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Factors Associated with Glycated Hemoglobin Levels > 6.5% among Diabetic Patients Attending Kenyatta National Hospital, Kenya

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Abstract

Introduction: Good quality care in Type 2 diabetes mellitus (T2DM), whose prevalence is approximately 10% in Kenya, may prevent or delay diabetes complications. This study determined blood glycemic targets, defined by HbA1c levels (>6.5% [53 mmol/mol]) and associated factors among patients receiving diabetes management at Kenyatta National Hospital in Kenya. **Methods:** In this cross-sectional study conducted between May to September 2017, we obtained blood samples from 381 consenting T2DM patients attending KNH. The study collected data using a detailed questionnaire while taking glycemic measurements. Factors associated with poor glycemic control (HbA1c levels >6.5%) were determined using Ordinal logistic regression modeling, STATA software version 13. **Results:** 103 (27.1%) T2DM patients with poor glycemic control were identified. In multivariate analysis, independent risk factors associated with poor glycemic control and their 95% confidence intervals included: concurrent hypertension (aOR 1.6, [1.1, 2.4]), receiving ≥3 oral anti-diabetes medication (aOR 2.4, [1.3, 4.6]) and good adherence to medication based on self-reporting (aOR 6.2, [1.9, 41.3). Independent protective factors included self-monitoring of blood glucose levels (aOR 0.35, [0.2, 0.4]), patients aged 51 to 60 years (aOR 0.5, [0.3, 0.9]), weight between 50 and 70 kgs (aOR 0.5, [0.3, 0.9]) and receiving 1 to 2 diabetes medication (aOR 0.4, [0.3, 0.7]). **Conclusion:** Significantly high proportion of T2DM patients receiving treatment at KNH had poor glycemic control. Addressing comorbidities and promoting good glycemic control among long-standing T2DM patients receiving ≥3 oral anti-diabetes medication is key to delaying or preventing chronic diabetes complications. Self-monitoring of blood glucose levels needs to be encouraged as suggested by its protective effect. While dif-

ferences in risk between diverse weights and ages need further studies, innovative ways of authenticating self-reports, e.g., triangulation, are required to ensure credibility. This work supports the Government of Kenya's *Vision* 2030 in creating a healthy and productive population contributing to the country's economic growth.

Keywords

Diabetes Mellitus, Glycemic Control, Glycated Hemoglobin, Kenya

1. Introduction

Diabetes mellitus (DM) is a chronic non-communicable disease (NCD) of impaired carbohydrate, fat, and protein metabolism caused by either lack of insulin secretion or decreased sensitivity of the tissues to insulin [1]. The disease is characterized by hyperglycemia, with fasting glucose greater than 1.26 g/L [2]. Diabetes is an increasingly prevalent global health problem and is the 9th leading cause of death. It is also the highest in disease burden as measured by adjusted life years, with approximate 90% increase in burden between 1990 and 2010 [3]. Of the 8.3% worldwide adults' population suffering from diabetes, about 90% have Type 2 diabetes (T2DM), with the majority living in developing countries according to the reports by International Diabetes Federation (IDF), 2013 and 2014. The estimated prevalence of diabetes in Africa is 1% - 3% in rural areas and 5% - 6% in urban areas with wide inter-country variation [4]. International Diabetes Federation (IDF) Atlas projects that in Sub Saharan Africa, 10.8 million diabetes cases in 2006 would increase to 18.7 million by 2025, which is equivalent to an increase of 80%. This increase exceeds the predicted worldwide increase of 55% [5]. The disease is progressively reported in Africa currently, most likely due to the change of lifestyle and dietary habits [6]. In Kenya, the prevalence of diabetes Mellitus rose from 3.3% in 2007 to 4.2% in 2009, reaching a high of 10% in some regions with the trend on the rising trajectory [7].

Many countries are armed with national and international guidelines developed to support diabetes care management. This is achieved through documentation of important deficits in the quality of diabetes care by national surveys in different countries [8]. Key among these deficits remain health care system challenges [9]. Measurement of quality of care in diabetes focuses on the process of care, including regular glycated hemoglobin (HbA1c) testing, as well as intermediate outcome measures such as achievement of glycemic control. Besides, international standards [10] recommend the control of risk factors (lipid levels, high blood pressure, and avoiding tobacco) and the detection of potential complications (retinopathy, nephropathy, etc.) early in the disease process to achieve the best health outcomes [11].

