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Original Research

Glycemic control among People living with HIV and diabetes in Eastern Uganda: A cross-sectional study

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Abstract

Background: Poor glycemic control remains a significant Public Health problem among people living with HIV(PLWH) and diabetes in Africa and Uganda specifically. Dual diagnosis of HIV and diabetes is associated with high costs of management and poor prognosis. This study aimed to determine the baseline glycemic control of PLWH and diabetes and associated factors in Eastern Uganda.

Methodology: This study employed quantitative methods along with a cross-sectional analytical study design. A total of 257 participants (ten didn't participate) from Mbale and Soroti Regional Referral Hospitals participated in this study from May 1 to July 30th, 2024. The sample size was determined using the modified Cochrane formula, and participants were selected using simple random sampling. An electronic questionnaire was used to collect socio-demographic and clinical data. An automated Finecare HbA1c analyser was used to determine the HbA1c levels of participants. The data was analysed using Stata version 15. Multivariable logistic regression analyses were conducted to identify associated factors. At $p<0.05$, statistical significance was established.

Results: The median age was 51(44, 60). The female participants comprised 152 (59.1%), and 52 (20.2%) of the total participants had a tertiary education. More than half, 136 (52.9%), had HbA1c above 7%. The age group above 50 years, having more than three children, and tertiary education were positively associated; however, only the tertiary level of education was statistically significant after adjusting for confounders, aPOR 3.9(95% CI:1.1-14.2), p=0.037.

Conclusion: The prevalence of poor glycemic control among people living with HIV and diabetes at Mbale and Soroti Hospitals in Uganda is high at 52.90%. The age group above 50 years, having children and tertiary education were positively associated with poor glycemic control. Routine HbA1c testing and immediate evidence-based management by health workers are encouraged among clients over 50, those with children, and those with tertiary education.

Keywords: People Living with HIV and Diabetes; Glycemic Control; Eastern Uganda.

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Introduction

The prevalence of poor glycemic control among people living with HIV(PLWH) and diabetes remains a significant and emerging public health problem in Africa and other developing countries globally.[1-3] Diabetes is a chronic disease caused by insufficient insulin production or inefficient use.[4] Due to inadequate detection, African people living with HIV(PLWH) have a high burden of diabetes; however, HIV-related factors do not change prevalence; rather, they are most likely influenced by conventional risk factors[2] According to the World Health Organisation (2023), the prevalence of diabetes among PLWH in Uganda is 5.8%; however, a study done in Mulago Hospital, Uganda, showed a higher prevalence of 7.5% [4]. People living with HIV and diabetes clients are known to be susceptible to developing diabetes due to several factors, including age, medication, gender, genetics, and obesity[1,5]. Earlier studies in Sub-Saharan Africa have demonstrated a strong association between prior Dolutegravir (DTG) exposure and subsequent diagnosis of hyperglycemia [4-6]. Nonetheless, a study by [6] in clinically stable young adult Ugandan PWH on Dolutegravir for 48 weeks showed negligible changes in pancreatic beta cell function and insulin resistance [6]. The report by [6] contributed to the information showing dolutegravir's safety in glucose metabolism for patients new to antiretroviral therapy. It is imperative to reconsider the limitations on the initiation of DTG in adults who are at high risk for diabetes but have never used ART. Medications such as corticosteroids and opiates have also been linked with the development of diabetes among HIV clients. [7,8]

Additionally, prior scholars have reported factors linked with poor glycemic control in diabetes to include poor diet adherence, lack of exercise, smoking and poor medication adherence [8]. Among people living with HIV and diabetes, the factors associated with poor glycemic control include the presence of Tuberculosis coinfection, poor knowledge about diabetes management, being unemployed and the use of integrase inhibitors [1,3,9]. These known factors associated with poor glycemic control have been utilised in HIV clinics to design and implement PLWH and diabetes prevention and management programs. The health workers in both facilities (Mbale and Soroti), Regional referral hospitals, have been trained in the management of diabetes, and health education is provided to all PLWH. However, the prevalence of poor glycemic control that is associated with mortality remains significantly high and rising, and diabetes clinical targets are not met in Mbale and Soroti hospitals. This may be attributed to the evolving local circumstances regarding diet, lingering effects of COVID-19, medication regimens and lifestyles. Nevertheless, no foundation study has been conducted in the Eastern Uganda region to substantiate this.

