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Glycaemic Control and Its Associated Risk Factors in Patients With Type 2 Diabetes Mellitus In Jos, North Central Nigeria.

Odoh G[1], Uwakwe J.N[1] Edah J.O[1], Ojobi J.E[2], Adebola Z.O[1] Puepet FH[1].

1. *Department of Internal medicine, Jos University Teaching Hospital, Jos, Nigeria.*
2. *Department of Internal Medicine, Federal Medical Center Makurdi.*

Corresponding Author,
Dr Odoh, Gabriel,
Department of Internal medicine, Jos University Teaching Hospital, Jos, Nigeria.

Abstract

Background. *Diabetes mellitus is assuming a major public health problem and its prevalence is reaching epidemic proportion, morbidity and mortality from the disease has also been on the steady rise, with over 5 million deaths recorded in the year 2015.Improving glycaemic control is of great importance because it helps to reduce the burden of the disease, prevent and delay complications and hence reducing associated mortality.*

Aim*: Is to determine the proportion of patients who achieve optimal glycaemic control and the contribution of demographic, clinical and treatment factors to glycaemic control.*

Methods*: It is a cross sectional descriptive Study. One hundred and fifty subjects diagnosed with type 2 Diabetes Mellitus at least one year prior to study entry were recruited into the study. Information on socio-demographic and clinical variables was obtained by a standard questionnaire.Biochemical measures such as lipid profile was obtained from patients medical records.Glycated heamoglobin(HbA1c) was performed for each study subject.*

Results*: Females comprised 64.9% of study population. The mean (SD) HbA1c of study population was 8.66(2.4).The number of study subjects who achieved HbA1c at goal was 59(38.3%). The proportion of males with HbA1c at goal was 48.1%, which was better compared to females at 33%, this difference was not significant (X^2=3.382, p=0.062).The proportion of study subjects younger than 45 years with good glycaemic control was 28.6%, this was lower than 41.3% in those older than 45 years. This difference was not significant (X^2=1.065, p=0.3020). Glycaemic control was also found to be better in study subjects with normal waist circumference, simpler regimen for diabetes treatment, shorter duration of diabetes treatment, adherence to medication and exercise prescription. This relationship was however significant only for waist circumference and regimen for diabetes treatment.*

Conclusion: *About 61.7% of our study subjects were not at glycaemic goal. Factors associated with poor glycaemic control include; female gender, longer duration of treatment of DM, complex treatment regimen, abnormal WC, non adherence to medications and exercise prescription. We advocate for improve government commitment to diabetes care with enhance coverage of the National Health Insurance Scheme and training of more specialist in diabetes care.*

Key words: *Glycaemic control, associated factors, type 2 diabetes.*

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I. Introduction

The increasing prevalence of type 2 Diabetes mellitus (DM) worldwide is becoming a major public health problem [(1).] In the year 2015, it was estimated that 415million (8.8%) adults aged 20-79 years are living with diabetes and about 193 million are undiagnosed[1].

The increasing prevalence and incidence of diabetes is also associated with high morbidity and mortality. It was estimated to have caused over 5 million deaths in 2015[(2).] Improving glycaemic control is of great importance, because it helps to reduce the burden of disease, prevent and delay complications [(3,4).]

Information on glycaemic control , factors that affect glycaemic control and measures to correct such factors has the potential to reduce short and long term complications of diabetes and hence reducing associated morbidity and mortality. A patient's glycosylated haemoglobin(HbA1C) is an indicator of glycaemic control over the previous 3 months[(5).] A cut off of <7% or <6.5% by American Diabetes Association (ADA) or International Diabetes Federation (IDF) respectively indicate optimal glycaemic control but may not be feasible for all patients with diabetes [(6).]The United Kingdom Prospective Diabetes Study (UKPDS) group showed that a

1% reduction in HbA1c is associated with a 35% reduction in microvascular complication and 7% reduction in all case mortality [7].

The aim of the study is to determine the proportion of patients attending the Endocrine Clinic of the Jos University Teaching Hospital (JUTH) who achieve optimal glycaemic control and the relative contribution of demographic, clinical and treatment factors affecting glycaemic control. It is hoped that findings from the study will help clinicians and policy makers to effect changes that will result in improvement in glycaemic control with consequent reduction in morbity and mortality.

