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Full Length Research Paper

Factors contributing to glycaemic control in an urban population of adults living with type 2 diabetes in Cameroon: A community-based cross-sectional study

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This study aimed to determine the prevalence of poor glucose control and identify contributing factors among type 2 diabetes patients in the Bamenda III health district, North West Region, Cameroon. A community-based cross-sectional study involved 162 adults with type 2 diabetes (mean age 58.7±9.5 years) in the Bamenda III health district, recruited using convenient sampling. Anthropometric measurements and blood glucose control (using fasting blood glucose as a proxy) were conducted following standard procedures. Data on sociodemographic and diabetes-related characteristics were collected using a structured questionnaire. Logistic regression calculated odds ratios (ORs) to assess the association between potential factors and poor glucose control. The prevalence of poor glucose control using fasting blood sugar levels was 51.8%. Males had a nonsignificantly ($p = 0.882$) higher mean fasting blood sugar (151.2mg/dl) compared to females (149.6mg/dl). Bivariate analysis showed that a family history of diabetes (OR 0.5, 95% CI, 0.3 to 0.9) and good dietary adherence (OR 0.4, 95% CI, 0.2 to 0.8) were significantly associated ($p < 0.05$) with good glycemic control, while age ≥ 67 years (OR 1.7, 95% CI, 0.7 to 4.6), gender (OR 1.3, 95% CI, 0.7 to 2.4), and owning a glucometer (OR 0.8, 95% CI, 0.4 to 1.7) were not significantly ($p > 0.05$) associated with glucose control. Multivariate analysis revealed that good dietary adherence (OR 0.4, 95% CI, 0.2 to 0.9) was significantly associated ($p = 0.020$) with good glucose control. This study demonstrated a high prevalence of poor glycemic control among adults with type 2 diabetes, with poor dietary adherence identified as a contributing factor in this setting.

Key words: Contributing factors, type 2 diabetes, adults, glycaemic control, Cameroon.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a significant global public health burden characterized by elevated blood glucose levels due to defects in insulin action and/or secretion (IDF, 2021). The International Diabetes Federation (IDF, 2021) estimates that over half a billion people worldwide, resulting in 6.7 million deaths, are living with diabetes. T2DM is considered the largest growing global health emergency of the 21st century, with one in every five adults aged 20-79 years in the African region affected (Zheng et al., 2018; Reed et al., 2021).

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This health challenge particularly affects the poor, posing a threat to fragile health systems in many low- and middle-income economies. In Cameroon, diabetes prevalence has seen a tenfold increase in the last two decades, with an estimated 620,800 adults aged 20-79 years living with type 2 diabetes in 2021 (Kengne et al., 2005).

Current evidence suggests that environmental and modifiable factors, such as lifestyle, play a significant role in increasing rates of type 2 diabetes (Beulens et al., 2022; Rewers and Ludvigsson, 2016). The primary goal of diabetes management is to prevent acute and long-term complications resulting from hyperglycemia (ADA, 2015; Fowler, 2008; Azzam et al., 2021). Maintaining optimal blood glucose control has been shown to reduce disease progression and the risk of microvascular and macrovascular complications by 35 to 76% (Nathan et al., 1993; Stolar et al., 2008; ADA, 2022). However, a majority of T2DM patients still have suboptimal glucose control, affecting their quality of life and increasing healthcare costs for both individuals and the health system (LeRoith and Smith, 2005; Fiseha et al., 2018). The current guidelines from the American Diabetes Association (ADA, 2022) recommend individualized glycemic targets for adults aged 65 and older to reduce the risk of hypoglycemia.

There is considerable inter-country variation in the prevalence of poor glycemic control among adults living with type 2 diabetes. This variation can be attributed to cultural factors, individual characteristics (such as age, religion, level of education, and marital status), and health system factors.

For example, in Ethiopia, the prevalence of poor glycemic control among adults with type 2 diabetes ranges from 63.8 to 70.4% (Abdissa and Hirpa, 2021; Dubale et al., 2023). In Uganda, it is reported to be 84.3% (Patrick et al., 2021), in South-eastern Nigeria 83.3% (Anioke et al., 2019), in Ghana 70.0% (Mobula et al., 2018), in Jordan 65.1% (Khattab et al., 2010), in Morocco 66.3% (Chetoui et al., 2019), in Saudi Arabia 74.9% (Alzaheb and Altemani, 2018), and in Bangladesh 82.0% (Afroz et al., 2019).

Furthermore, intra-country variation has also been observed. In Saudi Arabia, for instance, the prevalence of poor glucose control ranges from 45.2 to 93% (Alzaheb and Altemani, 2018; Bin Rakhis Sr et al., 2022). Additionally, within Ethiopia, the prevalence varies from 63.8 to 72.0% in Northeast Ethiopia (Fiseha et al., 2018), Western Ethiopia (Abdissa and Hirpa, 2021), South West Ethiopia (Dubale et al., 2023), and Addis Ababa (Demoz et al., 2019).

In sub-Saharan Africa, the prevalence of diabetes ranges from 3 to 9% in rural and urban areas, respectively (Anioke et al., 2019; Mobula et al., 2018; Patrick et al., 2021). Studies indicate a close relationship between diabetes-related factors such as older age, gender, diabetes duration, body mass index, family history of diabetes, and diabetes self-care practices—and the level of blood glucose in individuals living with type 2 diabetes (Anioke et al., 2019; Bitew et al., 2023).