The glycated hemoglobin (HbA1c) test is a robust measure of the quality of care in the management of diabetes [12]. The test, a biomarker of long-term

glucose control, was approved by the World Health Organization (WHO) to diagnose diabetes and monitor glycemic control in people with diabetes [12]. While long term targets recommend levels of sustained <6.5%, higher HbA1c levels are associated with diabetic complications [13]. Integrating medications, exercise, dietary changes, and regular HbA1c testing remain critical in the management of diabetes in Kenya [14].

Kenya's Ministry of Health (KMoH) has initiated strategies to improve the management and care of diabetes patients by setting up specialized diabetics clinics at all level 5 hospitals and managing standardized follow-up protocols. The latter is partly responsible for heightened diabetes health literacy among diabetic patients associated with better glycemic control, optimal medication, and enhanced individual participation in diabetes self-care [15]. Studies have shown that diabetic patients who know their HbA1c values better understand diabetes care and frequently assess their glycemic control relative to those who did not [15]. Although KMoH recommends HbA1c measurement 2 to 4 times in a year, limited data exists that shows the trends and associated factors for high HbA1c levels among diabetes patients [14]. This study sought to determine the level of glycemic control and associated factors among diabetic patients receiving treatment at the diabetic clinic at the Kenyatta National Hospital (KNH) to improve the quality of diabetic care in Kenya. This knowledge will inform existing policies focused on addressing diabetes and related complications and update Kenya's Government. Kenyan government is currently keen on meeting Sustainable Development Goal (SDG) 3.4 that calls to reduce premature NCD mortality by a third by 2030.

2. Materials and Methods

2.1. Study Design and Setting

We employed a cross-sectional study design to recruit 385 diabetic patients receiving treatment at the specialized diabetic clinic within KNHs, Kenya's largest national referral hospital. We applied the formula for estimating the population proportion with specified relative precision described by Lemeshow [16], setting the margin of error at 0.05, and a detection rate of 50% with 95% confidence. The ethics and research committee of the University of Nairobi and Kenyatta National Hospital approved the study with the approval number P629/09/2016.

2.2. Study Participants

Permission was obtained from the head of the diabetic clinic to review patients' files and records to evaluate those who met the study inclusion criteria. Type 2 diabetic patients who were at least 18 years old, receiving care and treatment at the diabetic clinic of KNH with 12 weeks postmedication, willing to undergo a 30 minutes face to face interview and consented for the study were eligible to participate. Those who were less than 18 years of age, had other types of diabetes and not in KNH, no 12 weeks post medication and are not willing to consent were excluded from the study.

2.3. Data Collection

A detailed, structured, face-to-face interview was employed to gather information on socio-demographic characteristics, healthcare access, current treatment, presence of diabetes-related complications (leg or foot ulcers, amputation, decreased vision, retinal damage, loss of sight, dialysis, vascular complications, diabetic coma, foot pain or burning, feet numbness), cardiovascular disease risk factors (tobacco use, obesity, and hypertension), occurrence of cardiovascular disease (heart attack, angina, heart failure or other heart diseases), and other comorbidities (depression, chronic obstructive pulmonary disease, asthma, musculoskeletal disease, neurological disease, and cancer).

2.4. Laboratory Analysis and Quality Control Materials

Five (5) mls single draw of whole blood sample was collected from each subject into EDTA tubes by veno-puncture and shipped into biochemistry laboratory for Glycated Hemoglobin (HbA1c) measurements. We used commercially acquired multi-sera normal level and pathological level materials for quality control. The IQC material was supplied in lyophilized form and reconstituted as per the manufacturer's preparation method. The HbA1c assay and test interpretation were carried out using DIRUI CS 4000 Clinical Chemistry analyzer according to the manufacturer's instructions as described in [17].

