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Performance of the FINDRISC tool in screening for diabetes in a primary care setting

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Abstract

Introduction: *the global prevalence of diabetes mellitus is on the rise worldwide. Identification of persons at high risk for the disease may aid in disease prevention. The study aimed to ascertain the relationship of* ***Finnish Diabetes Risk Score*** *(FINDRISC) score with fasting plasma glucose in detecting prediabetes and undiagnosed type 2 diabetes mellitus among adults.* ***Methods:*** *the study was a cross-sectional analytical study involving 187 adults aged 18 years and above attending the General Out-Patient Clinic of the Federal Medical Centre Keffi. Subjects were recruited by systematic random sampling. Their diabetes risk assessment was done using the FINDRISC scoring system and fasting plasma*

glucose carried out for each participant. The relationship between the FINDRISC score and the fasting plasma glucose was analysed using linear regression. The diagnostic accuracies were analysed using two by two contingency tables. ***Results:*** *the mean age of the participants was 38.5 years, the rate of pre-diabetes and undiagnosed diabetes was 18.7% and 7.5% respectively. There was a positive correlation between the fasting plasma glucose and diabetes risk score with a Pearson´s correlation (r = 0.52, p < 0.001). The sensitivity of the FINDRISC score for detecting pre-diabetes alone at a cut-off point of ≥17 was 80.7%, with a specificity of 96.5%. The positive predictive value was 83.3%, with a negative predictive value of 95.8%. The AUROC was 0.89 and the diagnostic accuracy was 93.6%. The positive likelihood ratio was 22.9, with a negative likelihood ratio of 0.20, while the diagnostic odds ratio was 105.* ***Conclusion:*** *the FINDRISC score was a useful non-invasive and practical tool to screen for undetected diabetes and future development of diabetes in primary care.*

Introduction

Diabetes mellitus is a group of metabolic diseases characterised by hyperglycaemia resulting from defects in insulin secretion, insulin action, or both [1,2]. The chronic hyperglycaemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart and blood vessels [1-3]. The world is facing an unprecedented diabetes epidemic. Data from International Diabetes Federation (IDF) indicates about 463 million adults had diabetes worldwide as at 2019 [4]. Identification of persons at high risk for the disease may aid in disease prevention [4,5]. The prevalence of undiagnosed diabetes is high especially in low-income countries where people have poor access to health care [6]. Identification of people at increased risk of developing diabetes is possible by the detection of those with the risk factors [6,7]. This will enable the institution of prompt interventions to prevent the development of diabetes [7].

Blood glucose test has been widely used as a screening test in the past to screen for type 2 diabetes [8]. However, fasting plasma glucose testing is invasive and requires a fasting state [8]. Various attempts have been made to assess diabetes risk based on risk factors such as age, obesity, physical inactivity, diet, family history of diabetes, blood pressure, blood lipids, history of intermediate hyperglycaemia, gestational diabetes, and hypertension [9]. Several diabetes risk scores or risk models have been developed in different countries intended to identify individuals at high risk of developing diabetes and those suffering from undiagnosed diabetes [10]. Examples of these diabetes risk scores include, Cambridge Diabetes Risk Score, FINDRISC (Finish Diabetes Risk Score) and Framingham Simple Clinical Model [10]. The FINDRISC score has been validated in several studies. It consists of eight parameters obtained from history and physical examination. The FINDRISC score was chosen over other scores in the study as it had been validated and utilised in previous studies in the study setting [11]. Given the rising burden of diabetes in Africa and the high proportion of undiagnosed diabetics who lack access to diagnostic facilities in most Nigerian primary care settings, a simple risk score for detecting pre-diabetes and undiagnosed diabetes that can be applied in a rural African setting would be invaluable. The study was designed to ascertain the relationship of a simple diabetes risk score (FINDRISC) with fasting plasma glucose in detecting pre-diabetes and undiagnosed type 2 diabetes mellitus among adults attending the General Outpatient Clinic (GOPC), of Federal Medical Centre (FMC), Keffi in Nasarawa state North Central Nigeria.

Methods

Study design/study area: the study was a facility based cross-sectional analytical study, conducted

at the GOPC of FMC, Keffi in Nasarawa state, North Central Nigeria [12].