Additionally, lifestyle factors, including excess alcohol intake, smoking, physical inactivity, unhealthy diet, and educational level (Dubale et al., 2023; Chetoui et al., 2019; Bitew et al., 2023; Demoz et al., 2019; Legese et al., 2023), are predictive of a patient's blood glucose level. For example, a study by Abdullah et al. (2019), aimed to determine predictors of good glycemic control among patients with type 2 diabetes in rural Malaysia, found that shorter diabetes duration was a predictor of good glycemic control.

Nevertheless, these factors have been identified in industrialized nations, and it is unclear whether these same factors or other determinants influence glucose control levels in settings with limited resources, such as Cameroon. This is particularly important given that differences in age, ethnicity, religion, culture, socioeconomic status (IDF, 2021), education, lifestyle, and diabetes duration (Chetoui et al., 2019; Bitew et al., 2023; Legese et al., 2023) may lead to disparities in glucose control levels. In Cameroon, there is limited data on the factors associated with glucose control among people living with type 2 diabetes. Identifying the factors contributing to suboptimal glucose control in this population will provide valuable information critical for designing appropriate treatment strategies tailored to our setting, aiming to improve glucose control in adults living with type 2 diabetes and reduce the burden of suboptimal glycemic control in our context. This study, therefore, set out to determine the prevalence of poor glucose control and identify the factors contributing to glucose control among type 2 diabetes patients in the Bamenda III health district, North West Region, Cameroon.

METHODOLOGY

Study design and participants

This study utilized a community-based cross-sectional design, involving 162 adults diagnosed with type 2 diabetes (52 males, 110 females), aged 30 years and above, residing in the Bamenda III health district in the North West Region of Cameroon. The participants were selected through convenient sampling, considering clinical diagnosis in accordance with WHO criteria (WHO, 1999). Exclusions were made for individuals with cognitive problems and pregnant women. Community health workers (CHWs) assisted in identifying households with adults living with type 2 diabetes for at least six months. The researcher, supported by the CHW and a trained nurse, visited eligible participants, explained the study's purpose, and distributed consent forms. Data collection meetings were scheduled with those consenting.

Prior to data collection, the research team, accompanied by a nurse and the CHW, met with participants between 7 am and 9 am to ensure they were in a fasting state. Using a prevalence of 83.0% for poor glycemic control from a study by Anioke et al. (2019) in South Eastern Nigeria, a significance level (α) of 5% (Z = 1.96), and a minimum sample size of 216 calculated using Cochran's formula (N = Z^2* p* (1-p) / d^2), the sample size for this study was determined to be 162 adult type 2 diabetics.

Ethical considerations

Approval to conduct this study was obtained from The University of Bamenda Institutional Review Board (IRB) with reference number 2022/0423H/UBa/IRB. Administrative clearance was also secured from the Regional Delegation of Public Health of the North West Region, indicated by reference number 203/ATT/NWR/RDPH/BRIGAD. Prior to data collection, written informed consent was obtained from all participants and quarter heads.

Data collection

Anthropometric measurements and blood glycaemia (fasting blood glucose)

Data for this study were collected by well-trained nurses who were recruited to assist in data collection at participants' homes between 7 and 9 am, ensuring adherence to all standard procedures. Height was measured to the nearest 0.1 cm without shoes using a portable stadiometer (Seca 213, Germany), while the body weight of each patient was measured using a digital scale (Omron BF511, Japan) to the nearest 0.1 kg. The body mass index (BMI) for each participant was then calculated as weight (kg) divided by height (cm) squared (Cole et al., 2000).

Blood pressure

The systolic and diastolic blood pressure of the study participants were measured using an automated blood pressure device (SANITAS SBM21, Hamburg, Germany). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured on the same day, three times within a 3-min interval, with the participant sitting in a relaxed position, palm facing up, and arm resting. The average of all three measurements was recorded. Any adult with an average blood pressure of >140/90 mmHg was considered hypertensive (Unger et al., 2020).

Glycemic control (fasting blood glucose)

Glycaemic control was assessed using fasting blood sugar (FBS) as a proxy for glycaemic control. Evidence has shown that FBS has a good predictive value for overall glycaemic control (Ketema and Kibret, 2015; Valensi et al., 2017) as it is one of the biomarkers that has a strong positive association with glycosylated haemoglobin (HbA1C). Fasting blood sugar for the study participants was measured using an Accu-Chek Active Blood Glucose monitoring system (Germany).

Good glycaemic control was considered when FBS measurement was between 70 and 130 mg/dl (ADA, 2018).