2.5. Data Analysis

All statistical analyses were conducted using STATA version 13 (Stata Corp LP, Texas, USA) at a significant level of $p < 0.05$. Descriptive data were presented in frequencies and percentages using tables and charts. Baseline characteristics were analyzed using Kruskal-Wallis test (non-categorical variables) and $\chi 2$-test or Fisher's exact test (categorical variables). Factors associated with elevated HbA1c were determined using linear regression analysis.

3. Results

3.1. Characteristics of the Diabetic Patients

As summarized in Table 1, the mean age (± SD) of the 381 (with all available data) of the 385 enrolled patients was 57.9 (± 12.2) years. Of these 381 patients, 172 (45.1%) were aged above 61 years, 229 (60.1%) were female, 167 (43.8%) had primary level education, 315 (82%) were married, 160 (42%) were self-employed. The majority of patients, 163 (42.1%), weighed above 71 kg, 127 (33.3%) had diabetes for more than ten years, while 285 (74.8%) were on 1 to 2 different diabetic medications. Nine (2.4%) of the 381 patients were cigarette smokers, while 22 (5.8%) were alcohol consumers. The majority 210 (55.1%) of the study patients had varied concurrent medical conditions, which included 45.4% hypertension, 3.1% bone-related conditions, 2.4% cancer-related conditions, 2.4% ears, nose, and throat conditions, while the least 0.5% had skin complications.

Table 1. Baseline and clinical characteristics of study participants.

Variable	Unit	Frequency	Percentage
Gender	Female	229	60.1
	Male	152	39.9
Age (Years)	**Mean (± SD)**	**57.9**	**(± 12.2)**
	Range	**68**	**18 - 86**
	<30	9	2.4
	31 - 40	36	9.4
	41 - 50	44	11.5
	51 - 60	120	31.5
	>61	172	45.1
Education level	Primary	167	43.8
	Secondary	163	42.8
	Tertiary	51	13.4
Occupation	Employed	68	17.8
	Self employed	160	42
	Unemployed	153	40
Weight	**Mean (± SD)**	68.5	**(± 16.2)**
	Range	75	**43 - 118**
	<50 Kg	85	22.3
	50 - 70 Kg	133	34.9
	>70 Kg	163	42.8
Blood pressure	90 - 140/60 - 90 (Normal)	121	31.8
	>140/90 (Highest)	99	26
Duration diabetic	**Mean (± SD)**	**8.8**	**(± 8.1)**
	Range	**39**	**(1 - 40)**
	< 5 Years	152	39.9
	5 - 10 Years	102	26.8
	>10 Years	127	33.3
Number of diabetes medication	**Mean (± SD)**	**2.1**	**(± 1.2)**
	Range	**7**	**(1 - 8)**
	1 - 2 Medications	285	74.8
	> 3 Medications	96	25.2
Concurrent medical condition	Heart condition	4	1
	Bone condition	12	3.1
	Skin condition	2	0.5
	Ears Nose and Throat conditions	9	2.4
	Hypertension	173	45.4
	Internal organ conditions	1	0.3
	Cancer related	9	2.4
	None	171	44.9
Cigarette smoking	Yes	9	2.4
	No	372	97.7
Alcohol consumption	Yes	22	5.8
	No	359	94.2

SD: Standard Deviation.

3.2. Glycemic Control among Diabetic Patients

The mean (± SD) levels of HbA1c 12 weeks post initial visit among study patients was 8.9% (± 2.6%), ranging from 4.9% to 24.1%. Based on the recommendation regarding the HbA1c ranges, there were 103 (27.1%) participants who had HbA1c levels >6.5% consider diabetic (poor glycemic control), 252 (66.1%) had HbA1c levels of 6.0% - 6.4% consider pre-diabetes indication while only 26 (6.8%) who had HbA1c levels <6% consider normal (Table 1).

3.3. Bivariate Analyses

In unadjusted analysis, socio-demographic and clinical characteristics associated with patients' glycemic control, Age, Weight, Blood pressure Number of Diabetes medication, Concurrent medical conditions, Duration with diabetes Index HbA1C LEVELS Three or more oral anti-diabetic drug, Good adherence to medication and Self-monitoring blood glucose.

