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PREVALENCE AND RISK FACTORS ASSOCIATED WITH DIABETES MELLITUS AMONG CHILDREN OF PARENTS LIVING WITH DIABETES IN ONDO STATE, NIGERIA

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ABSTRACT

Family history is recognized as one of the risk factors of diabetes mellitus, which could be used to single out individuals at various stages of risk and impact health-promoting behaviors and extend preventive efforts to such members of the family. To establish the prevalence of diabetes mellitus and problems associated with it among children of diabetic parents in Ondo state, Nigeria. The study comprises children of parents living with diabetes (n = 129) and children of parents without diabetes (n = 130) aged between18-59 years. The participants were recruited from various diabetes clinics in Government Hospital, Akure metropolis and University Teaching Hospital, Ondo State, Nigeria. Blood samples were collected, separated and stored for fasting blood glucose, glycated hemoglobin and fasting insulin analysis. Diabetes mellitus was determined using diagnostic criteria of glycated hemoglobin (HbA1c) level ≥48mmol/mol (≥ 6.5%) and fasting blood glucose (FBG) level ≥7.0 mmol/L. The incidence of diabetes mellitus was 38.8% and 14.0% among children of diabetic parents based on HbA1c and FBG criteria respectively. Among children of diabetic parents, higher ($p < 0.05$) prevalence of diabetes mellitus was observed in older adults, females, married, overweight/obese and those whose mothers were diabetic compared with younger adults, males, singles, normal weight and those whose fathers were diabetic respectively. The present findings call for an urgent need to improve healthy living that will lessen the risk of diabetic mellitus among children of diabetic parents and the general population.

Keywords: *Diabetes, HbA1c, Children, Prevalence, Risk factors.*

INTRODUCTION

Diabetes mellitus (DM) is a common, chronic, non-communicable, metabolic disease recognized worldwide as one of the leading causes of death and disability and affects people regardless of country, age group, or sex (GBD Diabetes Collaborators, 2021). Estimates by the International Diabetes Federation (IDF) indicate that 537 million people worldwide had diabetes in 2021 (IDF, 2021), and the number is projected to increase by 25% in 2030 and 51% in 2045 (Saeedi *et al.*, 2019). An increase in prevalence has also been observed in Africa, with about 24 million people estimated to live with diabetes in 2021, and the prevalence is predicted to increase by 129% to 55 million by 2045 (WHO, 2023). Among the countries in sub-Saharan Africa, Nigeria is noted to be currently experiencing an increase in the prevalence of diabetes mellitus. Currently, in Sub–Saharan Africa, Nigeria has the second highest incidence of diabetes after South Africa, with about 3.6 million people (aged 20 – 79 years) living with DM (WHO, 2O23). Approximately 3.7% of adult Nigerians (20 – 79 years) are living with DM according to a recent International Diabetes Federation report (IDF, 2021). Rapidly changing anthropometric and demographic trends, increased rate of urbanization, unhealthy diets, and gradual adoption of Western lifestyles in many African settings have been linked to the high prevalence of diabetes mellitus in Africa, particularly Nigeria (Mbanya *et. al*., 2010).

Diabetes mellitus is recognized as a hereditary condition that is passed from one generation to the next, thus research on parental transmission of diabetes can shed light on the relative roles of underlying maternal and paternal factors. Furthermore, primary preventive interventions for diabetes can also be developed based on the risk factors of the disease. A family history of diabetes has been recognized as one of the most significant risk factors for the disease (Annis *et al.*, 2005). According to Harrison *et al.* (2003), a family history of diabetes may be utilized to identify people at varying risk levels, encourage health-promoting behaviors, and target family members who may be more susceptible to the disease with preventative measures. Information from family therefore may serve as a unique and useful tool for public health and preventive medicine because it characterizes the combined interactions between environmental, behavioral, and genetic factors (Annis *et al.*, 2005).

There is insufficient literature on the occurrence of diabetes mellitus among children of parents living with the disease in Nigeria. Furthermore, the association between the related risk factors and family history among the children of diabetic patients is not well documented. The risk of coming up with diabetes mellitus is high in the children of patients living with type 2 diabetes (Kim, 2002), and has been estimated to be 2–4 times higher than in children of parents without diabetes (Kobberling, 2018). The present study is therefore aimed at establishing the frequency and risk factors associated with diabetes mellitus among offspring of diabetic parents in Ondo state, Nigeria.

