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Determinants of glycemic control among adult type 2 diabetic patients attending the National Health Insurance Authority (NHIA) clinic in a tertiary hospital in Benue State, Nigeria.

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Abstract

Background: Diabetes mellitus is a multisystem disease that requires multifaceted management approach with the aim of maintaining good glycaemic control. Proper knowledge of factors affecting glycaemic control will provide standard operational protocols in the management of adult patients with type 2 diabetes (T2DM) with resultant good glycaemic control, better quality of life, and overall reduced morbidity and mortality.

Objectives: This study aimed to assess the determinants of good glycaemic control among adult patients with type 2 diabetes.

Methodology: This study was a hospital based cross-sectional study conducted between December 2021 and March 2022 involving 381 adult patients with T2DM attending the National Health Insurance Authority clinic. The participants were selected by systematic random sampling. Data was collected by an interviewer administered questionnaire. Anthropometry and blood pressure measurements were also taken. Data was analyzed with the Statistical Package for Social Sciences (SPSS). Version 24 with level of confidence at 5% (p=0.005)

Result: There were 194 male (50.9%). The mean age of patients was 54.94±7.21 years. The proportion of adult T2DM patients with good glycaemic control was 106 (27.8%). Duration of diabetes diagnosis, co-morbidities, smoking or tobacco use, frequency of vigorous intensity sports, current complementary and alternative medicine use and blood pressure had statistically significant association with good glycaemic control following bivariate analysis.

Conclusion: Level of glycaemic control was poor. Primary care physicians should increase efforts in identifying, educating and counselling of adult patients with T2DM on measures to attain optimal good glycaemic control.

Keywords: Determinants; Glycaemic Control; Adult Diabetics; Type 2 Diabetes; Nigeria

1. Introduction

The global burden of diabetes mellitus is a significant and growing public health concern, with far-reaching implications for individuals, healthcare systems, and economies worldwide. The global diabetes prevalence in 20-79 year olds in

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2021 was estimated to be 10.5% (536.6 million people), rising to 12.2% (783.2 million) in 2045. In 2021, the prevalence of diabetes mellitus in Nigeria was 3.7% [1]. Global diabetes-related health expenditures were estimated at 966 billion USD in 2021, and are projected to reach 1,054 billion USD by 2045 [2].

Good glycaemic control can be defined as achieving a target fasting blood glucose (FBG) level of between 80 and 110mg/dl or glycosylated haemoglobin (HbA1C) of <7.0% [3,4,5,6,7]. Glycaemic control is the common factor that determines complications and death from diabetes [7]. Poor glycaemic control has led to preventable complications and reduced quality of life in adult patients with T2DM and in some cases even preventable deaths.

Although there are well-defined ways of T2DM management including the use of pharmacological and non-pharmacological modalities, in practice, achievement of optimal glycaemic control in adult patients with T2DM on a long-term basis can be quite challenging. This is because the reasons for poor glycaemic control are often multi-factorial and not fully understood [8]. A significant number of patients with T2DM worldwide still have poorly controlled diabetes with studies showing that the rate of poor glycaemic control among them in various parts of the world is high, between 40% and 80% [8-10].

Previous studies have identified some determinants of glycaemic control. They include sociodemographic characteristics [11-14], duration of diabetes [15,16], co-morbidities [12,17,18], cigarette smoking [19,20]. Others include alcohol use [21,22], exercise [21,23], medication adherence [24,25] and anthropometric indices [15,26]. In a study in Chiang Rai Province, Northern Thailand, those aged <40 years had 3.32 times greater odds of having suboptimal glycaemic control, than those aged >70 years [11]. A study in China found that half of the patients with T2DM achieved good glycaemic control and increasing age was a significant positive predictor of optimal glycaemic control [14]. Conversely, Gudisa and colleagues in Ethiopia reported that the overall incidence of poor glycaemic control among type 2 diabetic patients was 60.7% and poor glycaemic control was significantly associated with older age [13]. Similarly in a Nigerian study, majority had poor glycaemic control status of which about 95% constituted the elderly [12].

