**Determinants of Glycemic control among Diabetes Mellitus Patients in a Tertiary Clinic in Gaborone, Botswana: findings and implications**

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**Abstract:**

*Background and aims:* Glycemic control among patients with diabetes mellitus is associated with a marked reduction of both macrovascular and microvascular complications; however, glycemic control remains an elusive goal worldwide. The aim of this study was to determine factors associated with glycemic control among patients attending a tertiary clinic in Botswana as limited information to date. *Methods:* Cross-sectional study in a tertiary clinic in Gaborone, Botswana. Patients were recruited between 21st July 2015 and 21st September 2015. The majority of the randomly recruited patients (368/380 - 96.8%) had documentation of glycemic control (HbA1c) within three months of study recruitment and were subsequently included in the analysis. Glycemic control was categorized as desirable, suboptimal and poor if HbA1c was < 7%, 7-9% and > 9% respectively. Data was analyzed using SPSS for descriptive statistics including both bivariate and multinomial logistic regression. Ap-value < 0.05 was considered statistically significant. *Results:* The analyzed study population consisted of 258/368 (70.1%) females with a mean age (SD) of 56.7± 13.6 years. Means (SDs) for diabetes duration and glycated haemoglobin were 7.2± 7.1 years and 7.97± 2.02% respectively. Of the 368 patients, 136 (36.95%) and 132/368 (35.86%) had desirableand suboptimal glycemic control respectively. Older age, attending the clinic for more or equal to 3 years and not being on insulin were associated with both desirable and suboptimal glycemic control whereas duration of diabetes between 5-10 years was associated with poor glycemic control. *Conclusions:* The majority of patients had poor glycemic control. Older age and not being on insulin were associated with better glycemic control. The fact that patients on insulin had poor glycemic control calls for more research to determine timing of insulin initiations and dosing schedule factors as these will help toimprove overall glycaemic control in Botswana and elsewhere.

Key words: Diabetes mellitus, Glycosylated Hemoglobin A1c, HIV, Cross-Sectional Study, Antidiabetic Drugs, Insulin, Botswana

**1. Introduction**

Diabetes mellitus (DM) is a global pandemic, contributing appreciably to worldwide morbidity and mortality [1, 2]. This is particularly an issue in Africa where in 2010, 12.1 million people were estimated to be living with diabetes, and this is projected to increase to 23.9 million by 2030 [3]. In for instance in South Africa, 61% of the population are currently overweight, obese or severely obese [4], increasing future prevalence rates for DM unless addressed. According to 2015 International Diabetes Federation (IDF) data, 1 in 25 adults in Botswana currently have DM, which is growing. Overall, approximately 52,000 adults in Botswana currently have DM, with over 60% currently remaining undiagnosed. The overall prevalence of DM and impaired glucose tolerance (IGT) in Botswana in 2015 was estimated at 5.6% and 7.1% respectively [5].

Previous studies, including randomized controlled trials, have consistently shown that tight glucose control is associated with a reduction of both microvascular and macrovascular complications [1, 6-9]. In addition, improving patients’ quality-of-life [10, 11]. Despite this evidence, a high proportion of DM patients remain poorly controlled across countries [3,4,11-15]; consequently, patients are at risk of complications of DM. The challenges of failing to attain optimal glycemic control in clinical practice are complex [16]; including both patient and health-care provider related factors. Patient related factors include, but not limited to, medication adherence, fear of hypoglycemia, disease process and patients’ attitudes; health-care factors include the number of hospital visits, types and number of antidiabetic medications being prescribed and health-provider attitudes [16, 17].Previous studies have shown that several factors influence glycemic control. These include age, gender, race/ethnicity, education, marital status, body mass index, duration of diabetes, smoking, type and number of medications used, dietary habits and psychological aspects [16, 18, 19]. However, published studies have shown inconsistency, and in almost 50% of occasions the reason for poor glycemic control cannot be explained [20].