METHODOLOGY

Study Design

This research is a hospital-based, case-control study that involves both descriptive and analytical methodologies. The study sample was made up of a cross-section of adult males and females, aged 18 years and above, who were children of diabetic (n = 129) and non-diabetic parents (n = 130). The patients were enlisted from various diabetes clinics in Government Hospital, Akure metropolis, and University Teaching Hospital, Ondo, both in Ondo State, Nigeria. The

children of the registered diabetic parents were persuaded to use a noteworthy educational program on paternal diabetes, after this program, they were invited to take part in this study. Children of diabetic patients therefore had one or both parents living with the disease. The control group (children of parents without diabetes mellitus) was recruited from residents of Akure and Ondo towns of Ondo state and each of them was asked if either of his or her parents had been diagnosed with diabetes mellitus by a physician. The parents of children who responded 'no' to the question were then screened to ascertain they had no diabetes mellitus. The children of parents living with diabetes and those not living with the disease were also examined and diagnosed by a physician to determine whether they had diabetes mellitus or not. Individuals who were below the age of eighteen and those who did not give their consent were excluded. Also excluded were pregnant women, children who were not certain of the diabetic status of their parents, those who had underlying ailments, such as heart disease, hypertension, and lung disease, and those confirmed not to have fasted 8 -12 hours before blood glucose and insulin tests. The pains and gains of the research were made known to each of the participants to seek their consent. A well-prepared structured questionnaire was administered to everyone who enrolled in this study.

Questionnaire/ Ethical Approval

The participants were administered a structured open-ended questionnaire, made up of simple questions to elicit details about their data including age, sex, state of origin, occupation, marital status, family history of diabetes mellitus, current medications, as well as any underlying disease. The committees on ethics at the Ministry of Health, Ondo State, and the University of Medical Sciences Teaching Hospital, Ondo State approved this study.

Blood Sample Collection and Analysis

Under aseptic conditions, a sterile needle and syringe were used to collect about 5 millimeters of fasting blood samples from the ante-cubical vein of each subject. Three millimeters of the blood sample were dispensed into plain, non-anticoagulated bottles and the remaining 2ml into EDTA bottles for determination of glucose and glycated hemoglobin. The sample in the plain container was left to clot and centrifuged at 4000rpm for about 5 minutes for separation of serum from the clot. The separated serum was dispensed into another clean and dry plain container. The serum samples were stored at -20^0C before the analysis of insulin.

Sample Analysis

Glucose Estimation

The concentration of glucose was determined using a commercially purchased glucometer (Finetest, LOT Number A21JO79C1) after the participant had fasted for 8 to 12 hours. The participants were well instructed on the fasting procedures and were asked before the blood glucose test whether they fasted as instructed. Those who could not adhere to the instructions were not allowed to continue with the study.

Glycosylated Hemoglobin (HbA1c) Estimation

The estimation of HbA1c was done by the Modified Enzymatic method from the EDTA sample within 12 hours by following the manufacturer's protocols. The kit was commercially purchased from Fortress with LOT number 220525.

The diagnosis of diabetes was established considering the American Diabetes Association diagnostic criterion of HbA1c level ≥ 6.5% (IEC, 2009) and fasting blood glucose level ≥7.0 mmol/L (Sacks *et al.*, 2011).

Insulin Determination

Fasting insulin level was determined by solid phase sandwich ELISA kit within 30 days of storage by following the manufacturer's protocols. The kit was commercially purchased from Calbiotec with LOT number IN374S. Hyperinsulinemia was defined as insulin level ≥ 15mlU/L (Vaidya *et al.*, 2023).

Measurement of Anthropometric Indices

The weight of every participant was measured in kilograms using a standard scale, with the participant wearing light clothes and no shoes. The height in meters was determined with a stadiometer. Body mass index (BMI) was derived from the relationship between the ratio of height and weight (kg/m^2) of the participants. The reference normal value for BMI was taken as 18 - 25 kg/m^2.

