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Research Article

Diabetes Risk Susceptibility and Associated Risk Factors among Undergraduates of a Private Medical University in Nigeria

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ABSTRACT

The identification of undiagnosed type-2 diabetes mellitus and the prevention of the disease in at-risk individuals can be achieved by diabetes risk scoring. This study was aimed at an assessment of diabetes risk susceptibility among undergraduate students of a private medical University in Nigeria. The study involved 153 participants (male and female) drawn from PAMO University of Medical Sciences, Port Harcourt, Nigeria. They were subjected to anthropometric measurements following standard protocol while diabetes risk scoring was done using the Finnish diabetes risk scoring (FINDRISC) tool. Majority of the participants (61.4%) were in the lowest age group of 15-20 years. More females (68.6%) relative to males (31.4%) participated in the study. Low risk was found in 68% (89.6% in males *vs* 58.1% in females), slightly elevated risk was found in 25.5% (8.3% in males *vs* 33.3% in females), moderately elevated risk was found in 4.6% (2.1% in males *vs* 5.7% in females) while high risk was found in 2% (0.0% in males *vs* 2.9% in females) of the study population. Females had elevated diabetes risk status compared to males. Risk status was significantly associated with participants' gender (p=0.002). Participants' body mass index (p<0.001), waist circumference (p<0.001), previous diagnosis of diabetes (p<0.001) and family history of diabetes (p<0.001) were significantly associated with the risk of future onset of type-2 diabetes mellitus. Lifestyle modification is recommended in the study population in order to forestall future transitioning of participants to a higher diabetes risk status.

Keywords: *Diabetes, Hyperglycemia, Lifestyle, Medical sciences, Risk factors, Risk susceptibility, Undergraduate,*

INTRODUCTION

Diabetes mellitus is a disease condition resulting from multiple defects in insulin secretion and/or insulin action that is signposted by chronic hyperglycemia (Todkar, 2016; IDF, 2019). The enormity of the public health significance of the disease is further accentuated by the currently estimated global burden of 537 million cases and a projected increase to 783 million cases by 2045 (IDF, 2021). Although previously considered as a disease of the elderly, the onset of the disease condition in young adults is an emerging public health concern (Nnamudi *et al*., 2020). This probably underscores the current global call for action especially amongst member nations of International Diabetes Federation (IDF) towards the identification of undiagnosed diabetes and the prevention of type-2 diabetes mellitus in individuals at risk (IDF, 2021).

The identification of high-risk individuals when they are still in the normoglycemic state is a strategic primary intervention underpinning the development of diabetes risk scoring tools such as the Finnish diabetes risk scoring (FINDRISC) tool. The FINDRISC tool developed from Finnish cohorts takes into cognizance eight variable components that are linked with anthropometric and lifestyle patterns. The components of the tool include age, body mass index, waist circumference, physical activity, consumption of vegetables, fruits or berries, use of blood pressure medication, previous diagnosis of high blood sugar and family history of diabetes (Lindström and Tuomilehto, 2003). These components are thought to contribute to overall diabetes risk susceptibility in any particular study population. Moreover, the FINDRISC tool – a simple, easy-to-use, non-invasive screening tool, has been validated in the original Finnish population cohorts where it was developed as well as in Nigerian populations. In these studies, the tool has been used exclusively as a reliable screening tool for diabetes risk. Additionally, the findings from studies relying on the FINDRISC tool are reliable as there are precisely-measured parameters (such as body-mass-index, waist circumference) in the tool (Lindström and Tuomilehto, 2003; Nnamudi *et al.,* 2020; Opara *et al.,* 2020).

Thus, the current research effort is not a misplaced priority as it is geared towards the attainment of the lofty IDF goals and the assessment of diabetes risk susceptibility among undergraduate students of a private medical University in Nigeria.

MATERIALS AND METHODS

Sample size determination

The sample size was determined using the formula of Vaughan and Morrow (1989):

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

Where:

N = sample size; P = maximum expected prevalence rate of diabetes mellitus; Q = 100 – P; and E = 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 6.53% in Rivers State, Nigeria (Nwafor *et al.,* 2024), a minimum sample size of 116 participants was determined for the study. To eliminate attrition bias, a sample size of 153 participants was adopted.