This study was conducted to determine sociodemographic and clinical factors associated with glycemic control among DM patients attending a tertiary clinic in Botswana. Limited information is currently available regarding possible factors that help determine glycemic control among patients with DM in Botswana. This is important as the prevalence of diabetes is growing across sub-Sahara Africa including Botswana [3,4,21, 22]. We are aware that factors such as genetics, dietary patterns, and cultural backgrounds, may play a role in glycemic control. However, it is important to have local understanding to guide future studies and policies to improve glycemic control in Botswana, and ultimately reduce the extent of complications arising from DM. These findings may also be of interest to other sub-Saharan African countries as they try to improve the management of their patients with diabetes.

**2. Materials and Methods**

***2.1 Study design, population and data collection***

This was a cross-sectional study conducted among patients with Type 2 DM attending a tertiary clinic at Princess Marina Hospital (PMH) in Gaborone, Botswana. PMH is the leading tertiary public hospital in Botswana offering services to over 3000 diabetic patients, a number of whom will also have HIV and other co-morbidities, which may impact on medication adherence if pill counts are appreciably increased [22]. The data used for analysis in this study emanates from two primary studies, which have previously been published. Full details of how patients were selected for this study, along with their sociodemographic and clinical variables, can be found elsewhere [11, 22].

Briefly, the clinic in this tertiary hospital provides services for patients with DM including physician consultations, health education, and eye and foot screening as well as issuing medicines, which are provided free-of-charge. On average 1,800 to 2,000 diabeticpatients visit the clinic monthly with 1,400 of these visitations including physician consultations. Previously, we showed that glycemic control was not associated with adherence to antidiabetic medication overall, except for a subgroup of HIV-positive patents. There was better adherence to antidiabetic medicines among HIV-positive patients compared with HIV-negative patients and those with unknown serostatus [22]. Consequently, we undertook this study to examine further the determinants of glycemic control among our study participants. For the purpose of this study, 368/380 (96.8%) patients had recent results (within 3 months) for glycosylated haemoglobin (HbA1c); hence they were included in this analysis. Glycemic control (HbA1c) was categorized into three categories as follows: desirable (<7%), suboptimal (7-9%) and poor (≥9%) [23] Body mass index (BMI) was calculated as a ratio of weight in kg divided by height in m2 and categorized as underweight (< 18.5), normal weight (18.5-24.9), overweight (25-29.9) and obese (≥30). BMI categorization was done according to World Health Organization (WHO) [24]. Results of patients’ haemoglobin (Hb) were also extracted from the hospital Intergrated Patient Management System (IPMS) and categories of anaemia were made according to WHO as follows; Hb< 13g/dl for men and Hb< 12g/dl for women. Sub-categories of anemia were mild (11-11.9g/dl for women and 11-12.9 for men); moderate (8-10.9g/dl) and severe (< 8g/dl) [25].

At our clinic,during their first visit patients are screened for autoimmune and pancreatic antibodies. Patients categorized as type 1 DM had either of the two types of antibodies detected. Whilst the majority of patients’ antibodies results could not be traced for verification, we relied largerly on a diagnosis of DM as type 1 or 2 based on the diagnosis documented in the patients’ folders.

Ethical clearance was obtained from Institutional Review Boards of Princess Marina Hospital, University of Botswana and the Ministry of Health, Botswana.

***2.2 Statistical analysis***

Descriptive statistics were used to summarize patients’ sociodemographic and clinical characteristics. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS, version 22). Chi-square test was used to assess statistical significance of the difference in the percentages of good glycemic control according to independent categorical and continuous variables. One-way analysis of variance (ANOVA) was applied for comparisons of mean serum creatinine between three glycemic categories goups. Multinomial logistic regression models were performed to determine factors associated with glycemic control. All the independent variables studied were analyzed using both bivariate and multinomial logistic regression so as to ensure the impact of missing data, unbalanced sample size and large intragroup variation is countered as explained by Simpson’s paradox [26]. A 95% confidence interval and p value less than 0.05 was considered statistically significant.