In a multicentre study in study in Brazil and Venezuela, it was reported that on average, HbA1c levels in women were 0.13 higher than in men, after adjusting for age, marital status, education, race, country, body mass index, duration of disease, complications, type of healthcare, adherence to diet, adherence to treatment [27]. On the contrary, more females (55%) had controlled blood glucose compared to males in a study in Ife, Nigeria [28]. High family income and support was an independent predictor of good glycaemic control in a cross-sectional study in Ogun state [29]. Studies from Nigeria and Denmark have shown that shorter duration of diagnosis is associated with good glycaemic control.[21,30] Smoking and alcohol intake was significantly associated with good glycaemic control in a Nigerian study [21], however in another Nigerian study, there was no difference in glycaemic control amongst respondents who smoked or took alcohol except in association with other factors [31].

These studies cited on factors affecting glycaemic control reveal how several factors may prevent the achievement of glycaemic control. There is lack of studies in Benue State on factors impacting on glycaemic control especially among adult health insured patients, hence this study set out to assess the determinants of good glycaemic control among adult patients with type 2 diabetes attending the National Health Insurance Authority Clinic at Federal Medical Centre, Makurdi, Benue State.

2. Methodology

2.1. Study area

The study was conducted at the National Health Insurance Authority (NHIA) Clinic Federal Medical Centre, Makurdi, Benue State. Benue State is located in North Central Nigeria and its capital is Makurdi an urban town. Federal Medical Centre, Makurdi is the one out of two tertiary health institutions in Makurdi. The NHIA clinic provides affordable health to the staff of Federal parastatals, Non-Governmental Organization and their dependents in Makurdi where most investigations including HbA1c are done at no cost to the patient while other hitech investigations like computerized tomograghic scan (CT-scan), magnetic resonance imaging (MRI) are done at 50% cost (co-insurance) and the patient medication at 10% cost (co-payment).

2.2. Study design

The study was a hospital based cross-sectional study.

2.2.1. Study population

The study population was consenting adult patients with type 2 diabetes, 18 years and above, who had been taking their T2DM medications and presented for follow-up for at least 3 consecutive months prior to the time of study. However, critically ill patients; because they could be unable to give consent and to cooperate during measurement of waist and hip circumferences as well as Pregnant patients were exempted. This is because anthropometric measurements would have been affected by the expected weight gain during pregnancy. Also, renal absorption of glucose in pregnancy is less effective and some of the pregnancy hormones are diabetogenic and could act as confounders.

2.2.2. Estimation of sample size

The minimum sample size required was calculated using the Leslie Fisher's formula for descriptive studies [32].

$$n = \frac{Z^2 pq}{d^2}$$

where;

n= minimum sample size

Z= standard score which corresponds to a given confidence interval on the statistical table (in this case 1.96 for 95% confidence level)

p = Expected prevalence of good glycaemic control obtained from a previous similar study which was 54.2% [33].

q = 1-p = 1- 0.542 = 0.458

d= desired precision of 5% = 0.05

$$n = \frac{(1.96)^2(0.542 \text{ x } 0.458)}{(0.05)^2}$$

$$n = \frac{3.8416 \text{ x } 0.248236}{0.0025}$$

$$n = 381$$

2.2.3. Sampling technique

A systematic random sampling technique was employed

2.2.4. Method of data collection

A combination of structured interview and clinical measurements were used for data collection. A pre-test of the questionnaire was conducted at the General out-patient clinic of FMC Makurdi where adult patients with T2DM have similar characteristics with those at the NHIA clinic except that those at the NHIA are under insurance. The two sites are in two different locations within Makurdi.

2.2.5. Study tool

The questionnaire was interview-administered and consisted of three (3) sections. The first section of the questionnaire obtained information about the socio-demographic characteristics. The second section contained relevant history and the last section of contained record of anthropometric measurements (waist and hip circumferences and waist-hip-ratio), glycated haemoglobin values and blood pressure measurement.

2.2.6. Measured variables

1. Hip circumference (HC): Hip circumference was measured with the aid of a flexible stretch-resistant tape measure at the maximal circumference around the buttock posteriorly and the pubic symphysis anteriorly to the nearest centimetres.

2. Waist circumference (WC): Waist circumference was measured with the aid of a flexible stretch-resistant tape at the level midway between the lower rib margin and superior iliac crest with the tape wrapped snugly all around the body in a horizontal position. The study subjects stood with their feet fairly closed together (about12-15cm) and their weight equally distributed to each leg. The subjects were prevented from contracting their abdominal muscles or from holding their breath. The readings were taken to the nearest centimetre (cm) [34].

3. Waist- hip ratio (WHR): The WHR was calculated as the ratio of waist circumference to hip circumference. A WHR of less or equal to 0.9 for male and less or equal to 0.85 for female was considered normal [34].