Data Analysis

Data for continuous variables were expressed as means and standard deviation, while categorical data were expressed as percentages. Independent samples t-test was used to compare two parametric groups, but weighted categorical data were compared using the Chi-square test. The odds of developing diabetes were determined using logistic regression. $P < 0.05$ was chosen as the test of statistical significance. Statistical Software for Social Sciences (version 25.0) was used to carry out all statistics.

RESULTS

Table 1. Demographic and Anthropometric Characteristics of the Study Participants

Characteristics	**Children with Diabetic Parents, n = 129 [Mean ± SD or n (%)]**	**Children with Non-Diabetic Parents, n = 130 [Mean ± SD or n (%)]**	**Statistics** *t -Stat* **or Chi-Square**	**P – Value**
Age (years)	37.26 ± 11.66	37.15± 10.01	*0.08*	0.935
<35 years	57 (44.2)	48 (36.9)	1.42	0.234
≥35 years	72 (55.8)	82 (63.1)		
Sex				
Males	46 (35.7)	40 (30.8)	0.69	0.403
Females	83 (64.3)	90 (69.2)		
Marital Status				
Married	86 (66.7)	96 (73.8)	1.59	0.206
Single	43 (33.3)	34 (26.2)		
Weight (kg)	74.78 ± 15.03	76.01 ± 17.72	*-0.60*	0.547
Height (m)	1.62 ± 0.09	1.59 ± 0.09	*2.78*	0.006

BMI (kg/m^2)	28.45 ± 5.76	30.04 ± 6.52	*-2.08*	0.055
Normal	40 (31.0)	38 (29.2)		
Overweight	32 (24.8)	30 (23.1)	12.11	0.017
Obese I	41 (31.8)	32 (24.6)		
Obese II	14 (10.9)	14 (10.8)		
Obese III	2 (1.6)	16 (12.3)		

Abbreviation: BMI = Body Mass Index

Table 1 reveals selected socio-demographic and anthropometric characteristics of the study population. Independent sample t-test indicated no significant difference between the mean age of children of non-diabetic parents (37.15 ± 10.01 years) and that of the children of parents with diabetes (37.26 ± 11.66 years). Similarly, no significant differences were found in body weight (p = 0.547) and BMI (p = 0.055) between the two groups. In contrast, the children of the diabetic parents indicated significantly (p = 0.025) higher mean height (1.62 ± 0.09 meters) compared with the children of the non-diabetic parents (1.59 ± 0.09 meters). A greater percentage of the children of parents without diabetes were found within the age group ≥35 years (63.1%); in females (69.2%); in married participants (73.8%); and in those with normal BMI (29.2%). Similarly, children with diabetic parents were mostly females (64.3%), in the age group ≥35 years (55.8%), married (66.7%), and with normal BMI (31%).

Table 2. The Mean Glycated Hemoglobin, Blood Glucose and Insulin Levels in Children of Non-Diabetic Parents and Children of Diabetic Parents.

Variables	**Children with Diabetic Parents, n = 129** **Mean ± SD**	**Children with Non-Diabetic Parents, n = 130** **Mean ± SD**	**t -Stat**	**P – Value**
Glycated Hemoglobin (%)	6.34 ± 1.62	5.44 ± 0.71	5.75	0.000
Fasting Blood Glucose (mmol/L)	5.84 ± 0.83	5.50 ± 0.66	3.61	0.000
Insulin (mlU/L)	12.52 ± 10.14	13.68 ± 9.21	-0.97	0.332

The mean levels of glycated hemoglobin levels, blood glucose and insulin of the children of parents without diabetes and those of the parents living with diabetes are presented in Table 2. Independent sample t-test revealed that children of diabetic parents indicated significantly increased mean glycated hemoglobin level (6.34 ± 1.62% vs. 5.44 ± 0.71%; p < 0.001) and higher blood glucose level (5.84 ± 0.83 vs. 5.50 ± 0.66; p < 0.001) compared with the children of the non-diabetic parents. No significant differences were observed in insulin levels between the children of diabetic parents and non-diabetic parents (12.52 ± 10.14 vs. 13.68 ± 9.21; p = 0.332).