3.4. Multivariate Analyses

In Table 2, after adjusting for potential confounders, the multivariable logistic regression determined socio-demographic and clinical characteristics associated with patients' glycemic control. The variables were analyzed with a P value of ($P < 0.05$) as the significant level for all the data obtained. Table 2 shows P values given for the multivariate analysis showing the significance of the test.

Table 2. Factors associated with poor glycemic control.

Variable	Overall population		Poor glycemic control (>6.5%)		Bivariate	P-value	Multivariate
	No	%	No	%	uOR (95% CI)	(P-0.05)	aOR (95% CI)
Gender							
Female	229	60.1	66	28.8	1.2 (0.8 - 1.8)	0.408	0.8 (0.4 - 1.4)
Male	152	39.9	37	24.3	Reference	Reference	Reference
Age Group							
<30	9	2.4	3	33.3	1.1 (0.3 - 3.2)	0.732	0.8 (0.2 - 2.8)
31 - 40	36	9.4	10	27.8	0.9 (0.4 - 1.7)	0.706	0.9 (0.4 - 1.8)
41 - 50	44	11.5	14	31.8	0.9 (0.5 - 1.8)	0.857	1.1 (0.5 - 2.1)
51 - 60	120	31.5	20	16.7	0.8 (0.2 - 0.9)	0.025	0.5 (0.3 - 0.9)
>61	172	45.1	56	32.6	Reference	Reference	Reference
Weight (Kg)							
<50 Kg	85	22.3	31	36.5	1.2 (0.7 - 1.8)	0.61	0.9 (0.5 - 1.4)
50 - 70 Kg	133	34.9	21	15.8	0.5 (0.3 - 0.8)	0.023	0.5 (0.3 - 0.9)
>70 Kg	163	42.8	51	31.3	Reference	Reference	Reference

Continued

Blood Pressure							
90 - 140/60 - 90 (Normal)	121	31.8	47	38.8	2.7 (1.7 - 4.4)	0.001	2.3 (1.4 - 3.9)
>140/90 (Highest)	99	26	33	33.3	2.3 (1.3 - 3.9)	0.024	1.9 (1.1 - 3.2)
Unavailable	161	42.3	23	14.3	Reference	Reference	Reference
Number of Diabetes medication							
1 - 2 Medication	285	74.8	53	18.6	0.4 (0.2 - 0.5)	0.001	0.4 (0.3 - 0.7)
>3 Medication	96	25.2	50	52.1	Reference	Reference	Reference
Index HbA1c levels							
<6% (Normal)	11	2.9	2	18.2	Reference	Reference	Reference
6.0% - 6.4% (Prediabetes)	5	1.3	1	20	1.1 (0.2 - 8.2)	0.952	1.1 (0.2 - 7.7)
>6.5% (Diabetic)	118	31	46	39	1.8 (1.2 - 2.7)	0.003	1.8 (1.2 - 2.7)
Concurent medical conditions							
Heart condition	4	1	0	0	Omitted		Omitted
Bone condition	12	3.1	4	50	1.6 (0.6 - 4.6)	0.248	1.8 (0.7 - 5.2)
Skin condition	2	0.5	0	0	Omitted		Omitted
Ears Nose and Throat conditions	9	2.4	4	44.4	2.2 (0.7 - 6.1)	0.075	2.5 (0.9 - 7.3)
Hypertension	173	45.4	56	32.4	1.6 (1.1 - 2.4)	0.028	1.6 (1.1 - 2.4)
Internal organ conditions	1	0.3	1	100	4.8 (0.7 - 35.7)	0.233	3.4 (0.5 - 24.9)
Cancer related	9	2.4	3	33.3	1.6 (0.5 -5.2)	0.476	1.5 (0.5 - 5.1)
None	171	44.9	35	20.5	Reference		Reference
Three or more Oral anti-diabetic drug							
Yes	77	20.2	43	55.8	2.8 (1.9 - 4.2)	0.006	2.4 (1.3 - 4.6)
No	304	79.8	60	19.7	Reference		Reference
Good adherence to medication							
Yes	179	47.0	71	39.7	2.5 (1.6 - 3.8)	0.049	6.2 (1.9 - 41.3)
No	202	53.0	32	15.8	Reference		Reference
Self-monitoring blood glucose							
Yes	303	79.5	51	16.8	0.3 (0.2 - 0.4)	0.001	0.35 (0.2 - 0.4)
No	78	20.5	52	66.7	Reference		Reference

No—Number; %—Percentage; P—Level of significance; OR—Odds ratio; CI—confidence interval; u—Unadjusted odds ratio; a—adjusted odds ratio.