Study population: the study population comprised all consenting adult patients aged 18 years and above attending the GOPC of FMC Keffi. The sample size was calculated based on a previous study [13] to determine a difference of 10% between those identified by the diabetes risk score and those identified by blood glucose test, with 80% power and 95% confidence interval. The minimum sample size calculated was 187. We included all adult patients 18 years and above attending the GOPC FMC Keffi who gave consent to participate in the study. Patients with a previously established diagnosis of diabetes mellitus or patients unable to answer the questionnaire by virtue of illness such as mental illness were excluded. Using a systematic random sampling method, all consenting participants who met the inclusion criteria were recruited into the study after written informed consent was obtained. A total of 187 participants were recruited over five weeks.

Data collection: participants were recruited by systematic random sampling from the GOPC. Diabetes risk assessment was then carried out using an interviewer-administered FINDRISC questionnaire. The FINDRISC questionnaire consists of the following parameters; age in years, body mass index, waists circumference, daily exercise of at least 30 minutes, consumption of fruits/vegetables in diet, a history of taking regular antihypertensive medication, presence of high blood glucose in past examinations and presence of family history of diabetes mellitus. The risk of developing type 2 diabetes was stratified into different groups as follows; low risk (<7), slightly elevated risk (7-11), moderately elevated risk (12-14), high risk (15-20), very high risk (>20). After the diabetes risk assessment, the participants were instructed on the need for an overnight fast of at least eight hours, before presenting the next day for fasting plasma glucose (FPG). The FPG was done in the laboratory using the glucose oxidase method [14]. The participants were classified into the following: normal blood glucose = FPG < 6.1 mmol/L, impaired fasting glucose (IFG) = FPG 6.1-6.9 mmol/L, diabetes= FPG ≥7.0 mmol/L, based on WHO classification.

Data analysis: data were analysed using Statistical Package for Social Sciences (SPSS) version 21 software [15]. Means and frequencies of continuous and categorical variables were represented using tables and charts. The association between categorical variables were tested using the Chi-square test. The relationship between the FINDRISC score and the FPG was analysed using linear regression. A p-value of less than 0.05 was considered to be significant for all analyses. The sensitivity, specificity, positive and negative predictive values, diagnostic accuracy, diagnostic odds' ratio, likelihood ratio and area under receiver operating curve were analysed, using the two-by-two contingency tables. A cut-off FINDRISC score ≥ 17 was used to construct the 2x2 contingency table [16].

Ethical consideration: ethical approval for the study was obtained from the Ethical Committee of FMC Keffi. The study was funded by the authors.

Results

A total of 250 patients were approached to participate in the study. Of these, 232 gave informed consent, while 18 did not give consent. Out of the 232 who consented, 45 were excluded. Details are provided in Figure 1.

Socio-demographic characteristics of the study participants: the mean age of the participants was 38.5 years, and they were within the age range of 18-75 years. The commonest age group of the participants 91 (48.7%) was 35-54 years. There were more females than males, with a male to female ratio of 1: 1.3. The majority of the participants were married 122 (65.2%), and of Christian faith 122 (65.8%). Almost half, 90 (48.3%) had tertiary education, and majority 132 (70.6%) were employed. Details of socio-demographic

characteristics of the study participants are shown in Table 1.

Clinical characteristics of the participants: the mean body mass index was 25.4 kg/m^2. The mean fasting blood glucose was 5.6mmol/l. Other clinical characteristics of the study participants are shown in Table 1.

Diabetes risk assessment of the study participants: the mean diabetes risk score of the study participants was 8.02 The commonest risk category 91 (48.7%) were those with low risk. Details of the diabetes risk assessment using the FINDRISC scoring system is as shown in Figure 2. The majority of study participants, 138 (73.8%) had a normal FPG while 35 (18.7%) had pre-diabetes. About 14 (7.5%) of the study participants were found to have blood glucose levels in the diabetic range. The majority of the study participants, 77 (55.8%) with normal blood glucose, had a low risk, while 6 (4.3%) had high risk. None of the participants with normal blood glucose had a very high risk score. The majority of the participants 12 (34.3%), with FPG in the pre-diabetic range, had a low risk score while10 (28.6%) had high to very high risk score. Majority of the participants 5 (35.7%) with undiagnosed diabetes had a very high risk score, while 214.3 %) had a low risk score. Details of the blood glucose status in relation to the risk score status of the study participants is shown in Figure 3.