4. Blood Pressure measurement: The blood pressure was taken with Accuson(R) mercury sphygmomanometer and a 3M Littmann(R) stethoscope. Blood pressure was measured with the subject seated and relaxed for about 5 minutes, with back support, legs uncrossed and the arm supported at the level of the heart. The stethoscope was placed gently over the brachial artery at the point of maximal pulsation in the cubital fossa. The cuff which covered two third of the upper arm length was then inflated rapidly to about 30mmHg above the palpated systolic pressure and deflated at a rate of 2-3mmHg per second during which the first and fifth Korotkoff sounds were heard and corresponded to systolic and diastolic blood pressure respectively. The average of two blood pressure measurements taken at an interval of at least 2 minutes were used [34]. The subjects were then classified using the JNC-8 report on the prevention, detection, evaluation and treatment of High Blood Pressure into normal (<120/80mmHg), Pre-hypertensive (120-139/80-89mmHg) and Hypertensive(≥ 140/90mmHg) [35].

5. Glycated Haemoglobin (HbA1c): This was measured using the Bioscience Axceed P200 flourescence immunoassay analyzer calibrated for testing glycated haemoglobin. This was carried out by a senior registrar in the department of chemical pathology at the main laboratory which met the ISO 2000 certification standard. Procedure for the test required using a pipette to collect fifty micro liters (50µl) of blood from the collected blood sample of the adult patients with T2DM, this was then mixed with the standard glycated haemoglobin buffer provided in the test kit, thereafter one hundred micro liters (100µl) of the resultant mixture was put into the sample well on the test cassette provided. The cassette was then inserted into the space provided on the bioscience Axceed P200 fluorescence immunoassay analyzer. The result was displayed within 5minutes on the screen of the analyzer. Reference interval was Good control-<7% [35].

2.3. Data analysis

The collected data were sorted, coded and imputed in the Statistical Package for Social Sciences (SPSS Version 24) for analysis. Results were presented using frequency tables and charts. Qualitative variables were expressed as proportions while quantitative variables were expressed as mean and standard deviation. Chi square test was used to test association between categorical or qualitative variables while that of continuous variables was tested using the student's t-test. A multiple logistic regression analysis was done with all variables that showed a significant association (5% level of significance) with depression. Adjusted odds ratio (OR) and its 95% confidence interval were calculated and all analysis were done at the 5% level of significance.

2.4. Ethical approval

Ethical approval was gotten from Federal Medical Centre, Makurdi, Health Research Ethics Committee with number FMH/FM/MED/108/VOL1/x. Writen informed consent was obtained from the participants.

3. Results

The mean age was 54.94±7.21 years. Participants aged 55-64 years had the highest frequency (n=181, 47.5%). Approximately half (n=194, 50.9%) of the participants were males. Majority 308 (80.8%) of the participants were married. Over two-thirds (n=273, 71.7%) had tertiary education. About two-third (n=243, 63.8%) of the participants were employed. Variables that were significantly associated with glycaemic control included age, marital status, level of education, employment, ethnic group and average monthly income. See table 1

Table 2 below shows about half of the participants had been diagnosed with diabetes for 1-5 years (n=192, 50.4%). A greater percentage of the participants (n=186, 48.8%) had hypertension co-morbidity. A vast majority of the participants neither smoked (n=367, 96.3%) nor drank alcohol (n=286, 75.1%). Of the participants that consumed alcohol, (n=67,70.5%) took at least 2-3 drinks. Majority of the participants did not do vigorous sports or recreational activities (n=277, 72.7%). Out of the 104 participants who were involved in recreational activities, 41 (39.4%) exercised 2-3 times a week. Concerning times spent on watching TV, majority (n=357, 93.7%) of the participants watched TV for less than or equal to 2 hours per day. All the participants were on medication for diabetes (n=381, 100.0%). Concerning type of drugs taken, majority of the participants took oral drugs (n=307, 80.6%). Over two-third of participants did not

take CAM for diabetes (n=278, 73.0%). Variables that were significantly associated with glycaemic control were, duration of diagnosis, co-morbidities, smoking or tobacco, frequency of vigorous intensity sports and current use of CAM for diabetes treatment.

Table 3 shows clinical characteristics and anthropometry of participants. Majority (85.6%) of the participants were obese and 58.3% had high blood pressure. There was significant relationship between hypertension and glycaemic control.

Figure 1 shows pattern of glycaemic control of participants. Majority (72.2%) of the participants had poor glycaemic control measured by HbAlc.

