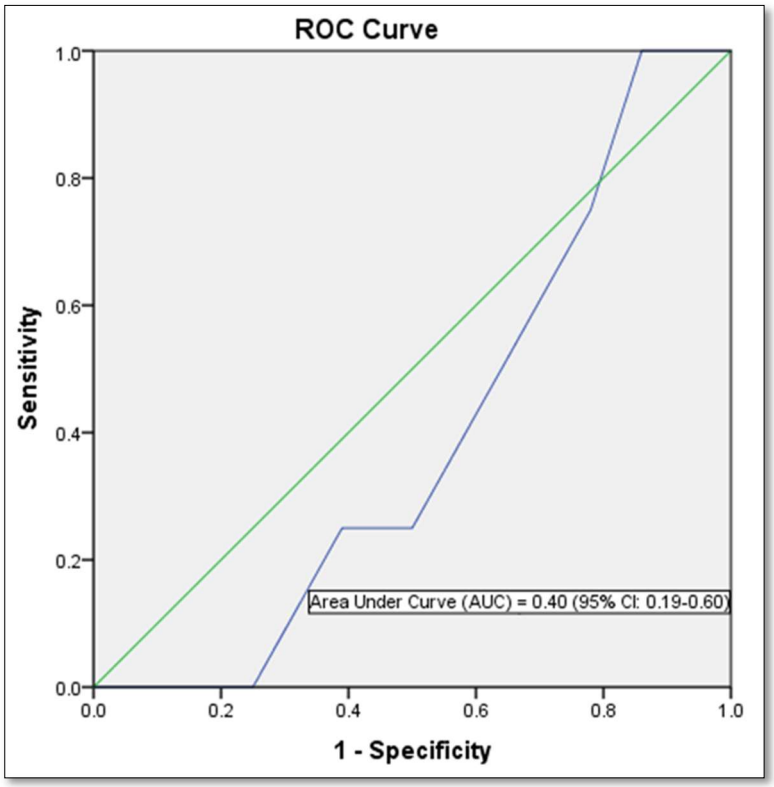

Figure 4. Receiver Operating Characteristic (ROC) curve for females in the population.

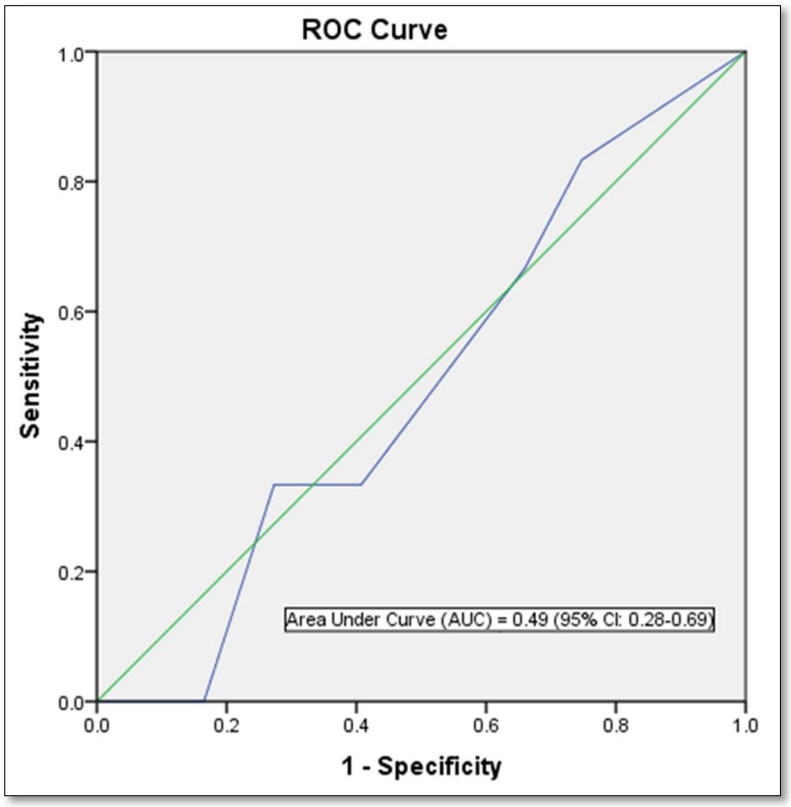

Figure 5. Receiver Operating Characteristic (ROC) curve for the rural population.