**3. Results**

***3.1 Sociodemographic and clinical characteristics***

 Out of the 368 patients, 258 (70.1%) were female; mean age of study population was (SD) of 56.7± 13.6 years with 71.4% aged more or equal to 51 years. Means (SDs) for diabetes duration and glycated haemoglobin were 7.2± 7.1 years and 7.97± 2.02% respectively. Approximately 40% of patients were illiterate with either no formal education or not completed primary school. The majority of the study population who had complete data for body mass index were either overweight or obese, consisting of 256/326 (78.5%) patients. Moderate anemia was found in 29/368 (7.9%) of the study participants (Table 1). Other sociodemographic and clinical characteristics are summarized in Table 1.

Insert Table 1

***3.2 Determinants of Glycemic control***

Of the 368 patients, only 136 (36.9%) had desirable glycemic control. Univariate analysis showed that older age groups were associated with desirable glycemic control in that 35.8% and 51.5% of patients aged 51-65 and ≥ 66 years respectively had desirable glycemic control compared to 16.7% and 28% of those aged 21-35 and 36-50 years. In addition,42.5% of patients with a duration of diabetes < 5 years had desirable glycemic control compared to 31.2% of those with a duration of diabetes > 10 years . Bivariate analysis revealed that older age, duration of diabetes of 5-10 years, duration of attending the clinic of ≥ 3 years and monotherapy with oral hypoglycemic agents were associated with better glycemic control (Table 2). Other sociodemographic and clinical variables did not have statistical significance (Table 2).

Insert Table 2

***3.3 Multinomial regression analysis of factors associated with good glycemic control***

In mind of the Simpson effect whereby some variables with either missing data in our study such as unknown HIV positive patients might have resulted into wrong bivariate analysis findings, we decided to run all the studied variables into a multinomial analysis model regardless of their significance in bivariate analysis.The type of diabetes caused some unexpected singularities in the hessian matrix which could give invalid estimates, hence it was removed from the final model. Older age, attending the clinic for more or equal to 3 years and not being on insulin were associated with both desirable and suboptimal glycemic control whereas the duration of diabetes between 5-10 years was associated with poor glycemic control. Of note is the fact that glycemic control was not associated with the degree of anaemia.(Table 3).

Insert Table 3

**3.4 Association between serum creatinine and glycemic control**

There was no significant difference in renal function using mean serum creatine between the three categories of glycemic control (p-value = 0.645) (Table 4)

Insert Table 4

**4. Discussion**

This study revealed that majority of our patients (60.1%) had poor glycemic control. This high proportion of patients with poor glycemic control is similar though to the findings from other previous studies [27-31].

It is paramount to point out that the use of glycosylated haemoglobin (HbA1c) to assess diabetes control should be interpreted with caution. HbA1c is recognized as a relaiable marker of excess glycation and it is an intergrator of both fasting and post-prandial glycemic disorders [32, 33]. On the other hand, results of HbA1c can be affected by several different factors including but not limited to genetic, physiological, haematological and illness-related factors such as haemolyticanaemia, hemoglobinopathies, acute and chronic blood loss, chronic malaria, pregnancy and serum creatinine [34-36]. Hence, variations in measurents of HbA1c are expected especially in different ethinic and racial populations [37, 38], calling upon for the need for validation. Care of patients with DM in Botswana has adopted Society of Endocrinolofy and Metabolism of South Africa (SEMDSA) guidelines [39] which recommends HbA1c for glycemic control. On the other hand, a recent study in Botswana looking at diagnostic accuracy found a modest relationship between HbA1c and fasting blood glucose [40].

Despite the lack of local research on some conditions that could affect HbA1c levels in our settings, clinical evidence indicates that malaria is non-endemic in the southern part of Botswana where this study was conducted; furthermore haemogloninapthies such as sickle cell disease are very rare.

The degree of anaemia and serum creatininine have been found to affect measurements of glycosylated haemoglobin in contrasting ways in previous studies [36, 41-43]. However, when we analyzed these two variables we did not find any association with HbA1c.

It has been consistently shown that a longer the duration of diabetes is associated with progressive impairment of insulin secretion [8] as well as poorer adherence to antidiabetic medications; hence poor glycemic control [18, 19, 31, 44-47]. However, our study showed contrasting findings whereby the duration of diabetes of 5-10 years was associated with both desirable and suboptimal glycemic control compared to duration of diabetes of > 10 years. One possible explanation is that majority of our patients were diagnosed late (less than 5 years prior to the interval date) and they already had presented with complications [22]. We will be following this up in future research projects.