Table 4 shows participants with aged 45-54 years were less likely to have good glycaemic control. This association was statistically significant ($p<0.001$). Those who had primary and secondary education had a 7 and 8 times likelihood of having good glycaemic control with reference to those who had tertiary education. This was statistically significant ($p<0.05$) respectively. Those who earned between 90,000 and <120,000 per month naira had 7 times likelihood of having good glycaemic control. Participants who were diagnosed with diabetes for 1-5 years and 6-10 years respectively, had 11 and 16 times likelihood of having good glycaemic control than those diagnosed >10 years and it was statistically significant ($p<0.001$). Participants who had HTN and those who had HTN+PUD co-morbidity had 28 and 15 times likelihood to have good glycaemic control compared to none and other co-morbidities. This was statistically significant ($p<0.001$ and $p<0.05$) respectively. In terms of participants' frequency of vigorous intensity sport, those who engaged in 2-3 times a week and ≥6 times a week of vigorous intensity sport had 11 and 29 times likelihood of having good glycaemic control with reference to those who engage in vigorous intensity sport once a week. These were statistically significant ($p<0.05$) respectively. Participants who used CAM for diabetes were less likely to have good glycaemic control compared to those who did not. This was however not statistically significant ($p=0.156$). With reference to hypertensive participants, those with normal blood pressure had 4.5 times likelihood to have good glycaemic control. This was statistically significant ($p<0.05$).

In summary, age, level of education, average monthly income, duration diagnosed diabetes, co-morbidities, frequency of vigorous intensity sport per week, and blood pressure status were the independent predictors of good glycaemic control.

Table 1 Socio-demographic characteristics of the respondents (N=381)

Socio-demographic characteristics	**Frequency (Percent)**	**Glycaemic control**		**Test statistic**	**p- value**
		Good control	Poor control		
Age (in years)				Fisher's exact=27.19	< 0.001*
18-34	0 (0.0)	0(0.0)	0(0.0)		
35-44	14 (3.7)	0(0.0)	14(100.0)		
45-54	146 (38.3)	25(17.1)	121(82.9)		
55-64	181 (47.5)	61(33.7)	120(66.3)		
65-74	40 (10.5)	20(50.0)	20(50.0)		
Mean=54.94; SD=7.21					
Gender				$\chi 2$=0.5	0.824
Male	194 (50.9)	53(27.3)	141(72.7)		
Female	187 (49.1)	53(28.3)	134(71.7)		
Marital status				Fisher's exact=14.49	<0.001*
Single	0 (0.0)	79(25.6)	229(74.4)		
Married	308 (80.8)	21(31.3)	46(68.7)		
Widowed	67 (17.6)	6(100.0)	0(0.0)		

Separated	6 (1.6)	0(0.0)	0(0.0)		
Divorced	0 (0.0)				
Level of education				Fisher's exact=18.61	<0.001*
No formal education	8 (2.1)	8(100)	0(0.0)		
Primary	29 (7.6)	8(27.6)	21(72.4)		
Secondary	71 (18.6)	19(26.8)	52(73.2)		
Tertiary	273 (71.7)	71(26.0)	202(74.0)		
Employment status				$\chi2$=13.78	<0.001*
Employed	243 (63.8)	52(21.4)	191(78.6)		
Unemployed	138 (36.2)	54(39.1)	84(60.9)		
Ethnic group					
Tiv	248 (65.1)	82(33.1)	166(66.9)	Fisher's exact=23.50	<0.001*
Idoma	67 (17.6)	6(9.0)	61(91.0)		
Igede	20 (5.3)	6(30.0)	14(70.0)		
Igbo	12 (3.1)	0(0.0)	12(100.0)		
Others*	34 (8.9)	12(35.3)	22(64.7)		
Religion				$\chi2$=1.02	0.733+
Christianity	371 (97.4)	104(28.0)	267(72.0)		
Islam	10 (2.6)	2(20.0)	8(80.0)		
Traditionalist	0 (0.00	0(0.0)	0(0.0)		
Location				$\chi2$=0.02	0.883
Urban	351 (92.1)	98(27.9)	253(72.1)		
Rural	30 (7.9)	8(26.7)	22(73.3)		
Average monthly income (in Naira)				$\chi2$=12.89	0.012*
<30000	99 (25.9)	20(20.2)	79(79.8)		
30000 to <60000	112 (29.4)	34(30.4)	78(69.6)		
60000 to <90000	73 (19.2)	19(26.0)	54(74.0)		
90000 to <120000	41 (10.8)	20(48.8)	21(51.2)		
≥120000	56 (14.7)	13(23.2)	43(76.8)		
Mean=68,023.62; SD=61,419.54					