This study, therefore, aimed to determine the baseline glycemic control among PLWH and diabetes in Mbale and Soroti Hospitals. The findings will be used to develop additional interventions in Mbale and Soroti Hospitals to improve glycemic control and other treatment outcomes among people living with HIV and diabetes.

Methods and Subjects:

Study design, Study site and Population: This was a cross-sectional study conducted at Mbale and Soroti hospitals, among registered PLWH and diabetes. This study was conducted from May to July 2024. Regional Referral Hospitals are public hospitals funded by the government of Uganda. Soroti Hospital serves ten districts and is situated 320 kilometres northeast of Kampala. Mbale Hospital serves sixteen districts. Both Hospitals have a large catchment population of over 4.5 million people. These public Hospitals offer free HIV and diabetes healthcare services in Uganda. PLWH and diabetes are expected to receive drug refills and health education monthly; however, a majority prefer to come for drug refills every three months. The study population comprised registered adult people living with HIV and diabetes attending the Mbale and Soroti Regional Referral Hospitals in Eastern Uganda.

The sample size was 267, determined using the modified Cochran formula for small populations and findings from (1) where p was the proportion of HIV-Diabetes clients with good glycemic control=0.381, q=1-p =1-0.381 =0.619, z standard normal deviation (1.96) at 95% of confidence. d = degree of accuracy desired in our study is 0.05. The registered adult people living with HIV and diabetes total population (N) was 524. The sample size was adjusted by 20% to allow for the non-response rate. Here n0 is Cochran's sample size recommendation, N is the population size of 524, and n is the new, adjusted sample size. 362 / (1 + (362 / 524)) = 214. The 214 plus 20% addition for non-response gives us a total proposed sample size of 267. Purposive sampling was used to select Mbale and Soroti Hospitals because they have a larger population of PLWH and diabetes. A computer-aided program was used to randomly select the 267 participants from a list of 524 registered participants in both Hospitals.

Eligible participants had to be registered PLWH with diabetes, 18 years or older and willing to consent. Expert PLWH and diabetes who were registered were also included. An expert client, especially in the sub-Saharan African context, is an individual who is stable on antiretroviral therapy (ART) and is trained to provide adherence counselling, psychosocial support, and help with retention in care. The registered people living with HIV and diabetes who had an additional diagnosis of mental illness were excluded. In addition, those registered PLWH and diabetes who also had an additional comorbidity of hemolytic disorders that affect HbA1c levels were also excluded. The past medical history of all the sampled participants was reviewed, and case notes of participants with hemolytic disorders and mental illness were excluded.

Data collection of demographic, laboratory, and clinical data

Clinical measurement results, Laboratory analysis results, diabetes knowledge levels, and socio-demographic characteristics of the participants were collected electronically by trained research assistants after informed consent. All the electronic data collected from participants was handled with utmost confidentiality**.** The participant's clinical data, diabetes knowledge levels, and socio-demographic data were collected using a validated questionnaire. The knowledge level was assessed using the Diabetes Knowledge Test (DKT). The DKT is a validated tool with 23 multiple-choice questions. The DKT has good reliability and validity [10]. The questions in DKT were translated into local languages. The research assistants administered the questionnaire through direct encounters with eligible participants. This was done to ensure the questionnaires were complete and accurate. The validated questionnaire had three sections. The first section captured sociodemographic (gender, income, educational level, marital status, religion and employment). The second section of the questionnaire captured life choices (smoking, alcohol consumption and clinical data (the drugs used, viral loads, BMI). The third section secured the level of HbA1c and participants' level of diabetes knowledge. The drugs used(regimens) by the PLWH and viral loads were extracted from client files.

Blood (Sample) collection:

The licensed laboratory technologist (a university graduate) used a 2ml syringe to collect fresh venous whole blood from the participant's arm. PLWH and diabetes in our study sites were always instructed to fast for eight hours overnight before arriving early the next morning for diabetes testing. The automated Finecare HbA1c analyser was used to determine the HbA1c level, which was reported as a percentage. The analysis of the blood sample was done in an accredited laboratory. The HbA1c test is a blood laboratory examination that reveals the average blood sugar (glucose) level over the past two to three months.The HbA1c test indicates an individual's average glucose level over the past three months, as glucose binds to haemoglobin for the duration of the red blood cell. A HbA1c value above 7% was considered high and an indicator of poor glycemic control among diabetes patients [11].