Study participants

The study involved apparently healthy male and female undergraduate students of PAMO University of Medical Sciences, Port Harcourt, Nigeria. A total of 153 participants (aged 16–34 years) who have been fully resident on the University campus for at least one full year and currently in the second year and/or third year of their undergraduate study were recruited by convenience sampling for this cross-sectional study. The participants read, understood and signed the informed consent form without coercion, to indicate their willingness to participate while Parents/Guardians of younger participants (aged 16–19 years) gave consent on behalf of such participants. As such, *bona fide* undergraduate students of the University were considered for inclusion in the study if they were willing to participate and if they did not satisfy any of the criteria for exclusion. Potential participants were excluded from the study on the basis of any of the following criteria: a prior diagnosis of diabetes, a baseline 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 and a decline of consent.

Ethical approval and consent to participate

This study was approved by the Research Ethics Committee of PAMO University of Medical Sciences, Port Harcourt, Nigeria (PUMS/REC/2023031). This study adopted the guidelines of the Helsinki Declaration of 1964 and later versions. All participants read, understood and signed the informed consent form prior to participating in the study.

Anthropometric measurements

All anthropometric measurements were done by trained research assistants and participants were not allowed to do self-measurement. Weight was measured using a standard weighing scale (Hana model, China) with participant in light clothing and without shoes. Height was measured using a stadiometer with participant in an erect posture and without shoes. Body mass index (BMI) was calculated by dividing weight by the square of height. Additionally, BMI charts were also provided to simplify the estimation of BMI. Waist circumference was measured using a non-stretchable measuring tape with the participant in an erect posture and measurement was taken in the horizontal plane at the midpoint between the lowest rib and the iliac crest.

Risk scoring Questionnaire

Participants' risk scores were determined using the FINDRISC questionnaire which has been described in detail in a previous paper (Nnamudi *et al.,* 2020). Participants were assisted by trained research assistants in completing their questionnaires. However, apart from anthropometric measurements, participants provided self-reported information as questionnaire responses. The total risk score was obtained as the sum of the different components of the FINDRISC tool. Depending on the risk score obtained, stratification of participants into various categories was done viz; < 7 (low risk); 7-11 (slightly elevated risk); 12-14 (moderately elevated risk); 15-20 (high risk).

Data analysis

Data 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 error of mean for continuous variables and as proportions for categorical variables. Chi-square (for categorical variables), t-test or one-way analysis of variance (ANOVA) followed by Duncan test (for continuous variables) was used for comparison. The association between parameters was determined using Pearson correlation analysis.

RESULTS

Table 1: Socio-demographic characteristics of study participants

Parameter	Frequency (n = 153)	Percentage (%)
Age		
15 – 20	94	61.4
21 – 25	48	31.4
26 – 30	7	4.6
31 – 35	4	2.6
Gender		
Male	48	31.4
Female	105	68.6
Religion		
Christianity	136	88.9
Islam	2	1.3
Traditionalist	2	1.3
Atheist	4	2.6
Others	9	5.9
Ethnicity		
Ikwerre	79	51.6
Ogoni	11	7.2
Andoni	18	11.8
Etche	7	4.6
Eleme	12	7.8
Others	26	17.0

Most of the participants (61.4%) were in the lowest age group of 15-20 years. More females (68.6%) than males participated in the study. Whereas Christianity (88.9%) was the dominant religion amongst the participants, Ikwerre (51.6%) was the dominant ethnic group in the study population (Table 1).

From the BMI, Overweight and Obesity were found in 21.6% and 5.9% of the study participants, respectively. More females relative to males were overweight (26.7% vs 10.4%) and obese (6.7% vs 4.2%). From the waist circumference, 24.9% and 12.4% of the participants had elevated waist circumference indicative of overweight and obesity, respectively. More females had elevated waist circumference than males. More than half (53.6%) of the study population do not have daily physical activity with a female preponderance of physical inactivity (60.0% vs 39.6%) relative to males. The Chi-square analysis revealed that BMI (p=0.050), waist circumference (p<0.001) and daily physical activity (p=0.019) were significantly associated with participants' gender (Table 2).