Others* = Jukun, Hausa, Yoruba, Igala; SD= Standard Deviation

Table 2 Relevant history of diabetes and life style of participants

Variables	**Frequency**	**Glycaemic control**		**Test statistic**	**p-value**
	Percent	Good control	Poor control		
Duration of diabetes diagnosis (in years)				χ^2=44.91	<0.001*
<1	0 (0.0)	0(0.0)	0(0.0)		
5-Jan	192 (50.4)	60(31.2)	132(68.8)		
10-Jun	56 (14.7)	32(57.1)	24(42.9)		
>10	133 (34.9)	14(10.5)	119(89.5)		
Co-morbidities				Fisher's exact=48.95	<0.001*
HTN	186 (48.8)	6(10.3)	52(89.7)		
HTN +CVA	70 (18.4)	76(40.9)	110(59.1)		
None	58 (15.2)	6(8.6)	64(91.4)		
HTN+PUD	33 (8.7)	6(46.2)	7(53.8)		
HIV	14 (3.7)	12(36.4)	21(63.6)		
PUD	13 (3.4)	0(0.0)	7(100.0)		
HTN+CCF	7 (1.8)	0(0.0)	14(100.0)		
Smoking or tobacco use				χ^2=0.42	0.014+*
Yes	14 (3.7)	0(0.0)	14(100.0)		
No	367 (96.3)	106(28.9)	261(71.1)		
Alcohol consumption in the past 12 months				χ^2=0.46	0.497
Yes	95 (24.9)	29(30.5)	66(69.5)		
No	286 (75.1)	77(26.9)	209(73.1)		
Consumption of 2-3 drinks of alcohol per day (n=95)				χ^2=0.07	0.205
Yes	67 (70.5)	21(31.3)	46(68.7)		
No	28 (29.5)	8(28.6)	20(71.4)		
Engages in vigorous intensity sports, fitness or recreational activities				χ^2=0.04	0.205
Yes	104 (27.3)	24(23.1)	80(76.9)		
No	277 (72.7)	82(29.6)	195(70.4)		
Frequency of vigorous intensity sports (n=104)				Fisher's exact=13.76	0.003*
Once a week	23 (22.1)	6(26.1)	17(73.9)		
2-3 times a week	41 (39.4)	6(14.6)	35(85.4)		
4-5 times a week	14 (13.5)	0(0.0)	14(100.0)		
≥ 6 times a week	26 (25.0)	12(46.2)	14(53.8)		

Daily frequency watching TV/ using computer or other electronic gadgets (in hours)					
≤2 hours	357 (93.7)	100(28.0)	257(72.0)		
> 2 hours	24 (6.3)	6(25.0)	18(75.0)		
Current treatment for diabetes				A	a
Yes	381(100.0)	106(27.8)	275(72.2)		
No	0 (0.0)	0(0.0)	0(0.0)		
Current medication for diabetes					
Oral drugs	307 (80.6)				
Insulin	34 (8.9)				
Both	40 (10.5)				
Current use of CAM for diabetes				χ^2=4.96	0.026*
Yes	103 (27.0)	106(27.8)	275(72.2)		
No	278 (73.0)	0(0.0)	0(0.0)		

*=Statistically significant; χ^2= Chi-square; += Fisher's exact reported; a=No statistic is computed, values are constant

Table 3 Clinical characteristics and anthropometry of the respondents

Variables	**Frequency**	**Glycaemic control**			
	Percent	Good control	Poor control		
Waist-hip-ratio (WHR)				χ^2=1.15	0.283
Normal	55	12(21.8)	43(78.2)		
	14.4				
Obesity	326	94(28.8)	232(71.2)		
	85.6				
Blood pressure status				χ^2=11.71	0.001*
Normal	159	59(37.1)	100(62.9)		
	41.7				
Hypertension	222	47(21.2)	175(78.8)		
	58.3				