II. Materials And Methods.

The Study was a cross-sectional descriptive study and was carried out at the Diabetic Clinic of The Jos University Teaching Hospital (JUTH) and a private DM specialist Center in Jos, North Central Nigeria. The study was conducted between July and December 2017.

One hundred and fifty-four patients with type 2 DM aged 30 years and above who consented to participate in the study were recruited consecutively into the study. Study patients diagnosed at least 1 year prior to study entry, with available medical records were eligible to participate in the study. Insulin treated patients were considered to have type 2 diabetes, if insulin treatment was initiated at least 2 years after diagnosis of diabetes. Patients with type 1 diabetes and/or patients with secondary diabetes (diseases of the exocrine pancreas, drug induce diabetes or pregnancy) were excluded from the study.

Information on clinical variables (Age, gender, DM duration, body weight, height, body mass index, physical activity, family history of DM and medication in use) was obtain by a standardized questionnaire.

Biochemical measures such as Lipid profile {Triglycerides, Total cholesterol, Low density Lipoprotein Cholesterol (LDL-C) and High density Lipoprotein cholesterol (HDL-C)} were obtained from patients medical records.

Glycated haemoglobin ($HbA1_c$) test was performed during the study using the same device for all study patients (STANDARD ™ A1c SD Biosensor ,Chungcheongbu-Do, Republic of Korea)

Diagnosis of DM was reached according to American Diabetes Association (ADA-2011) guidelines. Glycemic status was categorized as good control if HbA1c< 7% and poor glycemic control if HbA1c ≥ 7%. Duration of diabetes was categorized as <10years and ≥10years.

ETHICAL CONSIDERATION.

Ethical approval for the study was obtained from the Human Research Ethics Committee of the Jos University Teaching Hospital. Information concerning all study patients was treated with utmost confidentiality. Patients were educated appropriately about the study and decision to participate or not in the study did not affect patient's management.

III. Results

One hundred and fifty four subjects with type 2 DM enrolled into the study. A total of 100(64.9%) were Females. The mean age (SD) of study subjects was 55 (10.17). Males were slightly older with a mean age (SD) of 56 (13.16), this difference was however not statistically significant (t=0.36, p=0.7178). Sociodemographic and clinical variables are shown in table 1 below.

Table 1: Showing socio-demographic and relevant clinical characteristics of study participants

Variables	Number (percentage)
Gender	
Male	54 (35.1%)
Female	100 (64.9%)
Age	
≤ 45	28 (18.2%)
> 45	126 (81.8%)
BMI	
≥ 25kg/m^2	99(64.3%)
< 25kg/m^2	55(35.7%)
Waist circumference (WC)	
Abnormal	114 (74%)
Normal	40(26%)
Treatment	
Oral antidiabetic	115(74.7%)
Oral antidiabetic + insulin	39(25.3%)
Duration of diabetes	
≤ 10 years	83(53.9%)
> 10 years	71(46.1%)
Educational level	
None, informal & primary	65(42.2%)
Secondary & tertiary	89(57.8%)

Employment status	
Employed	84(54.5%)
Not employed	70(45.5%)
Adherence to therapy	
Yes	71(46.1%)
No	83(53.9%)
Adherence to exercise	
Yes	33(21.4%)
No	121(78.6%)

GLYCAEMIC CONTROL OF STUDY SUBJECTS.

The overall mean (SD) glycated haemoglobin(HbA1c) of study subjects was 8.66(2.84). The mean HbA1c (SD) of females subjects 9.02(2.56) was higher compared to males at 7.99(2.57), this difference was statistically significant (t=2.22, p=0.028).The number of study subjects with HbA1c at control levels was 59(38.3%). The proportion of males with HbA1c at controlled levels was 48.1% compared to females at 33%, this difference was not significant(X^2=3.382, p=0.062). The mean FPG (SD) of study subjects was 8.033(3.56). The mean FPG (SD) of female subjects was higher 8.467(3.70) compared to males at 7.22(3.16), this difference was significant (t=2.08, p=0.039).The proportion of male subjects with FPG at controlled level was significantly higher 62.96% compared to 42% in females (X^2=0.124, p=0.013).The proportion of study subjects younger than 45 years of with good glycaemic control(HbA1c<7%) 28.6% was lower than 41.3% for those older than 45years of age, this difference was not statistically significant(X^2=1.065, p=0.3020)

GLYCAEMIC CONTROL AND CLINICAL PARAMETERS OF STUDY SUBJECTS.

