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Glycemic Control and Its Determinants Among Type 2 Diabetes Mellitus Patients at the Limbe Regional Hospital, Limbe, Southwestern Cameroon

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Abstract

Background: Diabetes mellitus remains a global public health threat with a rising trend in morbidity and mortality. Poor glycemic control (GC) among patients with type 2 diabetes mellitus is a determinant of diabetes-related complications. Therefore, the aim of this study was to assess glycemic control and identify its contributing factors among type 2 diabetic patients attending the Limbe Regional Hospital in Cameroon.

Methods: A hospital-based cross-sectional study was conducted from February to July 2022. Glycated hemoglobin (HbA1c) in diabetic patients was measured using ion-exchange chromatography. Socio-demographic, clinical, and lifestyle data were collected using a structured and pretested questionnaire. Data were entered into an Excel sheet and exported to Statistical Package for Social Sciences (SPSS) version 22 for analysis. A multivariate logistic regression analysis was done to assess the association between explanatory variables and glycemic control. The level of significance was set at a p-value of <0.05.

Results: A total of 131 patients were included in the study with a mean ± SD age of 56 (± 5.1) years. Eighty-eight (67.2%) of them were females. The mean (±SD) HbA1c was 8.8 ±1.8%. Poor GC, inadequate GC, and good GC were

registered in 83 (63.4%), 23 (17.6%) and 25 (19.1%) participants, respectively, using the American Diabetes Association standard cutoffs for HbA1c. The factors associated with poor and inadequate glycemic control were age (AOR: 0.140, 95% CI: 0.033 – 0.595; p = 0.008), self-home glucose monitoring (AOR: 0.228, 95% CI: 0.071 – 0.737; p = 0.014), and adherence to diet/eating plan (AOR: 0.252, 95% CI: 0.069 – 0.917; p = 0.036).

Conclusions: The proportion of type 2 diabetic patients with poor and inadequate glycemic control was noticeably high. The absence of self-glucose monitoring at home, age group (40-49 years), and non-adherence to diet/eating plan contributed to the huge number of patients diagnosed with poor and inadequate glycemic control at the Limbe Regional Hospital. Behavioral programs for diabetic patients, particularly those aged 40-49 years, should be strengthened and disseminated during routine follow-up visits in order to prevent or mitigate complications of poor glycemic control.

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Background

Diabetes is a chronic metabolic disease characterized by a high level of blood glucose, which causes serious damage to the heart, blood vessels, eyes, kidneys, and nerves [1]. The term diabetes was coined by Apollonius of Memphis around 250 BC. Diabetes mellitus is derived from the Greek word diabetes, which means siphon (to pass through), and from the Latin word mellitus, meaning honeyed or sweet. This is because, in diabetes, excess sugar is found in blood and urine [2]. The American Diabetes Association (ADA) categorizes diabetes mellitus as Type 1, Type 2, gestational, and other specific types [3].

Glycemic control refers to the optimal blood glucose concentration in a diabetic patient[4]. It also refers to a way of managing the blood glucose level in diabetic patients. Glycated hemoglobin (HbA1c), postprandial glucose (PPG), and

fasting plasma glucose (FPG) are the markers of glycemic control in type 2 diabetic patients, but HbA1c is the gold standard of glycemic control estimation. Good glycemic control is defined as HbA1c = 7% and HbA1c = 6.5 %, according to the ADA and American College of Endocrinologists, respectively [4]. It is also described as FPG of 70-130mg/dL (3.9-7.2mmol/l), 110 mg/dL (6.1 mmol/l), and 100 mg/dl (5.5 mmol/l) by ADA, American College of Endocrinologists, and International Diabetes Federation (IDF), respectively. Glucose variability (GV) is the measurement of glucose fluctuations within a day, between days or longer term. There are predominantly two types of GV, including long-term GV and short-term GV [5]. Long-term GV is based on visit-to-visit measurements of HbA1c, FPG, and PPG, followed by a calculation of their standard deviation and coefficient of variation. A sudden and rapid fall and rise of glucose within- and between days is typical for short-term GV. Short-term GV is calculated from continuous glucose monitoring over the past few years [5]. Inadequate glycemic control can substantially reduce the quality of life of patients and life expectancy, and increase the healthcare costs of the disease via the complications of diabetes mellitus, such as retinopathy and nephropathy, among others [4].