Table 3: The Incidence of Diabetes Mellitus using Glycated Hemoglobin and Fasting Blood Glucose Levels by Parental History of Diabetes Mellitus

Variables	Children with Diabetic Parents, n = 129	Children with Non-Diabetic Parents, n = 130	Chi-Square	Odds Ratio (CI)	P - Value
HbA1C					
<6.5%	79 (61.2)	114 (87.7)	23.85	4.51 (2.39 – 8.48)	0.000
≥6.5%	50 (38.8)	16 (12.3)			
FBG					
<7.0 mmol/L	111 (86.0)	126 (96.9)	9.85	5.10 (1.67 – 15.54)	0.002
≥7.0 mmol/L	18 (14.0)	4 (3.1)			

Abbreviation: HbA1C = Glycated hemoglobin; FBG = Fasting blood glucose.

The incidence of diabetes mellitus (HbA1c ≥6.5%), was 38.8% among children of diabetic parents and 12.3% in those with non-diabetic parents (Table 3). Similarly, children of diabetic parents indicated a higher incidence of DM (FBG ≥7.0 mmol/L) compared to those with non-diabetic parents (14%vs 3.1%, p = 0.002). The bivalent logistic regression showed that children of diabetic parents were at greater odds of developing diabetes based on HbA1c (OR, 4.51; p < 0.001) and FBG (OR, 5.1; p = 0.002) cut-offs compared with the children of non-diabetic parents.

Table 4. Association of Diabetes Mellitus (Hba1c ≥6.5%) with Selected Risk Factors among Children of Diabetic Parents

Characteristics	Diabetic, n = 50	Non-Diabetic, n = 79	Odds Ratio	P – Value
Age Group				
<35 years	22 (44.0)	35 (44.3)	1.01	0.973
≥35 years	28 (56.0)	44 (55.7)	Reference	
Sex				
Males	18 (36.0)	28 (35.4)	1.02	0.949
Females	32 (64.0) *	51 (64.6)	Reference	
Marital Status				
Single	18 (36.0)	25 (31.6)	1.21	0.609
Married	32 (64.0) *	54 (68.4)	Reference	
BMI				
<25 kg/m^2	7 (14.0)	33 (41.8)	11.04	0.001
≥25 kg/m^2	43 (86.0) *	46 (58.2)	Reference	
Transmission of Diabetes				
Father	12 (24.0)	22 (27.8)	1.22	0.629
Mother	38 (76.0) *	57 (72.2)	Reference	

*Significant difference between diabetic groups. BMI = Body mass index.

Among 129 children of parents who are diabetic, who participated in the study, 50 (38.8%) had diabetes mellitus and 79 (61.2%) had no diabetes (Table 4). The prevalence of diabetes was higher among the age group ≥35 years compared with those aged <35 years (56% vs. 44%), but the findings were statistically not significant (p = 0.230). There was a higher proportion of female diabetics compared to males (64% vs. 36%; p = 0.005). Similarly, the incidence of diabetes

was elevated in married persons compared to unmarried individuals (64% vs. 36%; p = 0.005). Data showed that the diabetic individuals with elevated BMI (≥25kg/m^2) presented a higher frequency of diabetes (85% vs. 14%; p < 0.001) and an eleven-fold risk of developing diabetes mellitus compared with those with BMI <25 kg/m^2 (OR, 11.04; p = 0.001). There was an elevated occurrence of diabetes in patients whose mothers were diabetic than those whose fathers were diabetic (76% vs. 24%; p < 0.001).

Table 5. Association of Diabetes Mellitus (FBG ≥7.0 Mmol/L) with Selected Risk Factors among Children of Diabetic Parents