The mean BMI (SD) of study subjects was 28.21(6.65). The mean BMI (SD) of female subjects was Significantly higher at 30.00kg/m^2 compared to males 24.88(4.68)kg/m^2 (t=2.22, p=0.028). The proportion of study subject with abnormal BMI who had poor glycaemic control (HbA1c<7%) is 38.38%, this is comparable to those with normal BMI at 38.18% (X^2=10.000, p=0.980). The mean WC (SD) of study subjects was 98.08(14.4) cm. The proportion of study subjects who had abnormal WC with poor glycaemic control (i.e. HbA1c > 7%) was significantly higher 61.4% compared to 25% in those with normal WC (X^2=14.2959, p=0.0001).

The relative frequency of good glycaemic control in study subjects whose duration of DM is less than 10 years was higher (44.6%) compared to those with DM duration greater than 10 years (21%). This difference was however not significant statistically(X^2=2.443, p=0.111). Majority of our study subjects 115(74.68%) were on a simpler regimen of treatment for type 2 DM (i.e. diet and oral agents) compared to 39(25.32%) on complex regimen (oral agents and insulin). The proportion of study subjects on a more simpler regimen for treatment of type 2 DM with good glycaemic control was significantly higher 47.8% when compared to 12.85% in those on complex regimen.(X^2=13.59, p=0.002). These is shown in table 2 below.

Table 2: Showing Association between glycaemic control with clinical parameters of study subjects

Parameter n(%)	**HbA1c n(%)**		**Chi-square(X^2)**	
	At goal	**not at goal**		**P-value**
Total 154(100)	59(38.3)	95(61.7)		
Gender				
Male 54(35.1)	28(51.9)	26 (48.1)	3.382	0.065
Female 100(64.9)	33(33.0)	67(67.0)		
Body mass Index(BMI) kg/m2				
Abnormal 99(64.3)				
Normal 55(35.7)	38(38.3)	61(61.2)		
	21(38.2	34(61.82)	0.000	0.98
WC in cm				
Abnormal 114(74.0)	44(38.6)	70(61.4)		
Normal 40(26.0)	30(75)	10(25.0)	14.295	0.000*
Duration of DM				
≤10 years 83(53.9)	37(44.6)	46(55.4)		
>10 years 71(46.1)	22(30.98)	49(68.1)	3.382	0.065
Treatment Regimen				
Diet and oral agents 115(74.7)				
Oral agents and Insulin 39(25.3)	55(47.8)	60(52.2)		
			13.571	0.002*
	5(12.8)	34(87.2)		
Employment Status				
Employed84(54.5)	31(36.9)	53(63.1)		
Not Employed 70(45.5)	28(40.58)	41 (59.5)	0.088	0.765
Educational Level				
None, Informal and Primary				

65(42.2)	28(40.58)	37(56.9)		
Secondary and Tertiary 89(57.8)				
	33(37.1)	56(62.9)	0.719	0.369
Adherence to Therapy				
Yes 71(46.1)	32(45.71	38(54.3)		
No 83(53.9)	27(32.5)	56(67.5)	2.252	0.132
Adherence to exercise				
Yes 33(21.4)	17(51.5)	16(48.5)		
No 121(78.6)	42(34.7)	79(65.3)	2.887	0.089
Family history of DM				
Yes 90(58.4)	31(34.4)	59(65.6)		
No 64(41.6)	28(43.8)	36(56.3)	1.005	0.316

The proportion of those employed with good glycaemic control was slightly lower 36.9% compared to 40.58% in those not employed this difference was however not statistically significant (X^2=0.0889, p=0.765).The proportion of study subjects who adhere to their prescribed treatment with good glycaemic control was higher 45.7% compared to 32.5% in those not adhering to prescribed therapy. This difference was not statistically significant(X^2=2.257, p=0.132).