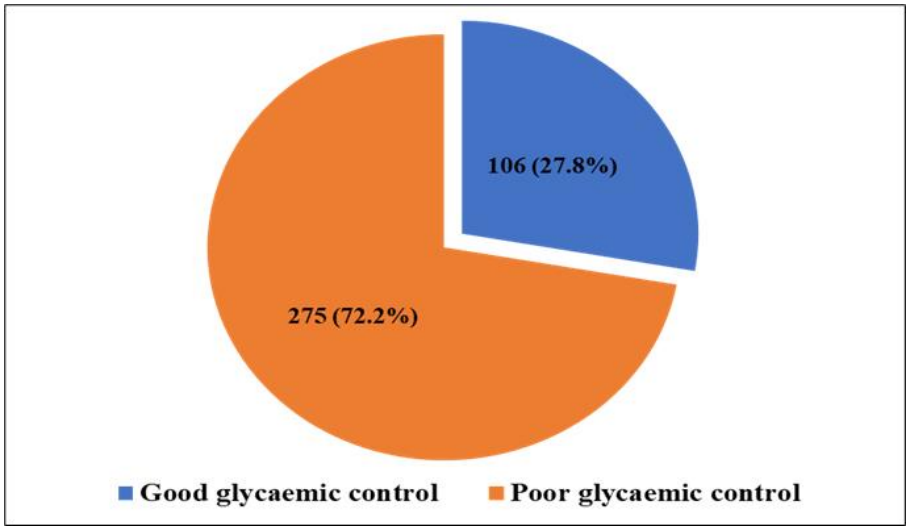

Figure 1 Pattern of glycaemic control of participants.

Table 4 Logistic regression model of independent variable predicting good glycaemic control

Variables	Adjusted odds ratio (aOR)	95% confidence interval (CI)	P-value
Age (in years)			
18-34	-	-	-
35-44	0.00	-	0.998
45-54	0.01	0.00 – 0.14	<0.001**
55-64	0.29	0.05 – 1.53	0.145
65-74	Reference		
Marital status			
Married	0.31	0.26 – 5.20	0.564
Widowed	0.23	0.50 – 4.20	0.461
Separated	0.29	0.31 – 4.70	0.650
Divorced	Reference		
Level of education			
No formal education	44048083985.69	-	0.999
Primary	7.65	1.15 – 50.83	0.035*
Secondary	6.75	1.57 – 29.03	0.010*
Tertiary	Reference		
Employment status			
Employed	1.50	0.36 – 6.33	0.574
Unemployed	Reference		
Ethnic group			
Tiv	0.42	0.06 – 2.34	0.756
Idoma	0.32	0.05 – 2.29	0.659

Igede	0.34	0.08 – 2.31	0.587
Igbo	0.31	0.07 – 2.19	0.547
Others	Reference		
Average monthly income			
<30000	0.30	0.04 – 2.10	0.229
30000 to <60000	1.30	0.31 – 5.43	0.714
60000 to <90000	0.44	0.08 – 2.18	0.316
90000 to <120000	7.32	1.04– 51.39	0.045*
≥120000	Reference		
How long have you been diagnosed diabetes			
<1	-	-	-
1-5	11.78	2.90 – 47.78	<0.001**
6-10	16.40	3.65 – 73.73	<0.001**
>10	Reference		
Co-morbidities			
None	Reference		
HTN	28.74	3.77 – 218.65	<0.001**
HTN +CVA	0.29	0.01 – 5.38	0.408
PUD	119803443761.33	-	0.998
HTN+PUD	15.44	2.13 – 111.79	0.007*
HTN+CCF	0.00	-	0.999
HIV	0.00	-	0.998
Do you currently smoke or use any tobacco product			
Yes	0.00	-	0.998
No	Reference		
How many times per week do you spent on vigorous intensity sport			
Once a week	Reference		
2-3 times a week	11.33	1.46 – 87.54	0.020*
4-5 times a week	0.00	-	0.998
≥ 6 times a week	29.88	4.38 – 203.49	0.001*
Current use of CAM for diabetes			
Yes	0.24	0.03 – 1.71	0.156
No	Reference		
Blood pressure status			
Normal	4.54	1.30 – 15.80	0.017*
Hypertension	Reference		

Note: *p<0.05, **p<0.001, Hosmer-Lemeshow goodness of fit test: $\chi^2 = 9.45$, df = 8, p =0.306, Nagelkerke R^2=0.679

4. Discussion

The study assessed the factors that affect glycaemic control among adult patients with type 2 diabetes (T2DM) attending the National Health Insurance Authority Clinic. In this study, the majority of the respondents were between the ages of 55-64 years of age and had attained tertiary level of education. This is an indication that type 2 diabetes is a disease whose onset is in adulthood. Also in Nigeria, most job opportunities are offered to people with higher educational qualifications who eventually have access to National Health Insurance Scheme. This finding is in keeping with a study in Abuja [36]. Studies in Ethiopia showed a different finding in which majority of the respondents were within the age group less than 50 years and mostly had secondary level of education [37,38]. Majority of the participants in this study were males and married which is in consonance with studies in Ethiopia in which majority of the respondents were males who were married [38]. However, studies in Oyo state Nigeria and Saudi Arabia showed that majority of the respondents were married females [39,40].