Adherence to diet, physical activity, medication, and blood glucose monitoring (BGM) was assessed using a validated self-administered structured questionnaire, adapted from the Summary of Diabetes Self-Care Activities (SDSCA) questionnaire by Toobert et al. (2000); Tang et al. (2008). The questionnaire, consisting of 20 questions, assessed the self-reported frequency of adhering to main areas of diabetes self-care in the last 7 days. These included a healthy diet intake, including the frequency of fruits and vegetables with a reduction in high fatty foods, the frequency of blood glucose measurements, moderate-to-rigorous physical activities for at least 30 min/day, and the taking of prescribed medications. The greater the number of times, the better the adherence. The questionnaire was piloted among 18 randomly selected adults living with type 2 diabetes in the Bamenda I health district one week prior to data collection.

a) Dietary adherence

Patient adherence to diet was assessed using a scoring process of following a low-fat eating plan. A maximum score of 10 was obtained for dietary adherence, and scores of less than 7 and ≥7 were interpreted as poor and good dietary adherence respectively.

b) Blood glucose monitoring adherence

This was classified as good for those who measured their blood glucose at least once a day and poor for those who did not measure their blood glucose every day in the past 7 days.

c) Physical activity adherence was graded as good for patients who carried out moderate-to-rigorous exercises for 30 min/day for at least 3 days in the last one-week and poor for those who did not exercise or exercised for less than 30 minutes/day during the last 7 days ADA, 2015).

d) Medication adherence was rated as good for those who took their prescribed medications regularly and/or rarely missed a dose of their medications and poor for those who always forgot to take their medications. The response rate in this study was 100%.

Statistical analysis

Data for this study were analyzed using Statistical Package for Social Sciences (SPSS) for Windows version 23.0. The Kolmogorov-Smirnov (K-S) test was used to test for normality for all the continuous variables. Frequency distribution tables were used to present participants' sociodemographic and diabetes-specific characteristics. The Chi-square test was used to assess the association between categorical variables, while a parametric t-test and ANOVA were used to assess the means of continuous variables as appropriate. Binary logistic regression analysis was performed to identify the predictors of poor glucose control, followed by multivariate logistic regression, including all the variables that were significant in the bivariate logistic regression, to identify independent predictors of poor glucose control. All measures of association were presented as odds ratios with their 95% confidence intervals. Statistical significance was set at $p < 0.05$.

RESULTS

Descriptive characteristics of the study participants

This study included 162 adults living with type 2 diabetes, with a mean age of 57.1 ± 9.6 years. More than half (56.8%) of the study participants were in the age group 51 to 66 years, with 67.9% of the study population being females. Regarding age, a higher proportion of females (74.1%) were ≥ 67 years compared to 35.9% of males aged 50 to 66 years. However, this difference was not significant (X2 = 1.419, p = 0.492) (Table 1). Additionally, this study found that 69.6% of females had been living with diabetes for more than 5 years, compared to 25.0% of males with a diabetes duration of less than 2 years, and the difference was not significant (X2 = 0.519, p = 0.771). Moreover, a higher proportion of females were obese compared to males (80.6% vs 19.4%, respectively), and this difference was statistically significant

Table 1. Descriptive characteristics of the study participants by gender (N= 162).

Variable	Whole sample (N=162)	Gender		X^2	*p*-value
		Males (N=52) n (%)	Females (N= 110) n (%)		
Age (years)					
30 - 50	43	12(27.9)	31(72.1)	1.419	0.492
51 - 66	92	33(35.9)	59(64.1)		
≥ 67	27	7(25.9)	20(74.1)		
Level of education					
Primary	74	13(17.6)	61(82.4)	19.438	<0.001
Secondary school	65	24(36.9)	41(63.1)		
Tertiary	23	15(65.2)	8(34.8)		
Marital status					
Married	132	47(35.6))	85(64.4)	4.417	0.036
Widow/widower	30	5(16.7)	25(83.3)		
Occupation					
Farming	58	2(3.4)	56(96.6)	40.870	<0.001
Business	44	15(34.1)	29(65.9)		
Civil servant	60	35 (58.3)	25(41.7)		
Diabetes duration (years)					
< 2	8	2(25.0)	6(75.0)	0.519	0.771
2 - 5	75	26(34.7)	49(65.3)		
>5	79	24(30.4)	55(69.6)		
BMI categories (kg/m^2)					
Healthy weight	32	17(53.1)	15(46.9)	12.230	0.002
Overweight	58	21(36.2)	37(63.8)		
Obesity	72	14(19.4)	58(80.6)		

(X2 = 12.230, p = 0.002).

Prevalence of poor glycaemic control in the study population

The prevalence of poor glycaemic control among the study participants, as assessed by FBS, was 51.8%. Figures 1a and b, and Figure 1c show the prevalence of poor glucose control according to gender, age categories, and family history of DM among the study participants. We found that a higher proportion (55.8%) of males had poor glycaemic control compared to their female counterparts (50.0%), and this difference was not significant (X2 = 0.472, p = 0.493).

Additionally, a higher proportion (58.1%) of poor glucose control was observed in patients aged 30 - 50 years compared to those 67 years and older (44.4%), and the difference was not significant (X2 = 1.296, p = 0.523). Furthermore, we found that the proportion of poor glycaemic control among study participants with no family history of DM was 53.6% compared to those with a family history of diabetes (43.5%), and the difference was significant (X2 = 4.403, p = 0.036).