The proportion of study subjects who adhere to exercise prescription with good glycaemic control was higher 53.1% compared to 34.7% in those not adhering to exercise, this difference was however not statistically significant (x^2=2.887, p=0.089). The proportion of study subjects with lower level of education (i.e. none, informal and primary) with good glycaemic control was higher 43.1% compared to 37.1% in those with better education (secondary, tertiary) .This difference is however not statistically significant (X^2=0.3421, p=0.558).The proportion of study subjects with family history of DM with good glycaemic control is slightly lower 34.4% compared to 43.7% in those without family history of DM, this difference was not statistically significant(X^2=1.005, p=0.316).

The proportion of study subjects with diastolic blood pressure controlled who had good glycaemic control 37.97% is comparable to those not controlled at 38.67% (X^2=0.0077, p=0.929), while those with controlled systolic blood pressure was 40.26% compared to 36.36% in those without control of their systolic blood pressure(X^2= 1.005, p=0.316).

When some of the above factors associated with glycaemic control like diabetes treatment regimen, gender, waist circumference, duration of DM treatment and adherence to exercise therapy where subjected to logistic regression, only increase complexity of diabetes treatment regimen was significantly associated with poor glycaemic control (OR 0.2191, 95% CI 0.0865-0.5546, p=0.004). This is shown in table 3 below.

Table 3. Logistic regression of factors associated with glycaemic control

Variable	Odds ratio	95%CI	P-value
Diabetes Treatment Regimen	0.2191	0.0865-0.5546	0.004
Gender	2.0177	0.9386-4.3375	0.0722
Waist circumference	1.0092	0.9834-1.0356	0.4890
Duration of DM diagnosis	0.9971	0.9508-1.0455	0.4044
Adherence to exercise	1.4435	0.6091-3.4212	0.9201

DM- Diabetes Mellitus, CI- Confidence Interval

IV. Discussion

Achieving optimal glycaemic is important in preventing development of morbidity and mortality in patients with diabetes. Diabetic patients with HbA1c persistently greater than 7% are at greater risk of developing eye, renal and cardiac complications as well as nerve damage, suffering from stroke and myocardial infarction[8] .The united Kingdom Prospective Diabetes Study(UKPDS) reported that each percentage point reduction in HbA1c is associated with a 35% reduction in microvascular complications and 7% reduction in all cause mortality[7].

The percentage of our study subjects achieving optimal glycaemic control (i.e HbA1c <7%) was 38.3%.This is comparable to 36% reported by Adebisi SA [9] from Ilorin Nigeria, 38.7% by Emmanule et al.,[10] from Zambia and 31% reported by The CODE-2 study conducted about 13 years ago in Europe[11], But better than reports by Adham et al[12] in Jordan, Akbar et al [13]in Saudi-Arabia, Sultan et al [14] Kuwait, and Valle et al [15] in Finland. However, reports by NHANES III, [16] UKPDS[7] and a study by Goudswaard et al[17]from Netherlands was better at 44, 50 and 58% respectively. The better glycaemic control in our study when compared to those from the Middle Eastern countries like Kuwait and Saudi Arabia may be related to the differences in methodologies used and the high prevalent rates of DM in these regions.

While the better controls from the NHANES III, UKPDS and Netherlands may be related to the advance economies of these regions the studies were carried out. Level of care, availability and access to

medications and number of specialist in DM management is better when compared to a developing economy like ours. Health insurance cover is also better, health insurance cover in our environment is very limited .The other factor may be the burden of both communicable and non communicable disease on our health care system, which leads to further stretch on the limited funds available for health care in our environment factors such as age, gender, waist circumference, duration of DM treatment and complexity of DM treatment were some of the factors found to be associated with glycaemic control in our study.