Previous studies have shown that old age is associated with better glycemic control [48-52]; probably because old people tend to have more complications with their symptoms [52] which could enhance adherence to antidiabetic medications. Our study also found consistent findings whereby older people had better glycemic control.

The increased number of medicines a patient is currently taking has also been associated with poor glycemic control. This may be a reflection of the efforts of physicians to increase the type and dosage of medicines used to counter poor glycemic control and associated complications [27, 53, 54], with pill burden known to adversely affect adherence [22, 53, 55]. However, our study revealed no significant association between the number of oral hypoglycemic agents in use and glycemic control. The reasons for this might be multifactorial. We paroxically found that patients whose treatment regimen did not include insulin regimen had a significant chance of having either desirable or suboptimal glycemic control. The possible explanation for this are factors such as the timing of initiation of insulin and insulin regimen schedules. This phenomenon has also been reported elsewhere [56, 57 ], and we will again be looking at this further in future research projects.

The combination of other factors such asa reluctance among physicians to initiate insulin early and wait until the disease has worsened, or a combination of other factors including a lack of physical exercise and diet modifications, may have contributed to overall poor glycemic control in our study particpants. Having said this, the contribution of physical exercise and diet to glycemic control in our patient population was not evaluated, which will need further exploration in the future.

Our study also revealed no significant association between glycemic control and other variables including gender, level of education, marital status, and blood pressure control. This is similar though to the findings from previously published studies [58, 59].

Higher body mass index (BMI) has been shown to be a predictor of poor glycemic control in previous studies [51, 60, 61]. However, this was in contrast to our study where BMI was not associated with glycemic control. A possible explanation for this is that our sample population consisted of an appreciably number of patients with higher BMIs, with over 75% of patients already being either overweight or obese. This will again be looked at further given the extent of patients overweight or obese in our study population.

Our previous study showed that glycemic control was not associated with adherence to antidiabetic medication [22].This underpins the fact that glycemic control may partly be affected by other self-management behaviors such as self-monitoring of glucose and self-care activities such as number of clinic visits which, as mentioned, we did not evaluateOur clinic also provide a range of other services including foot care, eye examination, and dietary couseling. The extent of adherence to such activities was not studied and they will also be the subject of future research.

According to Hartz et al, patients’ understanding of diabetes and adherence to recommended behaviors was associated with better glycemic control compared to physiological factors [54].However, this association was not studied in our population, and needs to be addressed to guide future policies alongside looking more closely at patients with diabetes mellitus This will also be studied in future research projects in this and others clinics across Botswana to provide additional guidance of possible measures to improve glycemic control in the future given current concerns.

***4.1 Study limitations***

It is imperative that our findings are interpreted on the background of several limitations. Firstly, this is a cross-sectional study design and does not explain causality. Secondly, we did not study self-management behaviors and we know psychosocial variables impact on glycemic control, which have been found to affect glycemic control in previous studies.Lastly, we did not collect data on fasting and post-prandial to compare with HbA1c levels. Despite these limitations, we believe our study findings are robust and offer insight for future targeted interventional studies in diabetes patients by providing epidemiological data and helping prioritize

management decisions in situations where there are limited resources.

**5. Conclusions**

The majority of patients in our clinic in Botswana had poor glycemic control, similar to most published studies. Older age and not being on insulin were associated with better glycemic control. The fact that patients on insulin had poor glcycemic control calls for more research to determine the timing of insulin initiations and dosing schedule factors as these will help to better improve overall glycaemic control in patients with diabetes in Botswana and elsewhere.

**Conflict of interests**

All authors declare that they have no conflict of interests related to this work. There was no funding for this research.