Diabetes related and treatment characteristics of the study participants

Table 2 shows the diabetes-related and treatment characteristics of the study participants according to family history of diabetes (FH). We found that more than two-thirds (66.0%) of the study participants with a family history of DM had a glucometer compared to those with no family history of DM (34.0%), and this difference was not significant (X2 = 3.613, p = 0.057). In the present study, we observed that a higher proportion of patients with a family history of DM were herbal medicine users compared to those with no family history of DM (56.9 vs. 43.1%) respectively. Again, a nonsignificant difference (p > 0.05) was observed in the SBP and DBP amongst type 2 diabetic patients with a family history of DM

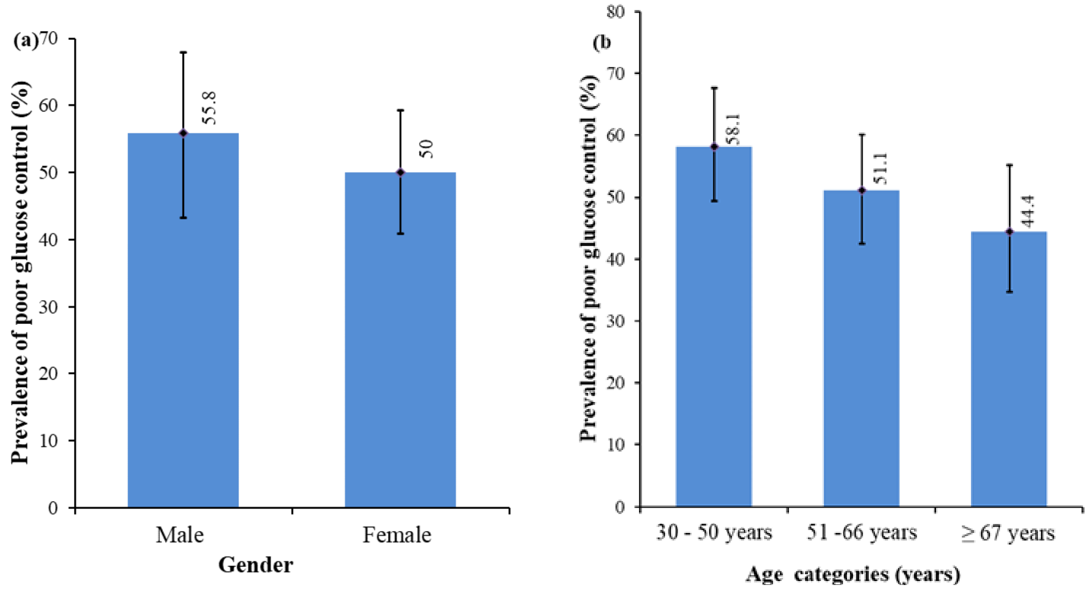

Figure 1. The prevalence of poor glucose control according to gender (p =0.493) and age categories (p=0.523) amongst the study participants.

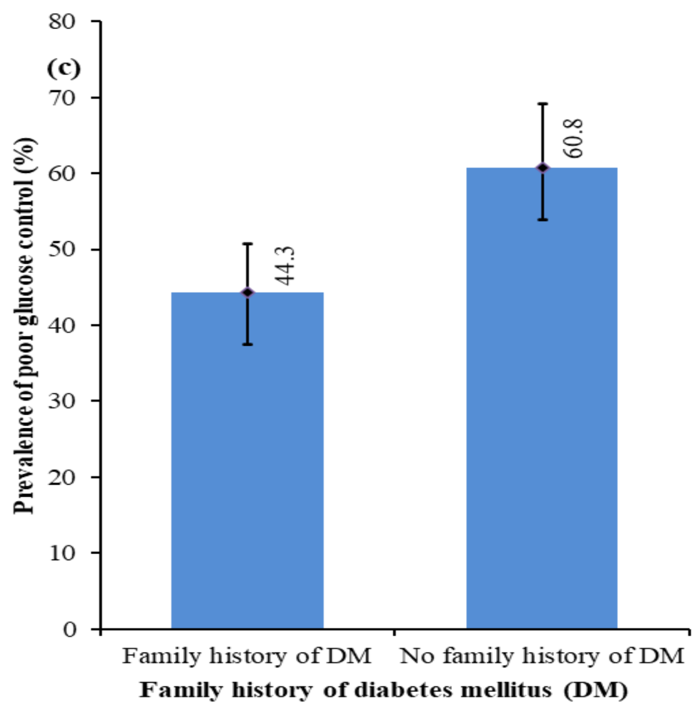

Figure 1c. The prevalence of poor glucose control according to family history of diabetes mellitus in the study population (p=0.036).

and those without a family history. Finally, a higher proportion (55.6%) of obese patients had a family history of DM compared to 44.4% who had no FH of DM. However, this difference was not significant (X2 = 3.103, p = 0.212).

Mean clinical and biochemical characteristics of the study participants

The authors did not find a significant difference ($p > 0.05$) in the mean weight, age, systolic BP, diastolic BP, and

Table 2. Diabetes related and treatment characteristics of the study participants by gender (N=162).