Furthermore, the optimal cut points in the ROC curve which maximizes the sensitivity and specificity of the test was determined **(Table 5).**

Table 5. Optimal FINDRISC cut points, sensitivity and specificity in the population.

FINDRISC cut points	Overall		Male		Female	
	Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)
≥ 2.5	93.8	23.1	90.0	33.7	95.5	13.2
≥ 3.5	75.0	48.1	60.0	60.7	81.8	36.3
≥ 4.5	75.0	56.0	60.0	71.3	81.8	41.6
≥ 5.5	71.9	59.2	60.0	76.4	77.3	43.2
≥ 6.5	56.6	72.6	40.0	85.4	63.6	60.5
≥ 7.5	43.8	78.3	20.0	91.6	54.5	65.8
≥ 8.5	34.4	87.8	20.0	94.9	40.9	81.1

DISCUSSION

Prevalence of FINDRISC components

The FINDRISC tool is scored by a cluster of eight components that are thought to be risk factors for diabetes mellitus [4]. The prevalence of these components contributes significantly to diabetes risk profiles in the population. We thus considered significant differences in the prevalence and values of risk factors across gender.

In this present study, there was a 16.0 % and 5.0 % prevalence of overweight and obesity (by waist circumference) respectively, with a female preponderance of participants who attained the threshold values for elevated waist circumference. Taken together, the prevalence of

overweight/obesity in this study nearly approximates using either waist circumference (21.0 %) or BMI (19.0 %) as the diagnostic index. This is because we also found an overweight and obesity prevalence of 15.5 % and 3.5 % respectively, using BMI as the diagnostic index. There was no significant difference in the prevalence of overweight (15.6 % vs 15.4 %) and obesity (1.0 % vs 5.8 %) in males compared to females. Our figures agree with the 3.6 % obesity prevalence reported recently amongst young adults in a tertiary health institution in South-West Nigeria [14] and also compares with the 13.4 % overweight and 6.5 % obesity reported in a young adult population in South-Eastern Nigeria [15]. However, our figures are lower than the 22 % overweight but higher than the 4 % obesity reported in an earlier study involving rural and urban adults in Benue state [16]. Our figures are also lower than the 28.0 % overweight and 10.9 % obesity recently reported in a rural community in South East Nigeria [17]. The age of our study population (young adults) may have accounted for these differences as overweight and obesity prevalence increases with age [18].

The higher prevalence of overweight and obesity in female participants is a recurring decimal in Nigerian populations [19,20]. This may not be unconnected with factors such as lack of physical exercise, involvement in less strenuous and physically tasking activities, poor participation in sports due to cultural and societal considerations [21] as well as gender differences in metabolism and hormonal balance [22,23]. This justifies the significantly ($p < 0.001$) higher prevalence of a lack of physical activity in the population (49.5 %) with a higher prevalence in female participants (66.3 % vs 31.3 %) compared to the male participants in this study. Generally, urbanization is associated with a drastic decline in the rate of physical activity while a preponderance of sedentary activity is associated with a higher risk of overweight and obesity [24]. Clearly, this urbanized sedentary lifestyle is gradually becoming evident in rural settings. This presents a double jeopardy specifically for the young adult females in the population since excess weight and a lack of physical activity are important non-genetic factors responsible for the increasing cases of diabetes mellitus [25,26]. Additionally, it is worrying that, the 66.3 % prevalence of a "less than 30 min of daily physical activity" amongst female young adults in the study population is higher than the 38.5 % prevalence reported amongst civil servants in South-Eastern Nigeria [25] and 11.6 % reported in an earlier study in Kaduna [27]. The fact that a lack of physical activity is a risk factor for type 2 diabetes mellitus [28] and a reduction of sedentary time via physical exercise can improve lipid metabolism and blood glucose control for the prevention and treatment of type 2 diabetes related disorders provides a valid basis for concern [29,30].