All participants who were overweight or obese by BMI (100%) had elevated risk status. Most of the participants who were overweight or obese by waist circumference (90%) had elevated risk status. All the participants who had no previous diagnosis of diabetes (100%) had low risk status while majority of participants with a family history of diabetes involving first degree relatives (80%) had elevated risk status. The Chi-square analysis revealed that BMI (p<0.001), waist circumference (p<0.001), previous diagnosis of diabetes (p<0.001) and family history of diabetes (p<0.001) were significantly associated with participants' risk status (Table 3).

Female participants' had significantly higher mean values of FINDRISC (p<0.001), pulse (p<0.001) and BMI (p=0.015) while males had significantly higher mean values of systolic blood pressure (p<0.001) in Table 4.

Participants in the FINDRISC high risk category had significantly higher mean values of body mass index (p<0.001), waist circumference (p<0.001) and FINDRISC (p<0.001) relative to the lower FINDRISC categories (Table 5).

In Table 6, Pearson correlation analysis showed that although systolic blood pressure (p=0.037) had a significant negative correlation with FINDRISC, other parameters such as body mass index (p<0.001), waist circumference (p<0.001), diastolic blood pressure (p=0.004) and pulse (p=0.048) had significant positive correlation with FINDRISC. Waist circumference was the strongest positively correlated variable to FINDRISC, (r (153) = + 0.593, p < 0.001).

Low risk was more prevalent in males relative to females. However, female participants had a higher prevalence of participants with slightly elevated risk, moderately elevated risk and high risk of developing diabetes relative to the male participants. The Chi-square analysis revealed that risk status (p=0.002) was significantly associated with participants' gender (Table 7).

Whereas 68.0% of the participants had a low risk of developing diabetes, 6.6% of the total study participants had a moderately elevated to high risk (FINDRISC ≥ 12) of developing diabetes in the population (Figure 1).

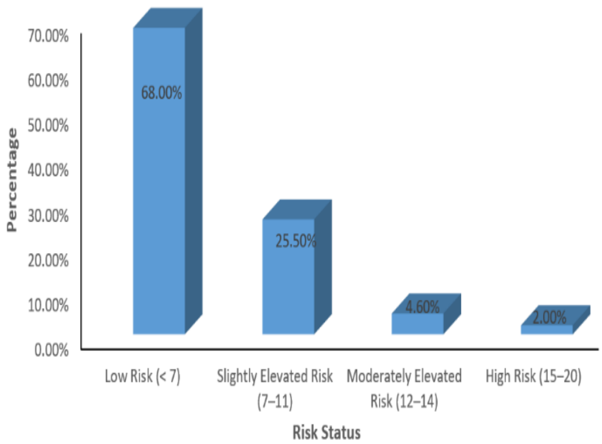

Figure 1. Diabetes risk susceptibility in the study population

Table 2. Distribution of FINDRISC components across gender in the study population

Parameter	Low Risk n (%)	Elevated Risk n (%)	Total	df	χ^2	*p*
Body Mass Index (BMI)						
Normal weight by BMI (< 25 kg/m^2)	111 (77.6)	0 (0.0)	111	2	36.261[a]	< 0.001
Overweight by BMI (25-30 kg/m^2)	27 (18.9)	6 (60.0)	33			
Obesity by BMI (> 30 kg/m^2)	5 (3.5)	4 (40.0)	9			
Waist Circumference (WC)						
Normal weight by WC: < 94 cm (M); < 80 cm (F)	95 (66.4)	1 (10.0)	96	2	33.412[a]	< 0.001
Overweight by WC: 94-102 cm (M); 80-88 cm (F)	36 (25.2)	2 (20.0)	38			
Obesity by WC: > 102 cm (M); > 88 cm (F)	12 (8.4)	7 (70.0)	19			
Daily Physical Activity (at least 30 minutes)						
Yes	69 (48.3)	2 (20.0)	71	1	2.999[a]	0.083
No	74 (51.7)	8 (80.0)	82			
Consumption of Vegetables, Fruit or Berries						
Every day	2 (1.4)	0 (0.0)	2	1	0.214[a]	0.899
Not every day	141 (98.6)	10 (100.0)	151			
Use of High Blood Pressure Medication						
No	142 (99.3)	10 (100.0)	152	1	0.070[a]	0.791
Yes	1 (0.7)	0 (0.0)	1			