Data analysis:

The collected data was cleaned and examined for accuracy and completeness before being exported to the Stata program version 15. Continuous and categorical variables were summarized using descriptive statistics and frequency distributions, respectively. Frequency distributions were made, and the proportions of those with HbA1c above 7% were determined. To determine the associations between potential exposure factors and poor glycemic control (HbA1c>7), univariate, bivariate and multiple logistic regression analyses were conducted. At $p<0.05$, statistical significance was established.

Ethics Statement: This study was approved on 04/04/2024 by the Busitema University Faculty of Health Sciences REC meeting. The research was approved for a year (24/04/2024 to 24/04/2025). BUFHS-2024-160 is the approval number. Informed consent was obtained from all the participants, and privacy and confidentiality were maintained.

Results

The socio-demographic characteristics of the participants

Table 1 shows that a total of 257 out of 267 (ten didn't participate) registered PLWH and diabetes from Mbale and Soroti Regional Referral Hospitals participated in this study. A majority of the participants, 156 (60.7%), were over 50 years old, with a median age of 51(44, 60). Most of the participants,152(59.1%), were women. The widows were 21.8% and more than half, 152 (59.1), were married. Only 6.2% had no formal education, and 52 (20.2%) had tertiary education. The unemployed participants were 42.8%. Table 1 has the details.

Table 1: Socio-demographic characteristics of the participants.

Variable	Frequency n=257	Percentage (%)
Age median (p25, p75)	51(44, 60)	
Age (years)		
20-34	20	7.8
35-49	81	31.5
50+	156	60.7
Female participants	152	59.1
Male participants	105	40.9
Catholics by religion	72	28.0
Muslims by religion	44	17.1
Protestant by religion	98	38.1
Others by religion	9	3.5
Married participants	134	52.1
widows	56	21.8
None (participants with no children)	13	5.1
1-2(participants with one to two children)	41	16.0
3-4 (participants with three to four children)	68	26.5

5+ (participants with more than five children)	135	52.5
Participants with no formal education	16	6.2
Participants with a Primary level of education	118	45.9
Participants with a secondary Level of education	71	27.6
Participants with a tertiary level of education	52	20.2
Unemployed participants	110	42.8
Employed participants	147	57.2

Clinical and laboratory Characteristics of the participants

A majority of participants, 256 (99.6%), were on ART. A large proportion of participants, 255 (99.2%), had viral load levels tested, and 219 (85%) were virally suppressed. Viral load suppression is below the recommended 95% target by the Joint United Nations Programme on HIV/AIDS. More than half, 136 (52.9%), had HbA1c greater than 7%. Figure 1 illustrates the specifics regarding the proportions of participants who had good and poor glycemic control.

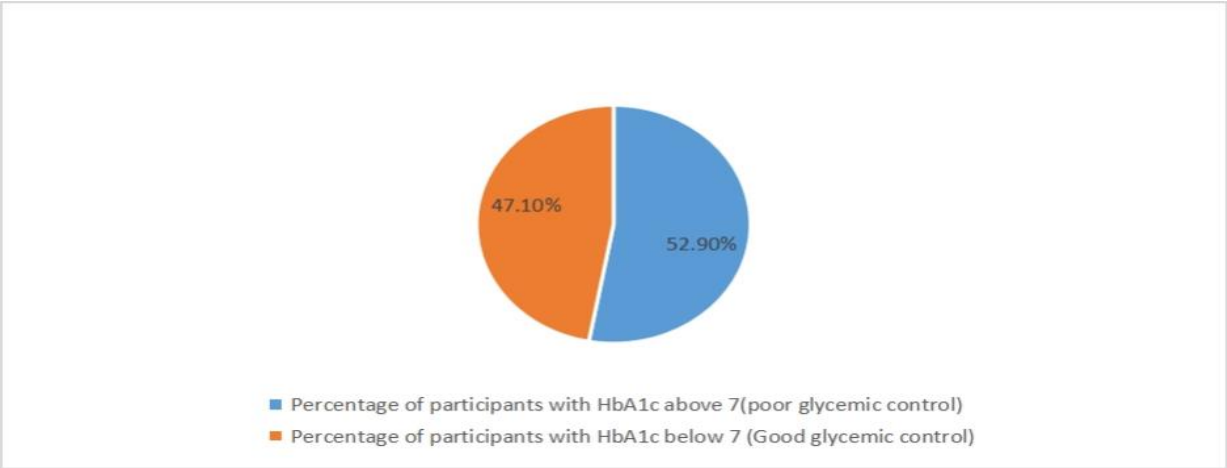

Figure 1: Pie chart with Proportions of participants who had HbA1c above and below 7%