Diagnostic accuracy of the FINDRISC score: the FINDRISC score at a cut-off point of ≥17, was able to detect pre-diabetes and undiagnosed diabetes with a sensitivity of 82.9% and specificity of 89.7%. Other details are shown in Table 2.

Discussion

The focus of this research was to ascertain the relationship between the FINDRISC score and the fasting plasma glucose, which is the current standard for detecting pre-diabetes and diabetes. The study also set out to estimate the overall risk of developing pre-diabetes and undiagnosed diabetes among the study participants. Overall, the FINDRISC score was found to perform well for all age groups, as the study population was between 18 years and above. The study participants were relatively young and mostly female. These demographics are similar to previous reports from Dankyau *et al*. in Nigeria and Omech *et al*. in Botswana [11,16]. The mean body mass index of the participants was in the overweight category, while their mean fasting plasma glucose level was in the normal range. These findings were similar to a study by Nnamudi *et al*. in Nigeria [17]. The mean diabetes risk score in the study was in the slightly elevated category for the risk of developing diabetes over a 10-year period. This finding was comparable to a study by Dankyau *et al*. [11]. Majority of the study participants had a low risk score, in keeping with a study done in South West Nigeria, by Olutayo *et al*. [18] In contrast, Dagdiya *et al*. in India, reported that majority of the participants had a slightly elevated risk [19]. From the study, the majority of the participants had a normal FPG, with the rate of pre-diabetes and undiagnosed diabetes at 18.7% and 7.5% respectively. The World Health Organization estimates the global prevalence of diabetes in adults as 9% which was slightly higher than the 7.5% recorded in the study, [20] while the WHO/IDF Expert Committee estimates the global prevalence of pre-diabetes using fasting blood glucose (IFG) to be 5% which was lower than the 18.7% noted in the study [21].

There was a significant positive correlation between the fasting plasma glucose and the diabetes risk score, with a Pearson´s correlation coefficient (r) of 0.52. This was similar to a study by Olamoyegun *et al*. [22]. From our study, the FINDRISC score had a good diagnostic property with a sensitivity of 82.9% and specificity of 89.7%. This showed that the FINDRISC score was a good screening tool for detecting pre-diabetes and undiagnosed diabetes among the study population. These results are limited by the fact that this was a hospital-based study. This is reflected in some of the socio-demographic

characteristics, which may not be representative of the general population. One other limitation of this study was the study design, which was analytic cross-sectional in nature. Hence, it was difficult to predict future development of diabetes in the study population, as there was no follow-up of the participants to actually know those who developed diabetes over time.

Conclusion

The study found a statistically significant relationship between the FINDRISC score and the fasting blood glucose in detecting pre-diabetes and undiagnosed diabetes. Furthermore, the diagnostic properties indicated that the FINDRISC score is a good screening tool for detecting pre-diabetes and undiagnosed diabetes even in primary care settings. It is therefore recommended as a useful non-invasive, easy to use, and practical tool to screen for undetected diabetes and future development of diabetes among high risk groups in this study population.

What is known about this topic

- *Risk scores can be used to identify people at high risk of developing diabetes and those with undiagnosed diabetes.*

What this study adds

- *Risk for developing diabetes is higher than previously reported in the study area;*
- *The FINDRISC score is a good screening tool compared to standard screening test (fasting plasma glucose) even in primary care settings in low and medium income countries;*
- *A FINDRISC cut-off point of ≥17 gave very good sensitivity and specificity for diagnosing diabetes and pre-diabetes in the study population.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Anuga Godfrey Agbo: conception, design, data acquisition, data analysis, data interpretation, drafting the article, revision and final approval. Emmanuel Itodo Ogwuche: contributed to conception and design, critical revision and final approval. Musa Dankyau: contributed to conception and design, data interpretation, critical revision and final approval. All the authors have read and agreed to the final manuscript.