Except otherwise indicated, data is presented as absolute number (absolute frequency)

Table 3 Association of FINDRISC parameters with risk status

Parameter	Low Risk n (%)	Elevated Risk n (%)	Total	df	χ^2	*p*
Body Mass Index (BMI)						
Normal weight by BMI (< 25 kg/m^2)	111 (77.6)	0 (0.0)	111	2	36.261[a]	< 0.001
Overweight by BMI (25-30 kg/m^2)	27 (18.9)	6 (60.0)	33			
Obesity by BMI (> 30 kg/m^2)	5 (3.5)	4 (40.0)	9			
Waist Circumference (WC)						
Normal weight by WC: < 94 cm (M); < 80 cm (F)	95 (66.4)	1 (10.0)	96	2	33.412[a]	< 0.001
Overweight by WC: 94-102 cm (M); 80-88 cm (F)	36 (25.2)	2 (20.0)	38			
Obesity by WC: > 102 cm (M); > 88 cm (F)	12 (8.4)	7 (70.0)	19			
Daily Physical Activity (at least 30 minutes)						
Yes	69 (48.3)	2 (20.0)	71	1	2.999[a]	0.083
No	74 (51.7)	8 (80.0)	82			
Consumption of Vegetables, Fruit or Berries						
Every day	2 (1.4)	0 (0.0)	2	1	0.214[a]	0.899
Not every day	141 (98.6)	10 (100.0)	151			
Use of High Blood Pressure Medication						
No	142 (99.3)	10 (100.0)	152	1	0.070[a]	0.791
Yes	1 (0.7)	0 (0.0)	1			
Previous Diagnosis of Diabetes						
No	143 (100.0)	7 (70.0)	150	1	43.758[a]	< 0.001
Yes	0 (0.0)	3 (30.0)	3			
Family History of Diabetes						
No	85 (59.4)	1 (10.0)	86	2	23.742[a]	< 0.001
Yes: Second Degree Relatives	35 (24.5)	1 (10.0)	36			
Yes: First Degree Relatives	23 (16.1)	8 (80.0)	31			

Except otherwise indicated, data is presented as absolute number (absolute frequency)

Table 4: Participants' characteristics across gender

Parameter	Male (n=48)	Female (n=105)	Total (n=153)	t	*p*
Body Mass Index (kg/m^2)	22.22 ± 0.60	24.17 ± 0.46	23.56 ± 0.37	2.463	0.015
Waist Circumference (cm)	79.40 ± 0.95	81.69 ± 1.05	80.97 ± 0.79	1.359	0.176
Systolic Blood Pressure (mmHg)	130.92 ± 2.09	119.70 ± 0.98	123.22 ± 1.03	-5.545	< 0.001
Diastolic Blood Pressure (mmHg)	76.13 ± 1.48	78.10 ± 0.76	77.48 ± 0.70	1.319	0.189
Pulse (beats/minute)	67.21 ± 1.42	79.66 ± 0.92	75.75 ± 0.90	7.474	< 0.001
FINDRISC	3.67 ± 0.37	6.37 ± 0.34	5.52 ± 0.28	4.831	< 0.001

Data is presented as Mean ± Standard error of mean except otherwise indicated.

Table 5: Participants' characteristics across FINDRISC categories

Parameter	< 7 (n=104)	7–11 (n=39)	12–14 (n=7)	15–20 (n=3)	F	*p*
Body Mass Index (kg/m^2)	22.05 ± 0.32^{a}	25.48 ± 0.69^{a}	29.41 ± 2.03^{b}	37.45 ± 3.09^{c}	29.129	< 0.001
Waist Circumference (cm)	77.49 ± 0.58^{a}	85.74 ± 1.51^{b}	94.43 ± 5.47^{c}	108.33 ± 9.24^{d}	32.401	< 0.001
Systolic Blood Pressure (mmHg)	124.54 ± 1.30^{a}	120.13 ± 1.89^{a}	121.43 ± 2.43^{a}	122.00 ± 7.57^{a}	1.207	0.309
Diastolic Blood Pressure (mmHg)	76.44 ± 0.85^{a}	79.33 ± 1.31^{a}	79.29 ± 3.21^{a}	85.33 ± 5.33^{a}	2.070	0.107
Pulse (beats/minute)	74.76 ± 1.11^{a}	77.85 ± 1.74^{a}	78.14 ± 4.32^{a}	77.33 ± 2.91^{a}	0.858	0.465
FINDRISC	3.63 ± 0.18^{a}	8.51 ± 0.20^{b}	12.57 ± 0.20^{c}	16.00 ± 1.00^{d}	173.948	< 0.001

Data is presented as Mean ± Standard error of mean except otherwise indicated. Values bearing different superscript are significantly different at p<0.05.