The estimated global prevalence of diabetes in 2021 by the International Diabetes Federation was 10.5% (537 million) among individuals aged 20-79 years. This prevalence is estimated to rise to 11.3% (643 million) by 2030, and to 12.2% (783 million) by 2045. The prevalence of diabetes among 536.6 million people worldwide is higher (11.1%) in high-income countries than in middle-income (10.8%) and low-income (5.5%) countries. In Africa, 4.5% (24 million) of people were living with diabetes mellitus [6]. The African region bears the highest proportion of individuals living with undiagnosed diabetes. In Cameroon, the current prevalence of diabetes was 4.8% (620, 800) [7].

The majority of the studies from Africa have currently reported proportions of poor glycemic control among type 2 diabetic patients ranging from 45.2% to 93%. A study in Egypt reported a remarkably high prevalence (93%) of poor glycemic control; meanwhile, a lower prevalence of 45.2% was reported by Nigussie *et al.* in Ethiopia [8][9]. The remaining (five) studies from Ethiopia reported poor glycemic control proportions from 64.1% to 73.8% [10][11][12][13][14]. Similarly, a current meta-analysis of the proportions of poor glycemic control from studies conducted only in Ethiopia has demonstrated an elevated (61.92%) prevalence of poor glycemic control [15]. The most frequently reported determinants of poor glycemic control include longer duration of diabetes mellitus, low education, overweight, older age, non-adherence to diabetes treatment, non-adherence to diet, and lack of physical exercise [8][9][10][11][12][13][14][15].

The above evidence on glycemic control in Ethiopia and other countries of Africa shows a high prevalence of poor glycemic control with conflicting results. Furthermore, the rate of urbanization in Cameroon is higher than that of the Central Africa sub-region and Africa as a whole, with about 60% of the Cameroonian population currently residing in urban areas [16]. In addition, residing in a rural area is associated with good glycemic control[17]. However, data on glycemic control and its contributing factors in Cameroon are scanty. Also, there are conflicting results on the determinants of glycemic control among diabetics. Therefore, the aim of this study was to assess glycemic control and identify risk factors of poor and inadequate glycemic control among type 2 diabetes mellitus patients attending the Limbe Regional Hospital in Cameroon.

Materials and Methods

Study design, setting, and period

A hospital-based cross-sectional study was conducted among type 2 diabetes mellitus patients. This study was carried out for six months, from February 2022 to July 2022, at the Limbe Regional Hospital. This hospital is about 1 mile from the Atlantic Ocean and has the following units: radiology, surgery, diabetic center, gynaecology and obstetrics, dental surgery, ophthalmology, pediatrics, physiotherapy, maternity, and general medicine. There were two hundred and three (203) registered diabetic patients in this hospital at the time of this study.

Ethical Considerations

Written consent was obtained from each participant, and ethical clearance was obtained from the Faculty of Health Science Institutional Review Board of the University of Buea (Reference number: 2022/1671-02/UB/SG/IRB/FHS). Administrative authorizations were obtained from the Southwest Regional Delegate of Public Health and the director of Limbe Regional Hospital.

Participant eligibility criteria

Type 2 diabetic patients with at least three consecutive months of measurements of fasting plasma glucose (FPG) and glycated hemoglobin, and those who fasted overnight were included in the study. Conversely, participants with a history of neurologic disorder or seizures, taking investigational or non-registered drugs or vaccines, receiving a blood transfusion, with anemia or conditions that affect erythrocyte production, and who were critically ill or pregnant were excluded from the study.

Administration of questionnaire

A structured questionnaire was administered to participants to capture socio-demographic, behavioral, and clinical data. The questionnaire was adapted from similar studies [18][19]. The following factors affecting glycemic control were considered: age, gender, body mass index, duration of diabetes, type of exercise, type of diabetic medication used, and level of education, among others. In order to prevent recall bias as regards participants' clinical data, we reviewed their medical records.

Blood collection and analysis

The respondents were informed to fast overnight for over 8 hours, and aseptic techniques were employed prior to sample collection. Fasting venous blood was drawn from each type 2 diabetic patient into dipotassium ethylene tetraacetic acid (K_2EDTA) and fluoride oxalate tubes using a vacutainer for the determination of HbA1c and FPG, respectively. FPG and HbA1c were measured using the glucose oxidase method and ion-exchange resin method, respectively, using

commercially available kits from SGM Italia (Rome, Italy). Biochemical tests were performed using a semi-automated chemistry analyzer (Cypress Diagnostics, Hulshout, Belgium). The weight of each participant was measured using a Kinlee-calibrated weighing scale in light clothing, with shoes off. Height was measured using a stadiometer to the nearest 0.1cm.