Characteristics	**Diabetic, n = 18**	**Non-Diabetic, n = 111**	**Odds Ratio**	**P – Value**
Age Group				
<35 years	3 (16.7)	54 (48.6)	4.73 (1.29 – 17.28)	0.011
≥35 years	15 (83.3) *	57 (51.4)	Reference	
Sex				
Males	6 (33.3)	40 (36.0)	0.88 (0.31 – 2.54)	0.824
Females	12 (66.7) *	71 (64.0)	Reference	
Marital Status				
Single	3 (16.7)	40 (36.0)	2.82 (0.77 – 10.32)	0.106
Married	15 (83.3) *	71 (64.0)	Reference	
BMI				
<25 kg/m^2	3 (16.7)	37 (33.3)	2.50 (0.68 – 9.18)	0.156
≥25 kg/m^2	15 (83.3) *	74 (66.7)	Reference	
Transmission of Diabetes				
Father	2 (11.1)	32 (28.8)	3.24 (0.70 – 14.91)	0.113
Mother	16 (88.9) *	79 (71.2)	Reference	

*Significant difference between diabetic groups. BMI = Body mass index.

Using the FBG criteria of ≥7.0 mmol/L, eighteen (14%) of the children of diabetic parents indicated DM, while one hundred and eleven (86%) had no presence of DM (Table 5). Data showed that DM was more prevalent in: patients of age ≥35 years compared with those aged <35 years (83.3% vs. 16.7%; p < 0.001); females compared with males (66.7% vs. 33.3%; p = 0.001); married compared with singles (83.3% vs. 16.7%; p < 0.001); overweight/obese patients compared with patients with normal-weight (83.3% vs. 16.7%) and maternal transmission compared with paternal transmission (88.9% vs. 11.1%; p < 0.001).

Table 6: Assessment of Age, Body Mass Index and Insulin Statuses by Risk Factors among Diabetic Children of Parents Living with Diabetes using the HbA1c Criteria.

Variables	Age (years) Mean (SD)	Presence of Older Adults N (%)	Body Mass Index (kg/m^2) Mean (SD)	Presence of OW/ Obesity N (%)	Insulin Level (mlU/L) Mean (SD)	Presence of Hyper-insulinemia N (%)
Age Group						
<35 years	25.4 (6.1)		27.3 (5.6)	17 (39.5)	11.1 (9.1)	4 (36.4)
≥35 years	44.6 (5.3)*		32.3 (4.1)*	26(60.5) *	9.9 (7.9)	7 (63.6) *
Sex						
Males	37.6 (12.7)	7 (25.0)	29.7 (2.7)	18 (41.9)	14.6(11.1)	6 (54.5)
Females	35.4 (10.4)	21(75.0) *	30.3 (6.4)	25 (58.1)	8.1 (5.2)*	5 (45.5)
Marital Status						
Single						
Married	24.6 (6.5)	0	25.8 (4.9)	13 (30.2)	9.1 (5.4)	2 (18.2)
	42.7 (7.2)*	28 (100)	32.5 (3.9)*	30(69.8) *	11.2 (9.7)	9 (81.8) *
BMI						
<25 kg/m^2	26.2 (12.1)	2 (7.1)	20.8 (2.3)		4.7 (1.8)	0
≥25 kg/m^2	37.8(10.3)*	26(92.9) *	31.6 (3.9)*		11.4(8.7)*	11 (100)
Parent with Diabetes						
Father	33.0 (12.0)	6 (21.4)	26.2 (4.7)	7 (16.3)	11.9(11.6)	4 (36.4)
Mother	37.2(10.9)*	22(78.6) *	31.3 (5.0)*	36(83.7) *	10.0 (7.2)	2 (63.6) *

*Significant difference between diabetic groups. OW = Overweight; BMI = Body mass index.

Table 6 compares the mean levels for age, BMI, and insulin between the risk factor groups. Data indicated significantly higher age among married ($p < 0.001$), overweight/obese ($p = 0.01$) and children with diabetic mothers ($p = 0.042$) compared with the singles, normal weight, and children with diabetic fathers. A greater percentage of older participants ($p < 0.001$) was also found among the females, married, overweight/obese, and children with diabetic mothers compared with the males, singles, normal weight, and children with diabetic fathers. Significantly higher BMI was observed among older participants ($p = 0.001$), married ($p < 0.001$), and children of diabetic mothers ($p = 0.003$). A higher presence of overweight/obese individuals was found among the older ($p = 0.037$) and married ($p < 0.001$) patients as well as the children of the diabetic mothers ($p < 0.001$). Results indicated significantly elevated insulin levels among males ($p = 0.006$) and overweight/obese ($p < 0.001$) compared with females and normal-weight participants. A higher incidence of hyperinsulinemia was found among older adults ($p = 0.005$), married ($p < 0.001$), overweight/obese (100%), and children of diabetic mothers ($p = 0.005$) compared with younger, single, normal-weight participants and children of diabetic fathers respectively. The incidence of hyperinsulinemia did not differ between genders ($p = 0.371$).