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**Tables**

**Table 1: Sociodemographic and clinical characteristics of study participants**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Glycemic control** | **Total** |
| **Desirable (<7%)** | **Suboptimal (7-9%)** | **Poor (>9%)** |
| **Gender**MaleFemale | 33 (30.0%)103 (39.9%) | 39 (35.5%)93 (36.0%) | 38 (34.5%)62 (24.0%) | 110258 |
| **Age in years**21-3536-5051-65≥66 | 5 (16.7%)21 (28.0%)58 (35.8%)52 (51.5%) | 5 (16.7%)28 (37.3%)67 (41.4%)32 (31.7%) | 20 (66.7%)26 (34.7%)37 (22.8%)49 (48.5%) | 3075162101 |
| **Highest level of education**No formal educationLess than primary schoolPrimary school completedSecondary school completedCollege/University completedPostgraduate degree | 30 (43.5%)31(40.3%)36 (35.6%)23 (31.1%)12 (29.3%)4 (66.7%) | 23 (33.3%)24 (31.2%)44 (43.6%)27 (36.5%)13 (31.7%)1 (16.7%) | 16 (23.2%)22 (28.6%)21 (20.8%)24 (32.4%)16 (39.0%)1 (16.7%) | 697710174416 |
| **Marital status**Never marriedCurrently marriedSeparatedDivorcedWidowedCohabiting | 32 (32.7%)62 (40.8%)0 (0%)2 (15.4%)34 (45.3%)6 (21.4%) | 31 (31.6%)49 (32.2%)2 (100%)7 (53.8%)31 (41.3%)12 (42.9%) | 35 (35.7%)41 (27.0%)0 (0%)4 (30.8%)10 (13.3%)10 (35.7%) | 981522137528 |
| **BMI in kg/m2**Underweight Normal weight (Overweight Obese Missing | 2 (40.0%)24 (36.9%)41 (43.6%)59 (36.4%) | 1 (20.0%)18 (27.7%)31 (33.0%)66 (40.7%) | 2 (40.0%)23 (35.4%)22 (23.4%)37 (22.8%) | 5659416242 |
| **Type of diabetes** mellitusType 1Type 2 | 2 (8.7%)134 (38.8%) | 5 (21.7%)127 (36.8%) | 16 (69.6%)84 (24.3%) | 23345 |
| **Duration of Diabetes in years**< 55-10> 10Missing | 74 (42.5%)25 (29.8%)29 (31.2%) | 58 (33.3%)29 (34.5%)37 (39.8%) | 42 (24.1%)30 (35.7%)27 (29.0%) | 174849317 |
| **Duration of attending block 6 clinic**<3 years≥3 yearsMissing | 75 (40.1%)60 (33.5%) | 55 (29.4%)76 (42.5%) | 57 (30.5%)43 (24.0%) | 1871792 |
| **Modality of treatment of diabetes**DietOral hypoglycemic agents (OHAs)InsulinBoth OHAs and Insulin | 3 (75.0%)98 (45.4%)11 (21.6%)24 (24.7%) | 1 (25.0%)77 (41.6%)17 (33.3%)37 (38.1%) | 0 (0%)41 (19.0%)23 (45.1%)36 (37.1%) | 42165197 |
| **Number of OHAs**OneTwoMissing | 58 (36.7%)64 (41.3%) | 55 (34.8%)59 (38.1%) | 45 (28.5%)32 (20.6%) | 15815555 |
| **Presence of complications**YesNo | 108 (35.8%)28 (42.4%) | 113 (37.4%)19 (28.8%) | 81 (20.6%)19 (28.8%) | 30266 |
| **Average Blood pressure**Controlled (<140/90mmHg)Uncontrolled (≥140/90mmHg) | 58 (37.4%)78 (36.6%) | 51 (32.9%)81 (38.0%) | 46 (29.7%)54 (25.4%) | 155213 |
| **HIV status**PositiveNegativeDon’t know | 19 (50.0%)76 (33.8%)41 (39.0% | 8 (21.1%)87 (38.7%)37 (35.2%) | 11 (28.9%)62 (27.6%)27 (25.5%) | 38225105 |
| **Anaemia**ModerateMildNo anaemia | 11 (37.9%)17 (32.1%)104 (38.0%) | 8 (27.6%)21 (39.6%)99 (36.1%) | 10 (34.5%)15 (28.3%)71 (25.9%) | 2953274 |