Glycaemic control was found to be relatively better in our male study subjects. This is consistent with the following studies [13,15,18] but is in contrast to a study in the United States where females were reported to have better glycaemic control[19].The reason for the differences is not very clear, but may be related to differences in study methodologies. Our study subject distribution showed that females were more in number in our study population (64.9%), and that this might also be a factor. The other reason might be the findings from the study that our male subjects were more physically active (i.e better compliance to exercise prescription) compared to females (29.63% vs 16%). The participants in our study who adhered to exercise prescription generally had better glycaemic control. The relative frequency of abnormal waist circumference was higher in females when compared to males 93vs38%; glycaemic control was better relatively in study subjects with abnormal WC .Age was another factor found to be associated with glycaemic control in our study subjects. Study subjects younger than 45 years with optimal glycaemic control were less than those older. This similar to reports from the following studies[(17,19)].Glycaemic control was found to be better in study subjects with shorter duration of DM (<10years) compared to those with duration of DM greater than 10 years. This is consistent with reports from the UKPDS and the following studies [(15,18)]The better optimal glycaemic control in study subjects with shorter duration of DM compared to those with longer duration of the disease may be related to the difficulty in glycaemic control with progression in type 2 DM disease process. At the earlier stages of type 2 DM, glycaemic control is aided by residual β-cell function, with progressive decline in β-cell function in advance disease, glycaemic control becomes increasingly difficult. The other factor might be the progressive increase in body fat mass, especially visceral fat with increase in age, visceral fat is more resistant to the action of insulin, which may contribute to worsening glycaemic control.

Glycaemic control was also found be better in study subjects with less complex regimen for treatment of type 2 DM(i.e. on diet and oral medications) compare to patients on complex regimen(i.e. on oral agents and insulin).This finding is similar to reports by Benoit et al[20] and Willey et al [21] in USA, other studies [(17,22)]also found poor glycaemic control in subjects with more complex treatments regimen for type 2 DM. This might also be related to decline in β-cell function with progressive disease, which require use of insulin and other oral anti-diabetic for treatment. The increasing complexity might also be associated with increase age of the patient, which also associated with increasing fat mass especially the visceral fat which is associated with poor response to insulin action. Additionally, in developing country like ours, increase complexity of treatment means increase cost of therapy, which is a very big challenge considering the poor and very limited health insurance coverage in our environment, the burden of disease as discussed above may also be a factor. The following studies [(23,24)] reported however, that the use of oral antidiabetic medications in combination with insulin is associated with good glycaemic control.

Obesity, both global (increased BMI) and central (abnormal waist circumference) was related to poor glycaemic control in our study subjects. This is unsurprising considering the fact that central obesity (abnormal waist circumference) as described earlier is associated with increase visceral fat which is more resistant to the action of insulin than peripheral (subcutaneous) fat.[25].Release of Free Fatty-Acids (FFAs) from visceral fats is also associated with decline βcell function (lipotoxicity). These are all expected to contribute to poor glycaemic control.

We would not forget to mention, at this point, the Diabcare multicenter study which took place in Nigeria amongst type 1 and 2 diabetics and which revealed that only 20.4% and 32.4% of participants achieved glycaemic control targets according to the International Diabetes Federation (IDF) and American Diabetes Association (ADA) recommendations respectively [28]

On logistic regression, only complex DM treatment regimen was significantly related to poor glycaemic control. This may not be unrelated to use of complex treatment regimen with advancing disease that is related to decline in β-cell function, increasing visceral obesity, which are all associated with difficult glycaemic control as mentioned earlier.

V. Conclusion

- The proportion of our study subjects with good glycaemic control using HbA1c targets was 38.3% and male participants had significantly better glycaemic control compared to females (using fasting plasma glucose levels). These figures are lower than those reported from Europe and other developed countries. This might be related to challenges in our health care systems; which include patient's factors like their poor socioeconomic status, lack of education, un- or underemployment. Others include, stretch on the limited funds to health care by

the double burden of communicable and non communicable disease, limited number of train specialist in DM, poor health facilities and limitation in coverage and accessibility to health insurance scheme.

VI. **Recommendations**

Increase political will from the Government with regards to improvement in the health insurance scheme, coverage and access to medications use in the treatment of DM. Support in training of more specialist and health care support staff involve the management of DM. these will go a long way in improving glycaemic control and reduce attendant morbidity and mortality associated with poor glycaemic control.

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