Definition of operational terms

The reference range of HbA1c was 4-6.5%. Poor glycemic control was defined as HbA1c > 8%, and inadequate glycemic control, HbA1c 7-8%. HbA1c <7% was described as good glycemic control according to recommendations by the American Diabetes Association [20]. BMI was calculated by dividing the weight of every patient in kilograms by his/her height in meters squared.

Statistical analysis

Data were entered into a Microsoft Excel worksheet and exported to Statistical Package for Social Sciences (SPSS) version 22. Socio-demographic and clinical data were reported as frequencies (percentages). The association between socio-demographic characteristics and poor and inadequate glycemic control was assessed using logistic regression analysis. Only characteristics with $p < 0.25$ after a bivariate logistic regression analysis were included in the multivariate logistic regression model. Predictors of poor and inadequate glycemic control with p-value < 0.05 were considered statistically significant.

Results

Socio-demographic characteristics of type 2 diabetics attending the Limbe Regional Hospital

Of the 131 Type-2 diabetes patients enrolled on this study, 88 (67.2%) were females. The mean ± SD age of the respondents was 56 (±5.1) years. The majority (69.5%) of the patients were married and self-employed, 96 (73.3%), whereas 13 (9.9%) of them were either private or government employees. Most, 48 (36.6%) of the participants had a secondary level of education (Table 1).

Table 1. Socio-demographic characteristics of type 2 diabetics attending the Limbe Regional Hospital

Parameter	Category	Frequency (%)
Age groups (years)	30-39	9 (6.9)
	40-49	33 (25.2)
	50-59	30 (22.9)
	≥ 60	59 (45)
Marital status	Single	23 (17.6)
	Married	91 (69.5)
	Divorce	5 (3.8)
	Widow/widower	12 (9.1)
Sex	Female	88 (67.2)
	Male	43 (32.8)
Occupation	Formal	13 (9.9)
	Retired	18 (13.7)
	Self-employed	96 (73.3)
	Unemployed	4 (3.1)
Level of education	Primary	48 (36.6)
	Secondary	58 (44.3)
	Tertiary	17 (13.0)
	Informal	8 (6.1)
Estimated monthly income (CFA)	5001-10000	1 (0.8)
	10001-15000	9 (6.8)
	15001-20000	15 (11.5)
	>20000	106 (80.9)

Clinical data of type 2 diabetics attending the Limbe Regional Hospital

The mean (±SD) duration of type 2 diabetes mellitus since diagnosis was 8.11 (±5.2) years. Forty-four (33.6%) of the respondents had a family history of diabetes. Sixty (45.5%) of them had been living with diabetes for at least eight years. Obesity (BMI ≥30kg/m^2) and overweight (BMI 25-29.9 kg/m^2) were recorded in 45 (34.4%) and 62 (47.3%) of the participants, respectively. One hundred and thirteen (86.3%) of the participants did not adhere to exercise, and 68 (51.9%) of them did not adhere to a diet/eating plan. More than half (77%) of the participants did not perform self-monitoring blood glucose (SMBG) at home. One hundred and twenty-eight (97.7%) respondents were non-smokers, while 106 (80.9%) of them were taking metformin (Table 2).

Table 2. Clinical characteristics of type 2 diabetics attending the Limbe Regional Hospital

Parameter	Category	Frequency (%)
Family history of diabetes mellitus	Yes	44 (33.6)
	No	87 (66.4)
BMI (kg/m^2)	18.5-24.9 (normal weight)	24 (18.3)
	25-29.9 (overweight)	62 (47.3)
	≥30 (obesity)	45 (34.4)
Duration of diabetes mellitus (years)	1-7	71 (54.2)
	8-14	44 (33.6)
	15-22	16 (12.2)
Type of diabetic medication(s)	Metformin	106 (80.9)
	Metformin + Actrapid	1 (0.8)
	Metformin + Mixtard	3 (2.3)
	Metformin + Daonil	1 (0.8)
	Metformin + Insulin or Adride	20 (15.2)
Adherence to exercise	Yes (150mins of moderate intensity/ week or 75mins vigorous intensity/week)	18 (13.7)
	No (<150mins of moderate intensity/ week or <75mins vigorous intensity/week)	113 (86.3)
Adherence to diet/eating plan	Yes (> 3 days per week)	63 (48.1)
	No (< 3 days per week)	68 (51.9)
Self-monitoring of blood glucose	Yes	30 (23.0)
	No	101 (77.0)
Smoking	Non-smoker	128 (97.7)
	Ex-smoker	3 (2.3)
	Current smoker	0 (0.0)