Table 7: Assessment of Age, Body Mass Index, and Insulin Statuses by Risk Factors among Diabetic Children of Parents Living with Diabetes using the Fasting Blood Glucose Criteria.

Variables	Age (years) Mean ± SD	Presence of Older Adults N (%)	Body Mass Index (kg/m^2) Mean ± SD	Presence of OW/ Obesity N (%)	Insulin Level (mlU/L) Mean± SD	Presence of Hyper-insulinemia N (%)
Age Group						
<35 years	18.0 ± 0		22.9 ± 3.6	2 (13.3)	6.6 ± 0.8	0 (0)
≥35 years	50.5 ± 6.5*		30.9 ± 3.7*	13(86.7)*	13.5± 11.1*	4 (100)
Sex						
Males	51.3 ± 6.3	6 (40.0)	31.1 ± 1.8	6 (40.0)	15.0± 12.4	2 (50.0)
Females	42.0 ± 15.6	9 (60.0)*	28.9 ± 5.6	9 (60.0)*	11.1 ± 9.6	2 (50.0)
Marital Status						
Single						
Married	18.0 ± 0	0 (0)	22.9 ± 3.6	2 (13.3)	6.6 ± 0.8	0 (0)
	50.5 ± 6.5*	15 (100)	30.9 ± 3.7*	13(86.7)*	13.5± 11.1*	4 (100)
BMI						
<25 kg/m^2	35.3 ± 15.0	2 (13.3)	22.3 ± 3.1		5.1 ± 2.2	0 (0)
≥25 kg/m^2	47.1 ± 13.2	13(86.7)*	31.1 ± 3.5*		13.9± 10.8*	4 (100)
Parent with Diabetes						
Father	44.0 ± 0	2 (13.3)	24.1 ± 0	0 (0)	3.8 ± 0	0 (0)
Mother	45.2 ± 14.7	13(86.7)*	30.3 ±4.5*	15 (100)	13.5± 10.5*	4 (100)

*Significant difference between diabetic groups. Abbreviations: OW = Overweight; BMI = Body mass index.

Diabetic children of diabetic parents who were married indicated higher mean age ($p < 0.001$), compared with their single counterparts (Table 7). Though patients who were overweight/obese and whose mothers were diabetic indicated higher mean age compared with normal-weight patients and children with diabetic fathers, the difference was not statistically significant. A greater percentage of older participants was found among the females ($p = 0.046$), married (100%), overweight/obese ($p < 0.001$), and children with diabetic mothers ($p < 0.001$) compared with the males, singles, normal-weight, and children with diabetic fathers. Significantly higher BMI was observed among older participants ($p = 0.004$), married ($p = 0.004$) and children of diabetic mothers ($p <0.001$) compared with patients who were younger, single, and with diabetic fathers respectively. A higher presence of overweight/obese individuals was found among older participants ($p <0.001$), females ($p = 0.046$), married ($p < 0.001$), and those with diabetic mothers (100%). Results indicated significantly higher insulin levels among older participants ($p = 0.03$), married ($p = 0.03$), overweight/obese ($p = 0.011$), and diabetic mothers ($p = 0.002$) compared with younger participants, single, with normal-weight and with diabetic fathers. A higher incidence of hyperinsulinemia was found among the older adults (100%), married (100%), overweight/obese (100%) and children of diabetic mothers (100%) compared with younger, single, normal-weight participants and children of diabetic fathers respectively.