In multivariate analysis, independent factors more likely associated with poor glycemic control included: having hypertension (aOR 1.6, 95% CI 1.1 to 2.4, P 0.028), receiving three or more oral anti-diabetes medication (aOR 2.4, 95% CI 1.3 to 4.6, P 0.006), and had good adherence to medication (aOR 6.2, 95% CI 1.9 to 41.3, P 0.049). Good adherence indicates the manner at which the patients' use and response to medication are measured. Good adherence to medication should translate to better glycemic control.

On the other hand, patients who were aged 51 to 60 (aOR 0.5, 95% CI 0.3 to 0.9, P 0.025), those who weighed between 50 to 70 kgs (aOR 0.5, 95% CI 0.3 to 0.9, P 0.023), receiving 1 to 2 diabetes medication (aOR 0.4, 95% CI 0.3 to 0.7, P 0.001) and those self-monitoring their blood glucose (aOR 0.3, 95% CI 0.2 to 0.4, P 0.001) were less likely to be associated with poor glycemic control.

4. Discussion

We employed HbA1c test, the gold standard test for glycemic control, finding that a considerable proportion of our diabetic study participants had poor glycemic control. 27% of our diabetic study participants had HbA1c levels considered globally as poor glycemic control, while a third of them had HbA1c levels considered pre-diabetic. We defined reasonable glycemic control as having values of HbA1c ≤ 6.5% and poor glycemic control of HbA1c > 6.5% [18]. Independent risk factors associated with poor glycemic control included concurrent hypertension, long-standing T2DM as implied by receiving ≥3 oral anti-diabetes medication, and good adherence to medication based on self-reporting. On the other hand, independent protective factors included self-monitoring of blood glucose levels, age, and weight and receiving 1 to 2 diabetes medication.

The high prevalence of uncontrolled T2DM reported in this study compares well with previous studies, which reported considerably higher prevalence levels. For instance, ≥60% of T2DM patients had poor glycemic control in the same clinic that we carried our study close to 2 decades ago [19]. 72% in PCEA Kikuyu Hospital in the outskirts of Nairobi [20] and 67% of T2DM patients had poor glycemic control and in Western Kenya in a 5-year follow-up [21]. Though these findings may reflect achievement in managing this disease, ours is a small study whose design is simple to extricate such hypotheses. A structured examination of medical records found in the specialized clinics when subjected to rigorous analyses such as time series exploration could reveal trends and patterns.

Other countries have reported a high prevalence of poor glycemic control, for instance, 50% in Ethiopia, 65.0% in Oman, 65.1% in Jordan, 69% in the United Arab Emirates, 74.9% in Saudi Arabia and 78.8% in Kuwait [22]-[27]. The overall picture established by our study and prior research suggests a generally high prevalence of poor glycemic control, which is a matter of significant concern globally linked to micro-and macro-vascular chronic complications. These include hypertension, kidney disease, eye problems, leg or foot ulcers, amputation, vascular complications, diabetic coma, cardiovascular disease and other comorbidi-

ties (depression, chronic obstructive pulmonary disease, asthma, musculoskeletal disease, neurological disease, and cancer) [26]. These complications may continue to appear since the incidence of diabetes in Kenya and Africa is rising [28].

The benefits of reasonable glycemic control are well known [29]. Despite this clear evidence, many patients fail to reach an optimal glycemic target [30]. Even with the medical advances and availability of modern drugs and health care facilities, managing diabetes has been a challenge throughout the world [31]. Notably, glycemic control challenges exist in countries with high levels of health awareness and strong health care systems; for instance, 36.5% of adults in the USA had uncontrolled HbA1c levels [32]. A recent retrospective cohort study reported the risk of glycemic variability as a predictor of mortality in older people especially in the United States of America [33].