Variable	Whole sample (N=162)	Family History of diabetes [n (%)]		X^2	*p**-value
		Yes (n=88)	No (n= 74)		
Have a glucometer at home					
Yes	47	31(66.0)	16(34.0)	3.613	0.057
No	115	57(49.6)	58(34.0)		
Last BGM measurement					
< 24 hours	92	54(58.7)	38(41.3)	3.099	0.212
<7 days	34	14(41.2)	20(58.8)		
A month	36	20(55.6)	16(44.4)		
Fasting blood sugar (mg/dl)					
≤130 mg/dl	78	49(62.8)	29(37.2)	4.403	0.036
>130 mg/dl	84	39(46.4)	45(53.6)		
Herbal medicine use					
User	51	29(56.9)	22(43.1)	0.194	0.660
Non-user	111	59(53.2)	52(46.8)		
Diabetes Complications					
Yes	16	11(68.8)	5(31.3)	1.533	0.216
No	146	77(52.7)	69(47.3)		
Vegetable consumption					
Everyday	7	4(57.1)	3(42.9)	10.231	0.006
1 - 2 times/week	81	34(42.0)	47(58.0)		
>3 times/week	74	50(67.6)	24(32.4)		
Maggi consumption					
Yes	67	34(50.7)	33(49.3)	0.588	0.443
No	95	54(56.8)	41(43.2)		
Systolic BP (mmHg)					
< 120	29	19(65.5)	10(34.5)	2.019	0.364
120 – 129	33	16(48.5)	17(51.5)		
≥ 130	100	53(53.0)	47(47.0)		
Diastolic BP (mmHg)					
< 80	50	30(60.0)	20(40.0)	2.862	0.239
80 - 89	63	29(46.0)	34(54.0)		
≥90	49	29(59.2)	20(40.8)		
BMI categories (kg/m^2)					
Healthy weight	32	21(65.6)	11(34.4)	3.103	0.212
Overweight	58	27(46.6)	31(53.4)		
Obese	72	40(55.6)	32(44.4)		

Calculated using cross tabulations; DM: Diabetes mellitus; BP: Blood pressure; BGM: Blood glucose monitoring.

diabetes duration in the study population according to gender. Nonetheless, participants 51 to 66 years had on average a significantly (p= 0.039) higher mean weight compared to those ≥67 years (90.3 kg vs. 72.1 kg) respectively. In this present study, we observed that males had a non-significantly (p = 0.882) higher mean fasting blood sugar (151.2 mg/dl) compared to females (149.6 mg/dl) (Table 3). Females had a significantly ($p < 0.001$) higher mean BMI (30.8 kg/m^2) compared to males (26.7 kg/m^2).

Table 3. Mean clinical and biochemical characteristics of the study participants by gender (N=162).

Variable	Whole sample [Mean (95% CI)]	Gender [Mean (95% CI)]		*p**-value
		Male	Female	
Age (years	57.1(55.6 - 58.6)	57.3 (54.7 - 59.9)	57.0 (55.1 - 58.9)	0.887
Height (cm)	163.3(162.2 - 164.4)	169.5(167.4 - 171.6)	160.4(159.4 - 161.4)	<0.001
Weight (kg)	78.5(76.2 - 80.8)	76.7(72.9 - 80.5)	79.4(76.5 - 82.3)	0.291
BMI (kg/m^2)	29.5(28.6 - 30.4)	26.7(25.5 - 27.9)	30.8(29.7 - 31.9)	<0.001
Diabetes duration (years)	6.5(5.9 - 7.1)	6.4 (5.3 - 7.5)	6.5(5.7 - 7.2)	0.805
FBS (mg/dl)	150.1(140.4 - 159.8)	151.2(135.8 - 166.6)	149.6(137.1 - 162.1)	0.882
RBS (mg/dl)	150.6(140.9 - 160.3)	151.9(143.4 - 160.4)	149.9(139.7 - 160.1)	0.834
SBP (mmHg)	136.3(133.6 - 139.0)	134.9(130.1 - 139.7)	136.9(133.5 - 140.3)	0.488
DBP (mmHg)	85.6(83.9 - 87.3)	85.7(83.1 - 88.3)	85.6(83.4 - 87.6)	0.939

*Calculated using independent student t-test; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; BMI: Body mass index; FBS: Fasting blood sugar; RBS: Random blood sugar.

Table 4. Mean glucose control (fasting blood sugar) of the patients according to some diabetes specific and treatment related characteristics [mean, (95% CI)].

Variable	N	FBS (mg/dl)		*p*-value
		Mean	(95% CI)	
Have a glucometer at home				0.544 [a]
Yes	47	154.8	(145.7 - 165.8)	
No	115	148.2	(139.1 - 157.3)	
Age categories(years)				0.019[a]
30 - 50	43	172.9	(160.5 - 184.5)	
51 - 66	92	141.8	(132.1 - 151.6)	
≥ 67	27	142.1	(144.6 - 156.4)	
BMI Categories (kg/m^2)				0.003[a]
Healthy weight	32	140.9	(129.2 - 153.7)	
Overweight	58	172.4	160.1 - 184.6)	
Obese	72	136.3	(126.9 - 145.6)	
Level of education				0.894[a]
Primary	74	151.9	(143.9 - 167.7)	
Secondary school	65	150.1	(141.5 - 165.6)	
Tertiary	23	144.7	(133.7 - 159.2)	
Family history of DM				
Yes	88	141.3	(133.2 - 149.4)	0.057
No	74	160.6	(149.4 - 171.2)	
Diabetes duration				0.114*
< 2	8	125.6	(114 -138.4)	
2 - 5	75	160.4	(152.7 - 171.2)	
>5	79	142.8	(132.5 - 153.1)	
Smoking				0.002 [a]
Yes	5	235.0	(223.9 - 248.1)	
No	157	147.0	(139.8 - 156.2)	
Dietary adherence				0.002 [a]
Good	106	136.8	(129.9 - 143.7)	

Table 4. Cont'd

Poor	56	175.4	(166.7 - 182.1)	
BGM adherence				0.544 [a]
Good	47	154.8	(146.8 - 161.8)	
Poor	115	148.2	(139.1 - 157.3)	
Physical activity adherence				0.762 [a]
Good	95	148.5	(135.4 - 161.6)	
Poor	67	151.5	(142.2 - 161.8)	
Medication adherence				0.105 [a]
Good	80	142.1	(133.9 - 150.3)	
Poor	82	157.9	(147.0 - 168.8)	

*Calculated using one-way ANOVA; [a] Calculated using independent Student *t*-test: CI: Confidence interval; BGM: Blood glucose monitoring.