Table 6: Correlation analysis of FINDRISC with some parameters

	FINDRISC	
	R	***p***
Body Mass Index (kg/m^2)	0.587**	<0.001
Waist Circumference (cm)	0.593**	<0.001
Systolic Blood Pressure (mmHg)	-0.169*	0.037
Diastolic Blood Pressure (mmHg)	0.234**	0.004
Pulse (beats/minute)	0.160*	0.048

**Correlation is significant at the 0.05 level (2 –tailed). **Correlation is significant at the 0.001 level (2-tailed)*

Table 7: Risk prevalence across gender in the study population

Risk Status	Male n (%)	Female n (%)	χ^2	*p*
Low Risk (< 7)	43 (89.6)	61 (58.1)	15.203^{a}	0.002
Slightly Elevated Risk (7–11)	4 (8.3)	35 (33.3)		
Moderately Elevated Risk (12–14)	1 (2.1)	6 (5.7)		
High Risk (15–20)	0 (0.0)	3 (2.9)		

Except otherwise indicated, data is presented as absolute number (absolute frequency)

DISCUSSION

As the global burden of diabetes mellitus continues to rise, there is need to timeously tackle the trend especially in resource-scarce regions of the world lacking quality health care services. Given that the cure for diabetes mellitus remains elusive, efforts to prevent or delay the onset of the disease condition must be prioritized across the globe. It is in the light of the foregoing that susceptible individuals must be identified early enough for screening. The identification of such individuals can be achieved via diabetes risk scoring using tools such as the Finnish diabetes risk score (Lindström and Tuomilehto, 2003) as was done in this study involving young Nigerian undergraduates of a private medical University.

In the overall population, 2% of the participants had a high risk of developing T2DM. This result is consistent with a previous report in a young Nigerian population that reported a 1.5% prevalence of high risk participants (Nnamudi *et al.,* 2020) and another study that reported a 1.8% high risk prevalence amongst young undergraduate students in Jordan (Al-Shudifat *et al.,* 2017). However, it is lower than the 9.0% and 9.1% high risk reported in previous studies conducted amongst older Nigerian populations by Agu *et al.* (2015) and Alebiosu *et al.* (2012) respectively. The discrepancy is most probably age-related since increasing age is a known risk factor for developing T2DM and the complications of the disease (Omar *et al.,* 2019; Ismail *et al.,* 2021). This amply justifies the design of risk scores and the prioritization of participants who are at least 40 years old for diabetes risk assessment. The role of aging in the causation of T2DM is most probably hallmarked by insulin resistance. Aging increases chronic inflammation which gives rise to insulin resistance (Sarkar *et al.,* 2004). Also, age-related disorders of lipid metabolism lead to body fat accumulation and a rise in the concentration of free fatty acids in the blood which eventually leads to insulin resistance (Suastika *et al.,* 2012). Whether aging is an independent risk factor is still debatable (Ismail *et al.,* 2021). Notwithstanding, it is now established that young-onset T2DM occurring at an age less than 40 years, progresses aggressively and leads to a longer disease exposure with an increased risk for associated complications of the disease (Lascar *et al.,* 2018). Therefore, the current study findings should ordinarily elicit public health concern in order for the high risk participants to timeously adopt lifestyle practices that will lower their risk status.