Body mass index (BMI)

Glycemic control among type 2 diabetes mellitus patients attending the Limbe Regional Hospital

The mean (± SD) HbA1c of the study participants was 8.8±1.8%. Poor glycemic control (HbA1c >8%), inadequate glycemic control (HbA1c 7-8%) and good glycemic control (HbA1c <7%) were diagnosed in 83 (63.3%), 23 (17.6%), and 25 (19.1%) of the patients respectively (figure 1).

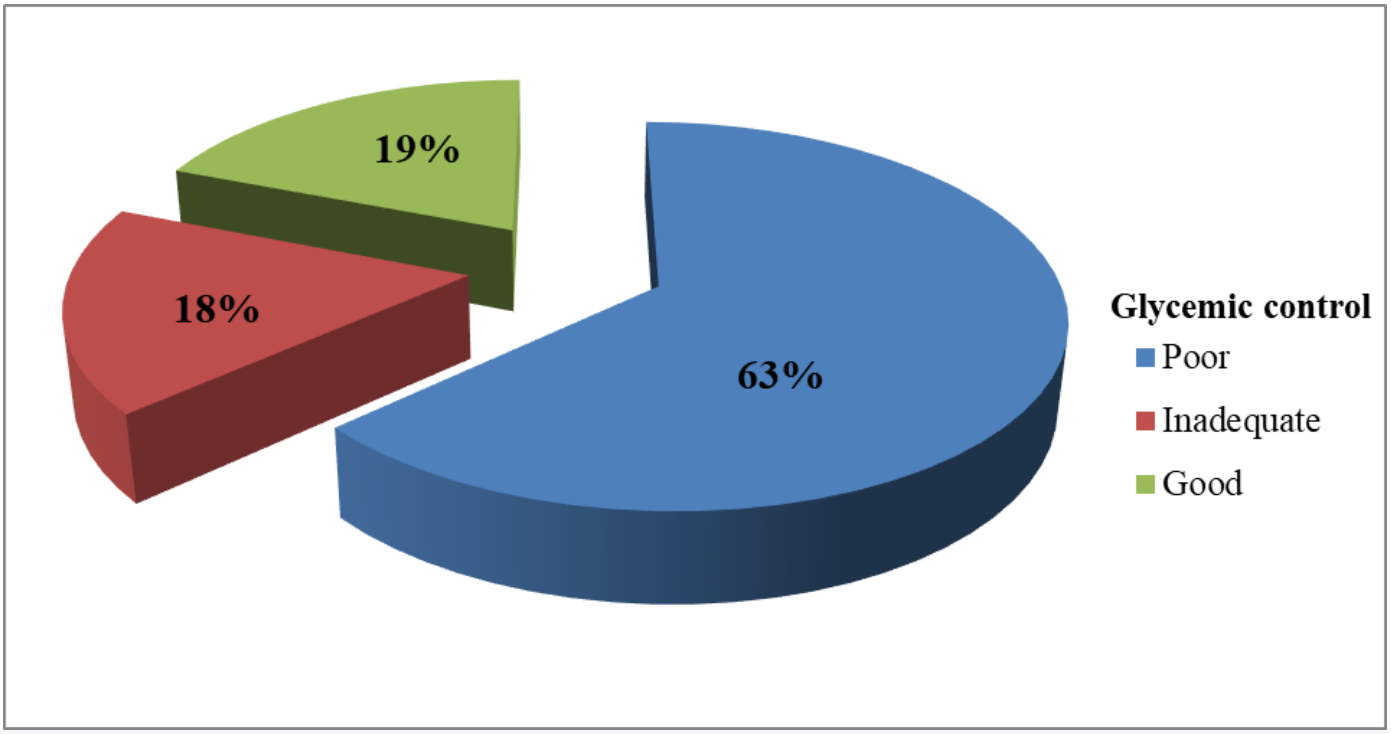

Figure 1. Glycemic control amongst type 2 diabetes mellitus patients attending the Limbe Regional Hospital