Mean fasting blood glucose of the study participants (glucose control)

Table 4 shows the mean fasting blood glucose (glucose level) of the study participants according to some diabetes-specific and treatment characteristics. Our study found that adults 30 to 50 years were poorly controlled with a higher mean FBS (172.9 mg/dl) compared to those ≥ 67 years (142.1 mg/dl), and this difference was significant (p = 0.019).

Additionally, the present study showed that overweight adult type 2 diabetics were poorly controlled with a higher mean FBS (172.4 mg/dl) compared to their healthy weight counterparts (140.9 mg/dl), and this difference was significant (p = 0.003). In addition, we found that there was a significantly (p = 0.002) higher mean FBS amongst participants who smoked compared to their non-smoking counterparts (235.0 mg/dl vs. 147.0 mg/dl) respectively. Similarly, we observed that there was a significantly (p= 0.002) higher mean FBS amongst participants with poor dietary adherence compared to those with good dietary adherence (175.4 vs. 136.8 mg/dl) respectively, a finding not observed with BGM, physical activity, and medication adherence. In contrast, no significant difference (p > 0.05) was observed in the mean FBS with respect to having a blood glucometer at home, family history of DM, and diabetes duration. Moreover, we observed that herbal medicine users had a higher mean FBS (159.2 mg/dl) compared to non-herbal medicine users (145.9 mg/dl). However, this difference was not significant (p = 0.264).

Factors associated with glycaemic control amongst the study participants

Bivariate analysis between poor glucose control and individual factors in Table 5 indicated that having a positive family history of diabetes (OR 0.5, 95% CI, 0.3 to 0.9) and good dietary adherence (OR 0.4, 95% CI, 0.2 to 0.8) were significantly associated (p < 0.05) with good glycemic control as indicated by fasting blood sugar. While age ≥ 67 years (OR 1.7, 95% CI, 0.7 to 4.6), gender (OR 1.3, 95% CI, 0.7 to 2.4), having a glucometer at home (OR 0.8, 95% CI, 0.4 to 1.7), and herbal medicine use (OR 1.1, 95% CI, 0.5 to 2.1) were not significantly (p > 0.05) associated with glucose control.

Multivariate analysis (Table 6), demonstrated that good dietary adherence (OR 0.4, 95% CI, 0.2 – 0.9) was significantly associated (*p* = 0.020) with good glucose control. The multivariate model showed that good dietary adherence was an independent determinant for good glucose control.

DISCUSSION

Achieving optimal glycemic control is the cornerstone in the management of T2DM, given that it slows the progression of acute and chronic complications, thereby improving the quality of life of the patients (ADA, 2022; LeRoith and Smith, 2005; Stratton et al., 2000). Nevertheless, a majority of type 2 diabetics still have poor glucose control. In Cameroon, very little attention has been focused on the factors contributing to glycemic control amongst adults living with T2DM. This study set out to determine the prevalence of poor glucose control and to identify the factors contributing to glucose control amongst type 2 diabetes patients in the Bamenda III Health district of the North West Region of Cameroon. This study found that the prevalence of poor glucose control (using FBS as a proxy for glucose control) was 51.8%. In addition, our study found in the multivariate analysis that good dietary adherence was an independent

Table 5. Frequency and odds ratio for the association between good blood glucose control and determinants (bivariate analysis).

Variable	N	Poor blood glucose control			*p*-value
		Frequency (%)	OR	95% CI	
Age categories (years)					
≥ 67	27	44.4	1.7	0.7 - 4.6	0.266
51 - 66	92	51.1	1.3	0.6 - 3.1	0.544
35 - 50	43	58.1	Ref		
Gender					
Male	52	55.8	1.3	0.7 - 2.4	0.493
Female	110	50.0	Ref		
BMI Categories (kg/m^2)					
Obese	72	50.0	0.5	0.3 - 1.4	0.209
Overweight	58	63.8	1.3	0.6 - 2.8	0.521
Healthy weight	32	34.4	Ref.		
Family History of DM					
Yes	88	44.3	0.5	0.3 - 0.9	0.037
No	74	60.8	Ref		
Owning a glucometer					
Yes	47	48.9	0.8	0.4 - 1.7	0.635
No	115	53.0	Ref		
Herbal medicine use					
User	51	52.9	1.1	0.5 - 2.1	0.851
Non-user	111	51.4	Ref		
Dietary adherence					
Good	106	44.3	0.4	0.2 - 0.8	0.009
Poor	56	66.1	Ref		
Physical activity adherence					
Good	95	49.5	0.8	0.4 - 1.5	0.471
Poor	67	55.2	Ref		
BGM adherence					
Good	47	48.9	0.8	0.4 - 1.7	0.635
Poor	115	53.0	Ref		
Medication adherence					
Good	80	48.8	0.8	0.4 - 1.5	0.435
Poor	82	54.9	Ref		
Diabetes duration (yrs)					
>5	79	49.4	0.3	0.1 - 1.8	0.205
2 - 5	75	57.3	1.4	0.7 - 2.6	0.323
<2	8	25	Ref		
Vegetable consumption					
1 – 2 times/ week >	81	51.9	2.3	1.1 - 7.4	0.331
3 times /week	74	50.0	0.9	0.4 - 1.7	0.818
Everyday	7	71.4	Ref		

OR: Odds ratio; CI: Confidence interval; BGM: Blood glucose control; FBS <130mg/dl; Ref: Reference category; BGM: Blood glucose monitoring; DM: Diabetes mellitus.