In this study, a total of 28.0 % of the participants had a family history of diabetes involving either their second degree or first-degree relatives. This is lower than a family history of 36.4 % previously reported in a Nigerian population [25]. The presence of a family history of diabetes is an important risk factor which increases the likelihood of developing type 2 diabetes mellitus [31,32]. The tendency towards subjectivity and even ignorance of accurate health information of relatives on the part of the participants may have contributed to the reported prevalence of family history of diabetes. Clearly, this is an aspect that requires further research on the best ways of eliminating possible errors due to subjectivity in order to improve the accuracy of risk prediction tools.

The prevalence pattern of these components is summed up in the overall risk profile. It follows that participant in the highest FINDRISC score group (FINDRISC = 12-14) in this population had the highest prevalence of risk factors. Although there were no high-risk participants, we however found that 16.0 % of the participants had a slightly elevated or moderate risk of developing diabetes with a female preponderance (24.1 % vs 7.3 %) compared to males. The absence of high risk in the population is suggestive of a reduced number and prevalence of risk factors. However, the high prevalence of slightly elevated or moderate risk of developing diabetes in the total population and specifically in females demand attention.

Although a previous diagnosis of diabetes is a high scoring component of the FINDRISC tool, we had a valid reason to exclude participants who had diabetes at baseline since the FINDRISC tool is aimed at predicting the risk of developing the disease. It is our considered opinion that there is no predictive utility derived from using a predictive tool for the prediction of an already existing condition. Indeed, using "a previous diagnosis of diabetes" as a predictor of the development of diabetes cannot be considered as a logical approach for identifying individuals at high risk for developing the disease [33]. Moreover, it has been clearly stated that cross sectional studies in which risk factors are determined in a population involving participants with and without diabetes are methodologically flawed since characteristics of people with diabetes commingle with risk factors in people without diabetes. Consequently, such studies are incapable of clearly proving that a putative risk factor predated diabetes onset [34].

Validation of diagnostic accuracy

Since the FINDRISC tool was developed in Finnish cohorts, it needs to be validated in any target population using AUC of receiver operating characteristic (ROC) curves [35,36].

FINDRISC performed poorly in our study population with an AUC value of 0.49 (sensitivity 71.9 %; specificity 59.2 %) in the overall population, an AUC value of 0.54 (sensitivity 60.0 %; specificity 76.4 %) in males and an AUC value of 0.40 (sensitivity 63.6 %; specificity 60.5 %) in females. The optimal cut point was 5.5 in the overall population and male participants but 6.5 in the female participants. Generally, FINDRISC does not perform well in

the diagnosis of prediabetes relative to undiagnosed type 2 diabetes mellitus and metabolic syndrome [37,36]. Our values are lower than the AUC values of 0.85 and 0.87 values in the 1987 and 1992 original Finnish cohorts respectively [4]. The AUC values of this current study implies that FINDRISC may not be accurate in the prediction of future diabetes risk in this particular young adult rural Nigerian population. Due to disparities in population characteristics, there may be need to validate the tool in other age groups, even in the same location.

STRENGTHS AND LIMITATIONS

Although our population size was not large enough, we avoided selection bias. Our sample population was fairly divided between males and females in the population. Thus, gender differences did not bias our study.

Furthermore, our choice of participants is a novelty. We studied a previously un-studied population; apparently healthy young adults, who are previously considered to be outside the at-risk group for diabetes risk assessment. We consider them to be without any chronic health complications or predisposing underlying ailments.

CONCLUSION

The FINDRISC tool performed poorly in risk prediction in the rural population. We found significant gender-based differences in the prevalence of risk factors and risk status for diabetes mellitus. Although diabetes risk susceptibility was low in the rural population, there appears to be a preponderance of risk factors and a higher risk status in female participants.

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