Factors associated with poor and inadequate glycemic control amongst type 2 diabetes mellitus patients attending the Limbe Regional Hospital

Bivariate logistic regression analysis revealed the following factors were significantly associated with poor and inadequate glycemic control: age group 40-49 years (UOR: 6.171, 95% CI: 1.937-19.660; p = 0.02), non-adherence to diabetic medications (UOR: 0.192, 95% CI: 0.043-0.864; p = 0.032), lack of self-home glucose monitoring (UOR: 0.278, 95% CI: 0.109-0.706; p = 0.007), and non-adherence to diet/eating plan (UOR: 0.171, 95% CI: 0.059-0.490; p = 0.001). On the contrary, after adjusting for all the predictors of poor and inadequate glycemic control in a multivariate logistic regression model, only age group 40-49 years (AOR: 0.140, 95% CI: 0.033-0.595; p = 0.008), lack of self-home glucose monitoring (AOR: 0.228, 95% CI: 0.071-0.737; p = 0.014), and non-adherence to diet/eating plan (AOR: 0.252, 95% CI: 0.069-0.917; p = 0.036) were identified as risk factors of poor and inadequate glycemic control among type 2 diabetic patients (Table 3).

Here is the data presented in a table format:

Parameter		Poor-Inadequate GC	Good GC	Bivariate logistic regression		Multivariate logistic regression	
				UOR (95% CI)	*p*-value	AOR (95% CI)	*p*-value
Age (years)	30-39	7	2	3.086 (0.500-19.026)	0.225	0.619 (0.063-6.100)	0.681
	40-49	21	12	6.171 (1.937-19.660)	**0.002**	0.140 (0.033-0.595)	**0.008**
	50-59	24	6	2.700 (0.750-9.716)	0.128	0.442 (0.103-1.902)	0.273
	≥60	54	5	1	-	1	-
Adherence to diabetic medications	Yes	73	23	1	-	1	-
	No	33	2	0.192 (0.043-0.864)	**0.032**	3.159 (0.499-19.996)	0.222
Duration of diabetes mellitus (years)	1-7	53	18	5.094 (0.628-41.339)	0.127	0.436 (0.042-4.513)	0.486
	8-14	38	6	2.368 (0.262-21.370)	0.442	0.636 (0.057-7.077)	0.713
	≥15	15	1	1	-	1	-
Self-home glucose monitoring	Yes	19	11	1	-	1	-
	No	87	14	0.278 (0.109-0.706)	**0.007**	0.228 (0.071-0.737)	**0.014**
Adherence to diet/eating plan	Yes	43	20	1	-	1	-
	No	63	5	0.171 (0.059-0.490)	**0.001**	0.252 (0.069-0.917)	**0.036**
BMI (kg/m^2)	≥30	17	7	0.525 (0.164-1.685)	0.279	1.949 (0.496-7.663)	0.340
	25-29.9	52	10	0.467 (0.154-1.418)	0.179	0.752 (0.156-3.628)	0.723
	18.5-24.9	37	8	1	-	1	-

Glycemic control: GC; Body Mass Index: BMI; Unadjusted Odds Ratio: UOR; Adjusted Odds Ratio: AOR

Table 3. Factors associated with poor and inadequate glycemic control among type 2 diabetics attending the Limbe Regional Hospital

Discussion

This study was conducted to assess glycemic control and identify risk factors of poor and inadequate glycemic control among type 2 diabetes mellitus patients at the Limbe Regional Hospital in Cameroon. We found that the majority (81%) of the patients were diagnosed with poor and inadequate glycemic control. Of this percentage, 63% of them had poor glycemic control, while 18% had inadequate glycemic control. Being aged 40-49 years, absence of self-glucose monitoring at home, and non-adherence to diet/eating plan were contributing factors to poor and inadequate glycemic control.