**Table 2: Factors associated with good glycemic control among the study population**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Desirable control** | **Suboptimal control** |
| **Crude OR (95% CI)** | **p-value** | **Crude OR (95%CI)** | **p-value** |
| **Gender**MaleFemale | 1 (Ref) 1.913 (1.09-3.36)  | **0.024** | 1 (Ref)1.46 (0.84-2.53) | 0.177 |
| **Age in years**21-3536-5051-65≥66 | 1 (Ref)3.23 (1.04-10.06)6.27 (2.17-18.16)12.24 (3.98-37.60) | **0.043****0.001****<0.001** | 1 (Ref)4.31 (1.41-13.15)7.24 (2.51-20.89)7.53 (2.40-23.61) | **0.01****<0.001****0.001** |
| **Highest level of education**No formal educationLess than primary schoolPrimary school completedSecondary school completedCollege/University completedPostgraduate degree | 1 (Ref)0.75 (0.33-1.70)0.91 (0.41-2.06)0.51 (0.22-1.18)0.40 (0.15-1.05)2.13 (0.22-20.73) | 0.4930.8290.1150.0620.514 | 1 (Ref)0.76 (0.32-1.80)1.46 (0.64-3.32)0.78 (0.34-1.82)0.57 (0.21-1.49)0.70 (0.04-11.96) | 0.530.370.570.250.80 |
| **Marital status**Married/ Cohabiting Single/ Separated/Widowed | 1 (Ref)1.04 (0.62-1.74) | 0.879 | 1 (Ref)1.21 (0.72-2.04) | 0.47 |
| **BMI in kg/m2**Underweight Normal weight Overweight Obese  | 1 (Ref)1.04 (0.14-8.04)1.86 (0.25-14.15)1.60 (0.22-11.81) | 0.9670.5470.648 | 1 (Ref)1.56 (0.13-18.661)2.82 (0.24-33.05)3.57 (0.31-40.69) | 0.7230.4090.306 |
| **Type of diabetesmellitus**Type 1Type 2 | 1 (Ref)12.76 (2.86-56.91) | **0.001** | 1 (Ref)4.84 (1.71-13.71) | **0.003** |
| **Duration of Diabetes in years**< 55-10> 10 | 1 (Ref)0.47 (0.25-0.91)0.61 (0.32-1.16) | **0.02**0.13 | 1 (Ref)0.70 (0.37-1.34)0.99 (0.53-1.87) | 0.280.98 |
| **Duration of attending block 6 clinic**<3 years≥3 years | 1 (Ref)1.06 (0.63-1.79) | 0.83 | 1 (Ref)1.83 (1.08-3.10) | **0.024** |
| **Modality of treatment of diabetes**DietOral hypoglycemic agents (OHAs)InsulinBoth OHAs and Insulin | >1000\*\*3.59 (1.91-6.75)0.72 (0.30-1.74)1 (Ref) | **<0.001**0.462 | >1000\*\*1.83 (1.01-3.31)0.72 (0.33-1.56) | **0.047**0.406 |
| **Number of OHAs**OneTwo | 1 (Ref)1.55 (0.87-2.76) | 0.135 | 1 (Ref)1.51 (0.84-2.70) | 0.167 |
| **Presence of complications**YesNo | 1 (Ref)1.11 (0.58-2.12) | 0.763 | 1 (Ref)2.82 (0.91-8.72) | 0.349 |
| **Average Blood pressure**Controlled (<140/90mmHg)Uncontrolled (≥140/90mmHg) | 1 (Ref)1.15 (0.68-1.93) | 0.608 | 1 (Ref)1.91 (0.87-4.19) | 0.261 |
| **HIV status**PositiveNegativeDon’t know | 1 (Ref)1.41 (0.62-3.18)1.24 (0.69-2.24) | 0.4090.477 | 1 (Ref)0.52 (0.20-1.36)0.98 (0.56-1.77) | 0.1830.938 |
| **Anaemia**ModerateMildNo anaemia | 1 (Ref)0.75 (0.30-1.86)0.77 (0.36-1.65) | 0.5360.507 | 1 (Ref)0.57 (0.22-1.53)`1.00 (0.48-2.08) | 0.2660.991 |