Table 6. Multiple binary logistic regression analysis with FBS (mg/dl) as the dependent variable (odds ratios adjusted for age and gender).

Variable	B	Standard error	Odds ratio (OR)	95% CI	*p*-value
Family history of DM	- 0.560	0.328			
Yes			0.6	0.3 – 1.1	0.077
No			Ref.		
Dietary adherence	- 0.811	0.349			
Good			0.4	0.2 – 0.9	0.020
Poor			Ref.		

OR: Odds ratio; CI: confidence interval; Ref: reference category.

predictor for good glucose control amongst adults living with type 2 diabetes in our setting.

Our study found that the prevalence of poor glucose control in our setting was 51.8%, with a higher proportion (55.8%) of males having poor glycemic control compared to females (50.0%). In Cameroon, there is limited data on the factors contributing to glycemic control amongst adults living with type 2 diabetes. This finding is in line with that reported in Malaysia by Amsah et al. (2022), who, in a study involving 3100 adult type 2 diabetes patients, reported that the prevalence of poor glycemic control was 59.2%, but lower than that reported in Nigeria by Anioke et al. (2019), where they reported a prevalence of 83.3% for poor glycemic control. However, the Nigerian study was a hospital-based study involving 140 adult type 2 diabetics, 30 years and older, who have been on treatment for at least one year and attending diabetic clinics in the country.

The prevalence of poor glycemic control in our study was lower than the 83.4%, 83%, 72%, 80%, and 82% reported in Uganda (Patrick et al., 2021), Ethiopia (Dubale et al., 2023), Turkey (Atcı et al., 2022), Sudan (Omar et al., 2019), and Bangladesh (Afroz et al., 2019), respectively. In contrast, reports from Germany (Reisig et al., 2007) and Japan (Arai et al., 2009) found that good glycemic control was achieved by more than 45% and 65% of patients with T2DM, respectively. The high levels of poor glycemic control in the African countries and in our study may be attributed to low literacy rates about the disease, lifestyle and cultural factors, and non-acceptance of chronic diseases in the population. These findings imply that more emphasis should be placed on lifestyle modification amongst the patients as this can help in improving blood glucose control.

Studies have shown that older age (≥ 65 years) is associated with poor glycemic control (Ayomote et al., 2022; Atcı et al., 2022). Our study found that a higher proportion (58.1%) of poor glucose control was observed in patients aged 30 to 50 years compared to those 67 years and older (44.4%). This finding is in contrast to that reported in Malaysia by Amsah and colleagues (2022), who found that 55.1% of patients 60 years and older had poor glycemic control. The Malaysian study was a registry-based study involving 3100 adults living with type 2 diabetes as opposed to our study, which was a community-based study. Similarly, Nanayakkara et al. (2018) in a national study in Australia involving 3492 adult patients with type 2 diabetes also found that younger patients aged <60 years had poor glycemic control compared to patients 60 years and older. The Australian study was hospital-based and involved type 2 diabetic patients receiving care in diabetes centers in the country compared to our sample, which was drawn from the community. However, our finding is similar to that reported in Turkey (Atcı et al., 2022).

Nevertheless, Berkowitz et al. (2013) found that persons diagnosed with diabetes between the ages of 30 and 65 years had worse glycemic control compared to those diagnosed at 65 years or older. Given that 55.6% of our study participants were 67 years or older, the high prevalence of poor glycemic control can also be attributed to aging, as aging is characterized by progressive glucose intolerance resulting in an increase in blood glucose due to an impairment in insulin release (Chiu and Wray, 2010; Chia et al., 2018; Cai et al., 2019; Tuduri et al., 2022). Despite the effort made by the government to improve the management of adult diabetes, the prevalence of poor glucose control is still high, and this is really worrisome. These findings highlight the necessity for more aggressive strategies in improving adherence, thereby improving glycemic control and thus improving the quality of life of diabetic patients. The present study also found that poor glucose control was higher amongst adult type 2 diabetes patients who smoke, had a family history of DM, and herbal medicine use (mean FBS > 145mg/dl). This finding is similar to that reported in Western Ethiopia (Abdissa and Hirpa, 2021) and Saudi Arabia (Alzaheb and Altemani, 2018). The Ethiopian study used glycosylated hemoglobin (HbA1c ≥7%) for glycemic control while the Saudi study used FBS to measure glucose control levels, similar to our study where we used FBS as a proxy for glycemic control.

In addition, our study observed poor glucose control in patients with poor dietary adherence, physical activity adherence, and medication adherence, a finding also observed in Bangladesh (Afroz et al., 2019) and Ethiopia (Legese et al., 2023). The Ethiopian study was a hospital-based cross-sectional study involving 180 adults living with type 2 diabetes attending a diabetic clinic in Gondar town near Addis Abba, as opposed to our study which was community-based.