The results of the study showed a preponderance of female participants having elevated diabetes risk status relative to the male participants. This pattern is consistent with the FINDRISC scoring components which are predominant in females relative to males in this study population. Risk status is a resultant sum of the various scoring components. The results of this study are in agreement with earlier studies of Kautzky-Willer *et al.* (2016) and Opara *et al.* (2020). Females have been reported to have a higher risk of T2DM relative to males and this has been attributed to their higher body fat composition (Kautzky-Willer *et al.,* 2016). However, the evidence of the close association of insulin resistance with abdominal fat distribution peculiar in males appears contradictory (Miyazaki and DeFronzo, 2009) as abdominal obesity is a male-specific risk factor even for prediabetes (Siddiqui *et al.,* 2020). It is therefore thought that the gender differences in T2DM risk may be due to a constellation of socio-cultural factors and biological differences (Mauvais-Jarvis, 2018; Krag *et al.,* 2016; Nnamudi *et al.,* 2020; Nnamudi *et al.,* 2023). Moreover, gender-based differences in some aspects of glucose homeostasis has been reported (Mauvais-Jarvis *et al.,* 2018).

In this study, the FINDRISC tool had a significant positive correlation with body mass index and waist circumference. A similar finding has been reported in previous studies (Mahmoud *et al.,* 2021; Nnamudi *et al.,* 2022). Additionally, this study reported a significant association of participants' body mass index, waist circumference, previous diagnosis as well as a family history of T2DM with the risk of developing T2DM. This significant association may also further justify why these risk factors are high scoring components in the FINDRISC tool (Lindström and Tuomilehto, 2003). Beyond the fact that obesity is a known risk factor that is linked with T2DM susceptibility (Nnamudi *et al.,* 2023), central obesity defined by waist circumference is highly associated with the risk of T2DM when compared with overall obesity defined by body mass index (Ohnishi *et al.,* 2006). Abdominal fat increases inflammation leading to insulin resistance via the disruption of beta-cell function (Ismail *et al.,* 2021). The result of this study is consistent with a previous study that found family history and obesity to be significantly associated with the onset of prediabetes or future T2DM (Yan *et al.,* 2016). A family history of diabetes particularly in first degree relatives is a strong and independent risk factor for prediabetes in adolescents (Rodríguez-Moran *et al.,* 2010). The association between obesity and diabetes mellitus is further strengthened with a family history of diabetes (Sargeant *et al.,* 2000).

There was unavoidable gender bias in sampling as more females participated in the study. However, this bias aligns with the gender distribution in the University which currently ranks first in female enrolment index amongst Nigerian Universities. Diet diversity and nutritional variation is almost non-existent in the study due to the uniqueness of the study population. Participants in the study are fully resident on campus and in line with University policy, they follow the same dietary pattern. As such, variations in nutritional pattern and diet diversity did not bias results. Some of the data obtained for this study were self-reported and may be biased if participants under-reported negative characteristics and amplified positive traits. For most studies involving diabetes risk assessment tools, social desirability bias is an unavoidable and common limitation since some of the risk scoring parameters (including family history of diabetes) relies on self-reported data. An attempt to precisely tackle this challenge has led to the development of a diabetes risk prediction equation (Nnamudi *et al.,* 2022) for which further validation studies are currently on-going. Nevertheless, the sampling of apparently healthy young adults without any known underlying health issue is a major strength of this study.

CONCLUSION

The findings of the study showed that 2% of the study participants had high risk of developing type-2 diabetes mellitus in the future. There was a female preponderance of diabetes risk susceptibility in the population. Participants' body mass index, waist circumference, previous diagnosis of diabetes and family history of diabetes were significantly associated with the risk of future onset of type-2 diabetes mellitus. In order to forestall future transitioning of participants to a higher diabetes risk status, there is urgent need for lifestyle modification in the study population.

ABBREVIATIONS

BMI – Body mass index; **FINDRISC** – Finnish diabetes risk score; **IDF** – International Diabetes Federation; **SPSS** – Statistical package for social sciences; **T2DM** – Type-2 diabetes mellitus; **WC** – Waist circumference

AUTHORS' CONTRIBUTIONS

ACN: Conceptualization; Investigation; Data curation; Formal analysis; Project administration; Funding acquisition; Writing – original draft. **UEB:** Conceptualization; Methodology; Supervision; Funding acquisition; Writing – review & editing. OEE: Supervision; Funding acquisition; Writing – review & editing. **FU:** Investigation; Formal analysis; Funding acquisition. **INE:** Conceptualization; Methodology; Supervision; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

FUNDING STATEMENT

None

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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