Poor control category is used as a reference category on the dependent variables

\*\*The hessian matrix is almost singular

**Table 3: Multinomial logistic regression of factors associated with glycemic control**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Desirable control** | **Suboptimal control** |
| **Adjusted OR (95% CI)** | **p-value** | **Adjusted OR (95%CI)** | **p-value** |
| **Gender**MaleFemale | 1 (Ref) 0.78 (0.33-1.84) | 0.57 | 1 (Ref)0.67 (0.29-1.55) | 0.35 |
| **Age in years**21-3536-5051-65≥66 | 1 (Ref)2.03 (0.30-13.69)4.32 (0.63-29.80)11.70 (1.40-97.69) | 0.4630.1370.023 | 1 (Ref)10.16 (0.82-1.26)13.99 (1.11-177.27)16.31 (1.10-241.70) | 0.07**0.04****0.04** |
| **Highest level of education**No formal educationPrimary to secondary completedCollege/University/Postgraduate completed | 1 (Ref)1.44 (0.44-4.74)1.14 (0.42-3.10) | 0.5520.796 | 1 (Ref)1.28 (0.40-4.13)1.08 (0.40-2.96) | 0.680.88 |
| **Marital status**Married/ Cohabiting Single/ Separated/Widowed | 1 (Ref)1.41 (0.69-2.89) | 0.35 | 1 (Ref)1.96 (0.97-3.98) | 0.60 |
| **BMI in kg/m2**Underweight/Normal (<24.99)Overweight/Obese (25-) | 1 (Ref)1.38 (0.53-3.59) | 0.51 | 1 (Ref)1.61 (0.61-4.27) | 0.336 |
| **Duration of Diabetes in years**< 55-10> 10 | 1 (Ref)0.34 (0.13-0.86)0.42 (0.15-1.15) | **0.02**0.09 | 1 (Ref)0.39 (0.15-0.98)0.57 (0.22-1.50) | **0.04**0.25 |
| **Duration of attending block 6 clinic**<3 years≥3 years | 1 (Ref)1.54 (0.68-3.45) | 0.30 | 1 (Ref)3.71 (1.66-8.31) | **0.001** |
| **Modality of treatment of diabetes**Diet/Oral hypoglycemic agents (OHAs)Insulin/Both OHAs and Insulin | 6.41 (2.28-18.00)1 (Ref) | <0.001 | 2.96 (1.03-8.47) | **0.043** |
| **Number of OHAs**OneTwo | 1 (Ref)0.47 (0.18-1.20) | 0.11 | 1 (Ref)0.79 (0.52-1.30) | 0.638 |
| **Presence of complications**YesNo | 1 (Ref)0.76 (0.44-1.30) | 0.70 | 1 (Ref)2.82 (0.91-8.72) | 0.25 |
| **Average Blood pressure**Controlled (<140/90mmHg)Uncontrolled (≥140/90mmHg) | 1 (Ref)1.04 (0.67-1.59) | 0.11 | 1 (Ref)1.30 (0.59-2.84) | 0.511 |
| **HIV status**PositiveNegativeDon’t know | 1 (Ref)4.29 (1.00-18.32)1.39 (0.60-3.21) | 0.050.44 | 1 (Ref)1.08 (0.23-5.09)1.75 (0.76-4.06) | 0.9220.189 |
| **Anaemia**ModerateMildNo anaemia | 1 (Ref)0.56 (0.15-2.14)0.85 (0.31-2.37) | 0.3970.762 | 1 (Ref)0.50 (0.13-1.93)0.83 (0.30-2.25) | 0.3170.706 |

**Table 4: Association between serum creatinine and glycemic control**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **Desirable control** | **Suboptimal control** | **Poor control** | **p-value** |
| Mean serum creatinine in umol/l (SD) | 71.55(28.17) | 74.33(31.36) | 75.44(41.62) | 0.645 |