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Tables and figures

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Figure 1: study flow chart

Figure 2: diabetes risk assessment of the study participants

Figure 3: relationship between the fasting plasma glucose and FINDRISC scores of the study participants

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Table 1: socio-demographic and clinical characteristics of the study participants (N=187)

Variables	**Frequency**	**Percentage =100**
Age group (years)		
18-34	70	37.4
35-54	91	48.7
55-74	25	13.4
75 & above	1	0.5
Sex		
Male	81	43.3
Female	106	56.7
Level of education		
No formal education	9	4.6
Primary	25	13.4
Secondary	63	33.7
Tertiary	90	48.3
Occupation		
Employed	132	70.6
Unemployed	55	29.4
Religion		
Christianity	123	65.8
Islam	64	34.2
Marital status		
Single	47	25.1
Married	122	65.2
Divorced	2	1.1
Widowed	14	7.5
Separated	2	1.1
Clinical parameters	**Mean**	**Standard deviation**
Weight (kg)	73.3	14.4
Height (m)	1.7	0.1
BMI (kg/m^2)	25.4	5.3
Fasting blood glucose (mmol/l)	5.6	1.8

Table 2: diagnostic accuracy of the FINDRISC score for detecting pre-diabetes and undiagnosed diabetes at a cut-off of ≥ 17		
Serial number	**Parameters**	**Value**
1.	Sensitivity	82.9%
2.	Specificity	89.7%
3.	Positive predictive value	69.4%
4.	Negative predictive value	94.9%
5.	AUROC	0.86
6.	Diagnostic accuracy	88.2%
7.	Positive likelihood ratio	8.07
8.	Negative likelihood ratio	0.19
9.	Diagnostic odds ratio	44.18