Many factors can influence optimal glycemic control, including gender, age, BMI, illness duration, type of medication, lipid profile, and blood pressure [34]. Our findings indicated that those aged 51 - 60 years were less likely to have poor glycemic control compared to those aged > 60 years. Similar studies from India, USA, and Ethiopia also showed that most patients with poor glycemic control belonged to the age categories 60 - 70 years [21] [35]. While clinical management of diabetes focuses on stringent glycemic control, evidence indicating that this is not necessarily beneficial is emerging among older adults [36]. Indeed, stringent glycemic control is linked to early cardiovascular death among geriatrics suggesting that diabetics patients ≥65 years old should be subjected to individualized glycemic targets of between <7.5% and <8.5% trading off with hyperglycemia and acute complications [32] [36]. Long-standing diabetes translates to more years with diabetes management, leading to increased prescription of more drugs, the same risk factor we found in this study (receiving three or more anti-diabetes medication). More studies are needed to establish the association between glycemic control, the number of drugs prescribed, the variability of HbA1c over time, and the presence of complications among geriatrics >60 years of age.

This study observed an expectedly significant protective association between poor glycemic control in diabetic people and weight between 50 to 70 kgs. This weight range primarily translates to standard body mass indices (BMI) for heights among many people in a population. A higher BMI > 30 and above is termed as being overweight or obese and is associated with raised blood cholesterol and triglyceride levels, lowered HDL (good) cholesterol levels, and an excess risk of high glycemic levels. Studies have shed light on the impact of integrating lowered HbA1c < 7.0% and BMI < 25 kg/m^2 for preventing certain complications. Large weights or obesity predict poor glycemic control in India [34]. Moreover, overweight and obesity invariably lead to insulin resistance with consequent high glycemic levels [37]. There are evidences that show diet, exercise, and health education as factors that can control overweight [33]. Lifestyle changes help in weight loss, resulting in clinically meaningful reductions in blood glucose

levels besides reducing blood pressure [36].

This study found an association between high blood pressure (HBP) among diabetic patients that we studied and poor glycemic control. While this was not unexpected, majority of diabetes patients are known to experience concurrent comorbidities such as high blood pressure and other cardiovascular diseases. Management of diabetes mellitus is resource-intensive in terms of time and direct medication costs, and indirect costs associated with accessing medical care from distant clinics, leading to stress that can trigger other non-communicable comorbidities [38]. Besides, experiencing both diabetes and HBP poses a twin burden as the management of both diseases calls for intensive and integrated care regarding special diets with possibilities of interrupting medication adherence [38].

A significant risk association between glycemic control and type of medication history was observed by studying the patients' medication history. Diabetes medication and the number of diabetic drugs in prescription at discharge were significantly associated with glycemic control. This finding is consistent with other previous studies [34] [39]. More likely, the number of years a person has influenced the multiple medications a diabetic patient is prescribed, causing the progressive lack of insulin secretion or decreased sensitivity of the tissues to insulin [36].

Adherence to anti-diabetic medications is crucial to reach metabolic control since non-adherence is associated with increased levels of HbA_{1c} as well as other adverse outcomes such as increased LDL levels, frequent hospitalizations, and mortality [40]. Even though the current study showed that patients who reported having good adherence to prescribed anti-diabetic medications had poor glycemic control, we did not confirm the level of adherence. Studies have generally shown the association between poor adherence to prescribed anti-diabetic medications to poor glycemic control compared with those with high and medium medication adherence mortality [40]. Innovative ways of authenticating self-reports, e.g., triangulation with other approaches, are needed for ensuring their credibility [28].

Despite the recommended self-monitoring of blood glucose (SMBG) as a component of diabetes management, there exists a substantial debate about this finance-burdening practice, especially for patients not on insulin. The current study showed patients who were self-monitoring blood glucose were less likely to have poor glycemic control. Historically, there has been less supportive evidence for self-monitoring of blood glucose used in patients with type 2 diabetes. Findings from studies have varied: some failing to detect any relationship between SMBG and glycemic control [41], others yielding positive anecdotal reports [42], while others reporting negative relationships [43]. Self-monitoring of blood glucose levels is essential to prevent or delay chronic complications associated with higher blood sugar levels. Nevertheless, early detection of either low or high blood glucose levels due to self-monitoring may rapidly facilitate thera-

peutic and dietary adjustments.