In this study, the proportion of respondents who had good glycaemic control were low. Studies conducted in Nigeria, Ethiopia and South Africa, showed similar poor glycaemic control [41-43]. In contrast, glycaemic control was higher in studies from Russia [44].

The present study found statistically significant relationship between age and good glycaemic control. The majority of the respondents that had good glycaemic control were those in age group 65-74years. Respondents in this study aged 45-54 years had a lowest chance of having good glycaemic control. Increasing age was associated with good glycaemic control and concurs with studies from Ghana and China where respondents who were older had good glycaemic control compared with younger ones [14,17]. This differs from a study in Enugu where respondents older age (>60years) was significantly associated with having poor glycaemic control [13]. This could have been because possibly with older age they had comorbidities causing drug-drug interactions and pill burden leading to poor drug adherence and resultant poor glycaemic control.

There was a statistically significant relationship between marital status and glycaemic control. Majority of the respondents who had poor glycaemic control were married. A study in Turkey showed similar finding where a higher proportion of married respondents had poor glycaemic control and this was statistically significant [45]. This may be due to family dysfunction. In contrast, a study in Canada found that being married was associated with lower $A1_c$ levels [46]. This was probably because the couples were married for longer periods and had better social support leading to better glycaemic control.

The majority of respondents in this study with good glycaemic control were those who had primary education. Education had a statistically significant association with good glycaemic control. A study done in China had a similar finding in which low educational level was associated with long-term glucose control [47]. This finding is in contrast with a study in Turkey where respondents with lower education had poorer glycaemic control [45].

In this study, majority of the respondents were employed and had poor glycaemic control. This was statistically significant with bivariate analysis but there was no independent association between employment status and glycaemic control on logistic regression. A study in Southern Taiwan showed a similar finding of employed participants having poor glycaemic control possibly due to self-stigma, poor adherence and poor self-care [48]. Another study in South-West Ethiopia also had findings that employment is associated with poor glycaemic control [42]. A study in South Africa had a contrasting finding in which respondents who were unemployed had poor glycaemic control [49]. Unemployment could lead to lack of finances to pay fees for drugs and food. This leads to poor medication adherence and glycaemic control.

Most of the respondents earned between 30,000-60,000 naira per month. This monthly earning is about the minimum wage in Nigeria and reflects the fact that Nigeria and indeed other Sub-Saharan African countries have majority of her people in the low and middle-income class with low income. Income was a predictor of good glycaemic control. Respondents who earned income (N90,000 to N<120,000) were 7 times more likely to have good glycaemic control. This finding is similar with findings of studies in China in which respondents who were financially stable had significant controlled glycaemia [14]. In a multicentre 3 year global perspective observational DISCOVER study participants with low income were associated with poor glycaemic control [50]. Study done in Ekiti, South-West Nigeria equally found low income to be associated with poor glycaemic control [24]. Low income may likely affect keeping hospital appointments, carrying out investigations, procuring medications and healthy diet which contribute to poor glycaemic control.

Increased duration of diagnosis was associated with good glycaemic control. Respondents whose duration of diagnosis was between 1-5 years and 6-10 years were 11 and 16 times more likely to have good glycaemic control respectively. A similar finding in Uganda was that respondents with longer duration of diagnosis >10 years (77%) had good glycaemic control [51]. This finding was possibly because living longer with T2DM might have contributed to better understanding of the disease through regular health education and counselling on its control measures leading to better control. A study from Benue showed contrasting results with statistically significant association between increased duration of diagnosis and poor glycaemic control by 9 times [21].

Co-existing co-morbidities was significantly associated with good glycaemic control. Participants with HTN and HTN+PUD as co-morbidities with type 2 diabetes had odds of 28 and 15 times of having good glycaemic control respectively compared with those that had no co-morbidity. This concurs with studies in China and Ghana which showed that respondents who had hypertension with type II DM were more likely to have good glycaemic control. [14,17] This may be because people with co-morbidities have frequent hospital visits which might explain their better control. But it is not congruent with the findings in Ethiopia which showed that respondents who had hypertension in conjunction with T2DM were 2.5 times more likely to have poor glycaemic control [13].