DISCUSSION

In this study, our data based on HbA1c threshold of 6.5%, indicated that the occurrence of diabetes mellitus among children of parents living with diabetes was 38.8%. This translated to a 4.5-fold increased risk of DM as compared to children of non-diabetic parents, who had a 12.3% prevalence of DM. According to the fasting blood glucose definition of ≥7.0 mmol/L, the prevalence for children of parents with diabetes was found to be 14.0%, while the prevalence for children of parents without diabetes was 3.1%. This result indicated that children of patients with DM had a 5.1-fold higher risk of having DM than children of parents without the disease. According to a previous study, children of type 2 diabetes patients indicated a 2-4 times higher chance of developing DM than children of parents without the disease (Kobberling, 2018).

Based on FBG criteria, the prevalence of DM among children of diabetic parents was 14%, whereas HbA1c criteria yielded a higher incidence of DM (38.8%). The American Diabetes Association (ADA) recently included the use of HbA1c as a diagnostic criterion for DM in its standards of care, following the International Expert Committee's (IEC, 2009) guidelines. When compared to FBG levels or glucose levels two hours after an oral glucose load of 75 grams, the consensus identified several benefits for HbA1c. In particular, compared to glucose, HbA1c was thought to have a more standardized assay, patient feasibility, an index of total glycemic exposure, and less exposure to biological variability, daily fluctuations, pre-analytical instability, prandial status, and acute stress (Rossi, 2010).

The older adult children of diabetic parents who were 35 years of age or older showed a greater prevalence of DM (56%) based on the HbA1c criterion than did the younger adult children who were under 35 years of age (44%), however, the difference was not statistically significant. Employing the FBG criteria, a far greater frequency was noted in the older adult offspring (83.3%) as opposed to the younger ones (16.7%). Being older was also associated with 1.01 and 4.23 odds of developing diabetes compared with being younger in HbA1c and FBG criteria respectively. Diabetes is more common in older persons than in middle-aged or younger adults, and advanced age is recognized to be a risk factor for DM (Yan *et al.*, 2023; Xia *et al.*, 2021). The aging process has been reported to create anomalies in the metabolism of carbohydrates and an impairment of energy homeostasis (Bartke *et al.*, 2021). The main causes of these abnormalities are developing insulin resistance and the absence of its secretion, which follow older people's weakened pancreatic function (Chang and Halter, 2003). Furthermore, compared to younger individuals, older diabetic offspring of diabetic parents had higher mean BMI and an increased incidence of overweight/obesity. Similarly, the incidence of hyperinsulinemia was also higher in the older adults compared with the younger ones. These findings may further explain the elevated occurrence of DM in the elderly participants in this study.

In terms of both the HbA1c and FBG criteria, we discovered that female children of diabetic parents had greater levels of DM than male children. Our result is inconsistent with previous studies that reported a lower prevalence of DM among females than males (Gebreyes *et al.*, 2018; Yunka *et al.*, 2020). Other studies have also shown that, compared to women with similar BMIs, men are more likely to develop diabetes, particularly type 2 diabetes, according to other studies (Wang *et al.*, 2010; Logue *et al.*, 2011). In another investigation, there was no discernible sex-based variation in the prevalence of diabetes mellitus (Zhang *et al.*, 2019). The different study designs and the criteria applied to determine a diagnosis of DM in these investigations could account for some of the discrepancies. The higher

prevalence of DM among females has been attributed to reduced muscle mass in women, which does not enable high fixed glucose load absorption, and high levels of progesterone and estrogen, which are implicated in lowering whole-body insulin sensitivity (Machado-Alba *et al.*, 2016). In addition, compared to men, women are more prone to consume unhealthy diets high in fat and carbohydrates and exercise less to burn off extra fat in their body tissues, which increases their risk of developing non-communicable diseases like diabetes (Bommer *et al.*, 2018). Our study also indicated a higher presence of overweight/obese individuals among the diabetic female offspring of diabetic parents compared to their male counterparts.