Studies among diabetic patients have identified other independent factors associated with poor glycemic control that we did not measure or find significant in this study, including gender, educational level, and income [44]. We did not measure other factors as well, including limited clinical training, screening, disease awareness among patients and clinicians, medication and diagnostic access, community-level support, and behavioral education and mortality [45] [46], these factors leading to severity of the infections especially in African and limited resource settings. Duration in years with the disease, and hospital admission are also other factors that influence results on treatment and adherence. This study's cross-sectional nature and the relatively small sample size, different study designs, and different study settings could partly explain the observed lack of association between poor glycemic control and the listed independent factors. We also experienced limitations of lack of historical medical records detailing HbA1c levels in our study participants, and neither could we follow up on them to describe variability in HbA1c levels.

5. Conclusion

A high number of diabetes mellitus patients attending the clinic at KNH had poor glycemic control. To prevent or delay resultant diabetes-related complications, reasonable glycemic control should be encouraged and manage comorbidities among long-standing diabetes patients receiving ≥3 oral anti-diabetes medication. There is a need to emphasize the importance of self-monitoring of blood sugar levels in diabetic patients given its protective effect. We recommend using other methods to authenticate the self-reports to ensure credibility. Lastly, differences in risk between high and lower weights and age need further studies.

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Authors' Contributions

This work was part of Master of Science degree (Epidemiology) for MCM of the Jomo Kenyatta University of Agriculture and Technology. MCM, JG and JM conceived and designed the study. MCM collected samples and conducted laboratory assays. MCM conducted data analysis and wrote the draft manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendices

(The interview guideline)

Appendix 1: Questionnaire

Age _____

Gender _____

Marital status _____

Highest education level _____

Occupation _____

Ethnicity _____

Smoker _____

Alcohol use _____

Please fill in your response to the following questions

	The following statements describe self-care activities related to your diabetes. Thinking about your self-care over the last 12 weeks, please specify the extent to which each statement applies to you.	**Strongly Agree**	**Agree**	**Neither**	**Don't Agree**
1	I check my blood sugar levels with care and attention. ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
2	The food I choose to eat makes it easy to achieve optimal blood sugar levels.	☐3	☐2	☐1	☐0
3	I keep all doctors' appointments recommended for my diabetes treatment.	☐3	☐2	☐1	☐0
4	I take my diabetes medication (e. g. insulin, tablets) as prescribed. ☐ *Diabetes medication/insulin is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
5	Occasionally I eat foods with a lot of simple sugars eg. Refined sifted flour, table sugar, jams, honey, soft drinks	☐3	☐2	☐1	☐0
6	Occasionally I eat foods with complex sugars eg. Green vegetables, pasta, whole grain, bread, beans, corn, sweet potato	☐3	☐2	☐1	☐0
7	I record my blood sugar levels regularly (or analyse the value chart with my blood glucose meter). ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
8	I tend to avoid diabetes-related doctors' appointments.	☐3	☐2	☐1	☐0
9	I do regular physical activity to purposelyachieve optimal blood sugar levels.	☐3	☐2	☐1	☐0
10	I strictly purposely follow the dietary recommendations given by my doctor or diabetes specialist.	☐3	☐2	☐1	☐0
11	I do not check my blood sugar levels frequently enough as would be required for achieving good blood glucose control. ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
12	I avoid physical activity, although it would improve my diabetes.	☐3	☐2	☐1	☐0
13	I tend to forget to take or skip my diabetes medication (e.g. insulin, tablets). ☐ *Diabetes medication/insulin is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
14	Sometimes I have real "food binges" (not triggered by hypoglycaemia).	☐3	☐2	☐1	☐0
15	Regarding my diabetes care, I should see my medical practitioner(s) more often.	☐3	☐2	☐1	☐0
16	I tend to skip planned physical activity.	☐3	☐2	☐1	☐0
17	My diabetes self-care is poor.	☐3	☐2	☐1	☐0