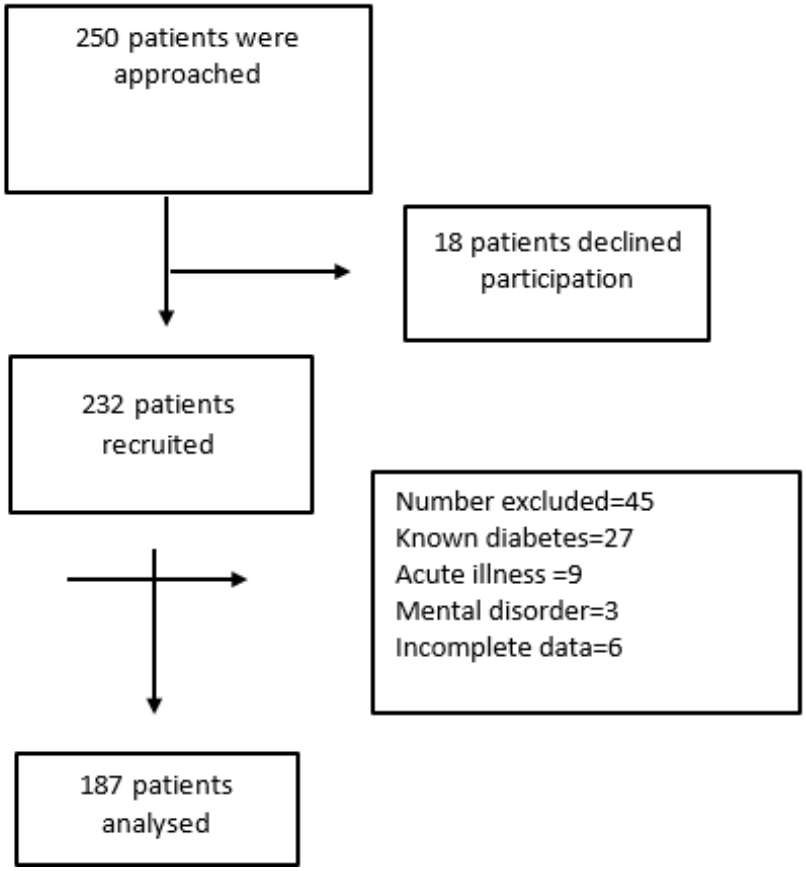

Figure 1: study flow chart

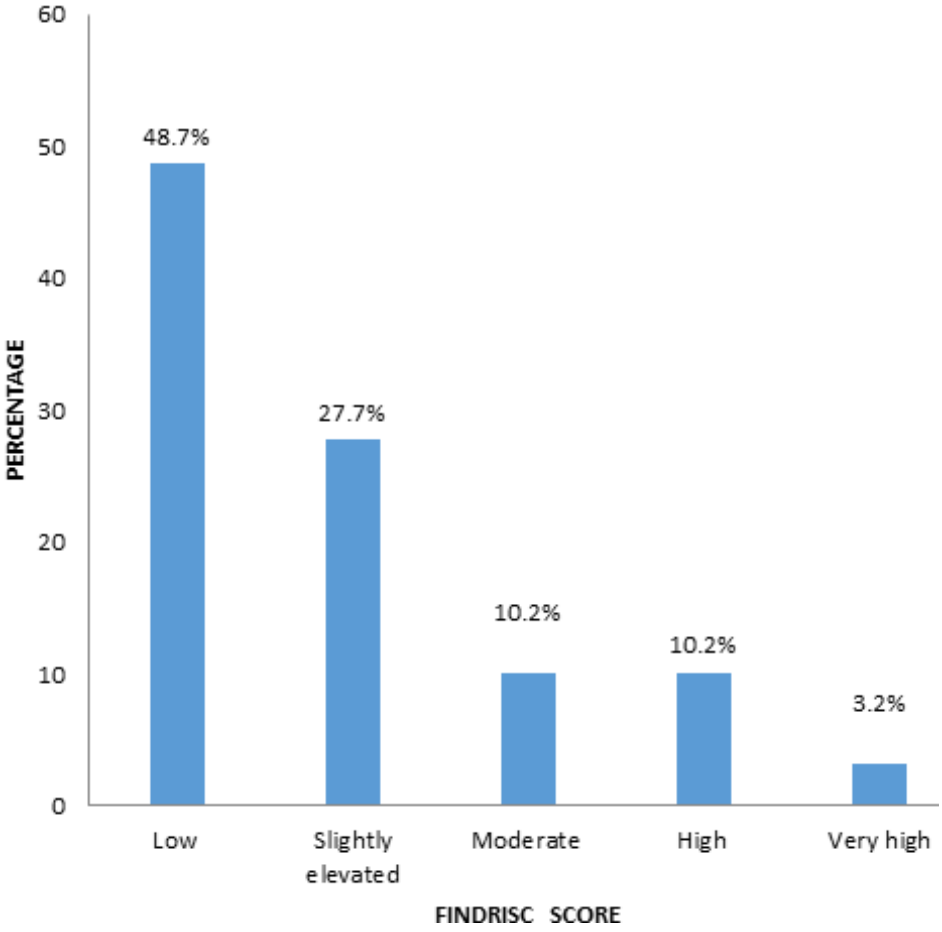

Figure 2: diabetes risk assessment of the study participants

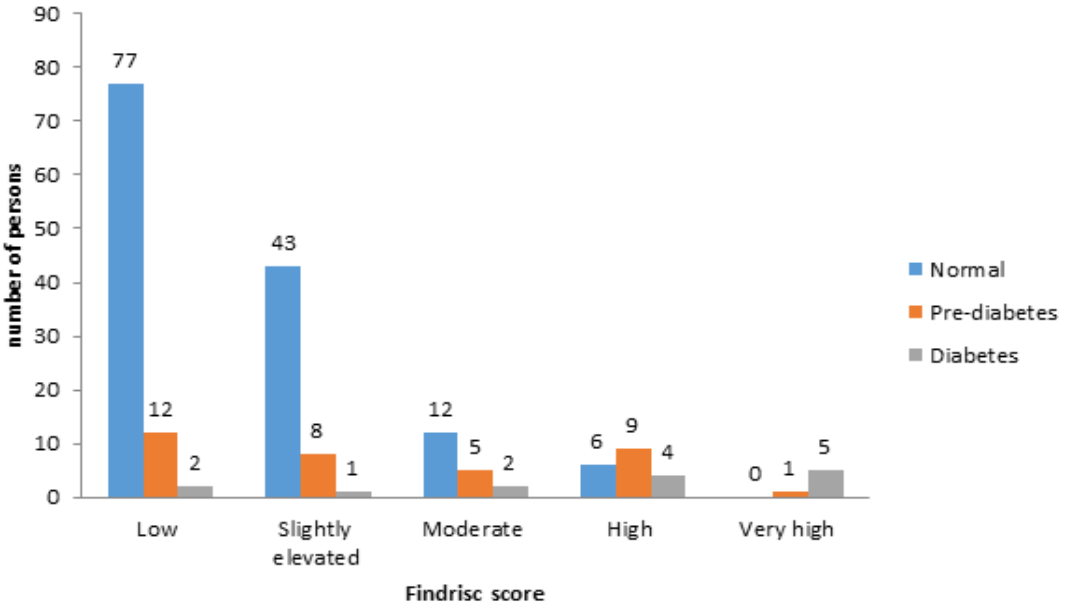

Figure 3: relationship between the fasting plasma glucose and FINDRISC scores of the study participants