Evidence has shown that longer diabetes duration is associated with poor glucose control (Alzaheb and Altemani, 2018; Chetoui et al., 2019; Demoz et al., 2019; Fiseha et al., 2018; Wang et al., 2021), a finding we also observed in our study. Our study also found that better fasting blood glucose was recorded amongst those with shorter diabetes duration (< 2 years). These findings are similar to those observed by Atcı and colleagues (2022), who aimed at identifying the risk factors for poor glycemic control in 256 adult type 2 diabetics in Turkey and found that patients with a shorter diabetes duration had better glycemic control (FBS <140mg/dl) compared to those with a longer diabetes duration.

Family history of diabetes has also been shown to be associated with poor glycemic control and higher FBS (Atcı et al., 2022). This is in line with our study where we observed that type 2 diabetes with a family history of diabetes had a higher mean FBS compared to their counterparts without a family history of DM. We found that patients with poor dietary adherence had a higher mean FBS (175.4mg/dl) compared to those with good dietary adherence (136.8 mg/dl). Similar findings were observed amongst study participants with poor physical activity adherence and medication adherence.

However, type 2 diabetics with good blood glucose monitoring (BGM) adherence had a higher mean fasting blood sugar compared to those with poor BGM adherence. Owning a glucometer greatly enforces the ability of the patient to regularly measure their blood glucose and has been found to be associated with better glucose control (Mariye et al., 2020).

In the present study, we also observed that 29.0% of the study participants had a glucometer, with those having a glucometer having a higher mean FBS (154.8mg/dl) compared to those without a glucometer at home (148.2mg/dl). Although this is counterintuitive at first glance, it might be due to the fact that patients who own a glucometer believe they can always monitor their blood sugar, but it is not always the case. These findings are different from those obtained in Brazil (Degefa et al., 2020), Nigeria (Enikuomehin et al., 2021), Ghana (Agidew et al., 2021), and Ethiopia (Kassa et al., 2021). A study by Schmitt et al. (2013) reported that the lack of a personal glucometer or poor access to laboratories in health facilities can be attributed to irregular measurement of blood glucose amongst diabetics.

Our study found that 70.9% of the study participants had poor blood glucose monitoring (BGM) adherence, which can be attributed to the fact that only 29.0% of type2 diabetes patients owned a glucometer at home. Variation in BGM adherence, medication adherence, and physical activity adherence might be due to differences in cultural values, literacy levels, and differences in the way diabetic educational messages are disseminated amongst study participants in different settings. These findings highlight the necessity for more aggressive diabetes education programs to sensitize patients on the need for regular and frequent blood glucose monitoring, which will help in treatment modification, thereby maintaining optimal glucose levels to reduce the risk of complications from the disease, thus improving the quality of life amongst adults living with type 2 diabetes.

Bivariate analysis, which explores unadjusted associations between good glucose control behaviours and individual factors, indicated that being 67 years and older (OR 1.7, 95% CI, 0.7 to 4.6), being female (OR 1.3 95% CI, 0.7 to 2.4), herbal medicine use (OR 1.1, 95% CI, 0.5 to 2.1), good blood glucose monitoring (BGM) adherence (OR 0.8, 95% CI, 0.4 to 1.7), and diabetes duration of less than 2 years (OR=0.3, 95% CI, 0.1 to 1.8) were not significantly ($p > 0.05$) associated with good glycemic control. This is in contrast to reports from Ethiopia (Abdissa and Hirpa, 2021) and Saudi Arabia (Alzaheb and Altemani, 2018), which revealed that longer diabetes duration and older age were positive predictors of poor glycemic control. Nevertheless, our study found that a family history of diabetes (OR 0.5, 955 CI 0.3 to0.9) and good dietary adherence (OR 0.4, 95% CI 0.2 to 0.8) were significantly associated with good glucose control in the bivariate analysis. The multivariate model revealed that good dietary adherence (OR 0.4, 95% CI, 0.2 to 0.9) was an independent predictor of good glycemic control amongst adults living with T2DM in our setting. This implies that interventions to improve glycemic control amongst adult type 2 diabetics in our setting should focus on diabetes self-care behavior at the individual level and culture at the population level to improve outcomes for patients with type 2 diabetes in our setting.

The main limitations of this study include the cross-sectional nature, which cannot establish causality, and findings might not be a true reflection of glycemic control amongst type 2 diabetes patients in the country. Additionally, given that the measurement of adherence to the different diabetes self-care behaviors was self-reported, there could have been bias in the reporting. Despite these limitations, this study has, for the first time, provided data on factors contributing to glycemic control amongst adults living with type 2 diabetes in the North West Region of Cameroon. Given the association between glucose control and health outcomes in patients with type 2 diabetes, the high level of poor glucose control in the study population is worrisome. Therefore, there is a need for effective strategies to improve glucose control amongst adults living with T2DM in the country.

Conclusions

This study among T2DM patients in Cameroon has demonstrated that the prevalence of poor glycemic control among adults living with type 2 diabetes is high. Moreover, having good dietary adherence was identified as an independent factor contributing to good glucose control in our setting. Therefore, an integrated approach in the management of T2DM is essential for adults living with the condition, encompassing health education and treatment to reduce the risk of complications. Further studies should delve into the challenges faced by adult type 2 diabetes patients in effectively controlling blood glucose levels. This data will be valuable in informing targeted interventions, thereby improving outcomes for patients and reducing the burden of the disease in the population.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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