In Nigeria, there aren't many prospective studies evaluating the relationships between marital status and important health outcomes. Specifically, compared to other socioeconomic and demographic risk variables, the significance of marital status in the prevalence of DM is not as thoroughly investigated and understood. Only married and single people made up the study group in this study, and our findings showed that married women had a higher frequency of DM in both HbA1c and FBG criteria than single women did. These findings are in disagreement with a previous study that showed that remaining single is associated with a higher risk for type 2 diabetes in women (Schwandt *et al.*, 2010). Another previous study (Johnson *et al.*, 2000) showed a reduced occurrence of diabetes in partnered patients compared with unpartnered patients. A Chinese prospective study involving 41,378 men likewise discovered a link between widowhood and an elevated risk of type 2 diabetes (Cornelis *et al.*, 2014). Specifically, widowhood was linked to an increased risk of diabetes. According to a different study, widowed women had a decreased chance of developing type 2 diabetes than married women (Ramezankhani *et al.,* 2019). It is unclear why there was a higher frequency of DM in the current study among singles than married people. It is significant, nonetheless, that our data showed that, in comparison to their single counterparts, married diabetics were older, had higher BMIs, and had greater levels of hyperinsulinemia. These details could help to partially explain why married patients in our study had a greater prevalence of DM.

From our study, we found out that the incidence of DM was elevated in overweight/obese children of diabetic parents (BMI = ≥25 kg/m^2) than in those with normal BMI (<25 kg/m^2). According to the HbA1c and FBG criterion, having a BMI ≥25kg/m^2 was also significantly associated with 11 and 2.5 odds of developing diabetes. Our findings broadly concur with earlier research that found comparable relationships between BMI and DM. For instance, obesity is a known risk factor for non-insulin-dependent diabetes in Nigerians, according to a systematic review of studies on the disease (Uloko *et al.*, 2018). Our findings also align with previous studies (Velasco *et al.*, 2010; Al-Sharafi *et al.*, 2014; Medhi *et al.*, 2021) that examined the relationship between BMI and type 2 DM risk. It is well-recognized that obesity and DM are strongly associated with insulin resistance, heightened sympathetic nerve activity, and beta cell dysfunction (Masuo *et al.*, 2010). Interestingly, all of the overweight/obese patients presented with hyperinsulinemia, and the overweight/obese patients were older and had considerably higher insulin levels than the normal-weight patients.

Numerous studies have revealed that genetic vulnerability and familial aggregation are the causes of DM in many populations (Erasmus *et al.*, 2001; Lee *et al.*, 2000). According to estimates, having one or both parents with non-insulin-dependent diabetes mellitus increases the chance of the disease by two to four-fold (Harrison *et al.*, 2008).

Between 25% and 33% of those with type 2 diabetes have family relatives who also have the disease (Bener *et al.*, 2013). In this study, the frequency of diabetes was more elevated in children with whom mothers are living with diabetes than in children with diabetic fathers. Based on HbA1c and FBG criteria, respectively, having a diabetic mother was linked to 1.22 and 3.24 odds of developing diabetes, in comparison to having a diabetic father. These outcomes were consistent with earlier studies that found similar results (Karter *et al.*, 1999; Bo *et al*, 2000; Papazafiropoulou *et al.*, 2009). However, other research (McCarthy *et al.,* 1996; Gupta *et al.*, 2015; Thorand *et al* 2001) did not show any appreciable variations between maternal and paternal transmissions. Lots of arguments have been put forth to explain the increased mother-to-child heredity of DM, including behavioral risk factors such as non-genetic variations in obesity that are passed on preferentially by the mother; intrauterine environments, and maternally transmitted mitochondrial DNA mutations and deletions (Alcolado and Thomas, 1995; Mayer *et al.,*1996). It's interesting to note that, in contrast to children whose fathers had diabetes, the diabetic children whose mothers had the disease had higher BMIs, higher prevalence of overweight/obesity, and higher levels of hyperinsulinemia.

CONCLUSION

The present study indicated that children of diabetic parents had a greater rate of diabetes mellitus compared with children of parents without diabetes mellitus. Children of parents living with diabetes were more probably to have diabetes mellitus if they were older, females, married, overweight, or obese, or if their mothers had diabetes. These results highlight the critical need to encourage healthy lifestyle choices to lower the general population's risk of developing diabetes mellitus.

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AUTHORS CONTRIBUTIONS

JOF and BIGA conceived and designed the study. The execution of the project and manuscript revision were done by EOA, MOO, UCO, and UIA. All the authors participated in the writing and revision of the manuscript. The authors committed to taking responsibility for every part of the work, having reviewed and approved the completed document.

CONFLICT OF INTEREST

None reported.

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