Glycemic control is the main goal of type 2 diabetes mellitus management. Our result on the proportion of poor and

inadequate glycemic control (81%) in diabetic patients is consistent with findings in Nigeria (83.3%) [21] and Kenya (81.6%) [18]. On the contrary, it is higher than estimates in Ghana (70%)[22], Ethiopia (68.3%) [23], Northeast Ethiopia (70.8%) [24], Kolkata (37.5%) [25], Saudi Arabia (74.9%) [26], and Tanzania (49.8%) [27]. This discrepancy in findings may be due to disparity in sample sizes, poor lifestyle conditions, failure to adhere to regular follow-ups at diabetes clinics, and care given to diabetes patients at each hospital. It could also be because some studies used fasting blood glucose to measure glycemic control levels, while other studies considered glycated hemoglobin.

Older age was associated with poor and inadequate glycemic control among type 2 diabetics. This result corroborates the findings of Abera and colleagues at Tikur Anbessa Specialized Hospital in Addis Ababa, Ethiopia [10], and Espinosa et al. in Brazil [28]. Our results do not support the findings of Mideksa et al. in Mekelle-Ethiopia, Shita et al. at Felege Hiwot and Debre Markos Referral Hospitals in Ethiopia, Fiseha et al. in Northeast Ethiopia, and Yosef et al. in East Ethiopia [12][13][17][29]. Insulin sensitivity is known to decrease with an increase in age. The progressive and chronic nature of diabetes mellitus makes it difficult for patients to maintain good glycemic control. This could be explained by impaired secretion of insulin resulting from the dysfunction of the beta cells.

Lack of self-home glucose monitoring was associated with poor and inadequate glycemic control among type 2 diabetics. Approximately half (45%) of the diabetic patients were aged 60 years and beyond. Also, the majority (80.9%) of them had a primary and secondary level of education. These factors may have influenced the willingness of the patients to own personal glucometers at home. Our result is similar to the findings of Mbanya et al. in Cameroon and Mideksa et al. in Ethiopia [12][30]. Mbanya and co-investigators reported a significant relationship between self-management and good glycemic control among type 2 diabetic patients treated with insulin alone. Similarly, Mideksa et al. found a significant association between non-glucometer use and poor glycemic control among type 2 diabetes mellitus patients. Self-home glucose monitoring was not considered in the analysis of predictors of poor and inadequate glycemic control in most studies conducted on the subject of risk factors of inadequate and poor glycemic control among type 2 diabetic patients. Informed decisions about medication dosage and when to urgently meet a healthcare professional are made by diabetic patients if they monitor their blood glucose levels. Lifestyle changes can also be achieved if self-monitoring is done by these patients. They could aid in meeting goals towards optimal glycemic control in diabetic patients.

Non-adherence to diet/eating plan was associated with poor and inadequate glycemic control among our study participants. This result corroborates the findings of Gebermariam et al. [14] and Abera et al. [24]. A diet rich in fiber is helpful for the management of hyperglycemia in diabetics. Dietary fiber has the ability to delay the rate of digestion and absorption of carbohydrates and lipids, leading to the improvement of glycemic control and reduction of body weight. Fiber in the diet can boost insulin sensitivity through short-chain fatty acids produced from the fermentation of fiber at the level of the intestines.

Strength and Limitations

We used glycated hemoglobin in assessing glycemic control among the patients. Our results show that over 81% of type

2 diabetics have poor and inadequate glycemic control, and the contributing factors to this high prevalence are being aged 40-49 years, absence of self-glucose monitoring at home, and non-adherence to diet/eating plan.

Due to the cross-sectional nature of the study, the cause-effect relationship of the independent variables to the outcome variable could not be made.

Conclusions

The overall prevalence of poor and inadequate glycemic control among type 2 diabetes mellitus patients attending the Limbe Regional Hospital is high. Older age, particularly 40-49 years, lack of self-home glucose monitoring, and non-adherence to diet/eating plan are factors associated with poor and inadequate glycemic control. Hence, diabetic patients, particularly those aged 40-49 years, should be regularly educated during follow-up visits in the hospital by health professionals on the importance of adhering to a diet plan and encouraged to own a glucometer at home for self-glucose monitoring.

Competing interests

The authors have declared that no competing interests exist

Authors' contributions

C.N.S conceived, formulated the design, drafted the manuscript, and interpreted the data. N.N.V drafted the manuscript and analyzed and interpreted the data. W.O.E participated in the conception of the study and critically revised the manuscript for relevant intellectual content. M.N.N participated in formulating the study design and the conception of the study, and critically revised the manuscript. All the authors read and approved the manuscript for submission.

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