Increasing frequency of vigorous intensity sports was significantly associated with good glycaemic control. However, respondents who were involved in vigorous intensity sports of 2-3 times per week and greater than or equal to 6 times per week were 11 and 29 times more likely to have good glycaemic control compared with those who had once a week. This finding is similar with another study in Benue, in which moderate physical exercises were independent predictors of good glycaemic control by 1.8 times [21]. A Korean study equally had similar finding showing respondents who were physically active had controlled blood glucose [52]. This finding might be because exercising skeletal muscles decreases weight, aids in glucose absorption by increasing insulin sensitivity, thereby leading to glycaemic control [53].

Findings from this study indicate that involvement in CAM use was statistically associated with poor glycaemic control. The use of CAM amongst T2DM patients is high and this could be due to perceived efficacy, low cost and safety. This finding may be because most CAM are used by patients without prescription and may not be regulated possibly leading to drug interactions and resultant poor glycaemic control [54]. A study in Kenya had similar findings of CAM being associated with poor glycaemic control [55]. This finding was inconsistent with that of a systematic review in which the use of CAM was associated with the with good glycaemic control [56]. Similarly, a study in Jamaica, showed that the use of CAM was significantly associated with good glycaemic control [57].

Normal blood pressure status was found to be an independent predictor of good glycaemic control. Subjects with normal blood pressure had 4.5 times likelihood of having good glycaemic control than those with hypertension. Studies in Anambra, Ethiopia and China showed similar findings; respondents who had uncontrolled hypertension in conjunction with type II DM were 2.5 times more likely to have poor glycaemic control [12-14]. However, a study in Ghana showed contrasting finding in which respondents who had uncontrolled hypertension with type II DM, were more likely to have good glycaemic control [17].

The Waist to hip ratio did not have significant relationship with glycaemic control. Conversely, Waist-to-hip ratio was found to have an association with glycaemic control. Participants with abnormal WHR were less likely to have controlled fasting blood glucose as against those with normal WHR in a study by Alramadan in Saudi Arabia [58].

Conclusion: The respondents' age, marital status, level of education, employment status, ethnic group, average monthly income, duration of diabetes diagnosis, co-morbidities, Smoke or tobacco use, Frequency of vigorous intensity sports, current CAM use and blood pressure had significant association with good glycaemic control on bivariate analysis.

Furthermore, increasing age, lower level of education, higher average monthly income, increased duration of diagnosis of diabetes, presence of hypertension and hypertension plus peptic ulcer disease as co-morbidities, involving in vigorous intensity sport and normal blood pressure status were independent predictors of good glycaemic control.

4.1. Limitations

The subjects were on different medications and dosages and so this might have affected the results.

Patients self-report of adherence may be biased which could have affected results of the study, and some patients might not have been entirely honest in answering questions on lifestyle habits like exercise, co-morbidities, smoking and alcohol consumption.

This was a hospital-based study; thus, findings may not be accurately extrapolated beyond the study population.

4.2. Recommendations

In view of the observations made in this study, the following are recommended:

- Most of the factors affecting good glycaemic control were patient dependent. Thus, clinicians especially primary care physicians should improve the participation of patients in their care as part of the management team.
- Intervention protocols can be setup by hospitals, government and non-governmental organisations to mitigate factors affecting good glycaemic control, and hence their complications.
- Primary care physicians should increase efforts at counselling T2DM patients on the identified determinants of good glycaemic control in order to improve their glycaemic control and prevent complications.
- Training and retraining of physicians and health care workers on the identified factors could be an important step in preventing complications from poor glycaemic control.
- Further interventional studies on the identified factors affecting good glycaemic control could be done to identify relationship pointed out in this study more confidently.

Compliance with ethical standards

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We want to acknowledge every participants that consented to participate in the study.

Disclosure of conflict of interest

The Authors have no conflict of interest to declare

Statement of Ethical Approval

Approval for the study was given by the Hospital Research Ethical Committee before commencement of data collection

Statement of Informed Consent

Informed consent was obtained from all individual participants

Authors Declaration

All Authors made substantive contributions to the conduct of the study and have approved the copy to be published promising to take public responsibility for the work.

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