Demographic parameters and glycemic control (HbA1c levels)

Table 2 shows the bivariate analysis results of the correlation between demographic parameters and HbA1C levels. Age above 50 years ($p<0.001$), religion ($p<0.048$), number of children ($p<0.005$), and highest level of education ($p<0.012$) were associated with HbA1c levels.

Table 2: HbA1c levels and demographic parameters.

Variable	Total n=257(%)	HbA1c		P-value
		<7	7+	
		n=121(%)	n=136(%)	
Age median (p25, p75)	51(44.6)	47(39.6)	54(497)	
Age (years)				
20-34	20(7.8)	16(13.2)	4(2.9)	
35-49	81(31.5)	52(43.0)	29(21.3)	
50+	156(60.7)	53(43.8)	103(75.7)	< 0.001
Religion				0.048
Catholic	72(28.0)	33(27.3)	39(28.7)	
Muslim	44(17.1)	17(14.0)	27(19.9)	
Protestant	98(38.1)	53(43.8)	45(33.1)	
Pentecostal				
Others	9(3.5)	7(5.8)	2(1.5)	
How many children are you having				0.005
None	13(5.1)	11(9.1)	2(1.5)	
1-2	41(16.0)	25(20.7)	16(11.8)	
3-4	68(26.5)	28(23.1)	40(29.4)	
5+	135(52.5)	57(47.1)	78(57.4)	
Maximum degree of education attained or school				0.012
Absence of formal education	16(6.2)	11(9.1)	5(3.7)	
Primary level	118(45.9)	49(40.5)	69(50.7)	
Secondary Level	71(27.6)	42(34.7)	29(21.3)	
Tertiary level	52(20.2)	19(15.7)	33(24.3)	

Results of clinical, laboratory and HbA1c tests

High viral load levels were reported among participants with poor glycemic control (HbA1c>7%. The detailed values of the clinical and laboratory tests are reported in Table 3.

Table 3: Clinical, laboratory parameters and HbA1c levels

Variable	Total n=257(%)	HbA1c		P-value
		<7	7+	
		n=121(%)	n=136(%)	
When was the last time you visited a hospital?				0.950
<6months ago (1)	238(92.6)	113(93.4)	125(91.9)	
Approximately a year ago (2)	14(5.4)	6(5.0)	8(5.9)	
Never visited (5)	2(0.8)	1(0.8)	1(0.7)	
Two years prior (3)	3(1.2)	1(0.8)	2(1.5)	
When was the last time you had a thorough medical checkup?				0.069
Five years	6(2.3)	1(0.8)	5(3.7)	
Less than one year	29(11.3)	16(13.2)	13(9.6)	
Less than six months	197(76.7)	94(77.7)	103(75.7)	
More than five years	12(4.7)	2(1.7)	10(7.4)	
Two years	12(4.7)	8(6.6)	4(2.9)	
missing	1(0.4)	0(0.0)	1(0.7)	
On any treatment for HIV				0.345
No	1(0.4)	0(0.0)	1(0.7)	
Yes	256(99.6)	121(100.0)	135(99.3)	
checked your viral load.				0.181
No	2(0.8)	0(0.0)	2(1.5)	
Yes	255(99.2)	121(100.0)	134(98.5)	
Viral load				0.038
Suppressed	219 (85.2%)	109 (90.1%)	110 (80.9%)	
Non suppressed	38 (14.8%)	12 (9.9%)	26 (19.1%)	
Diabetes knowledge score				0.875
<50%	107(41.6)	51(42.2)	56(41.2)	
50%+	150(58.4)	70(57.9)	80(58.8)	

Factors associated with poor glycemic control among PLWH and diabetes at Mbale and Soroti Hospitals, Eastern Uganda.

Binary logistic regression analysis revealed that age above 50, primary and tertiary education, higher viral load levels, and having five or more children were associated with poor glycemic control among People living with HIV and diabetes as noted in Tables 2 and 3.

In the multivariate regression model analysis, after controlling for likely confounders, only the tertiary level of education was found to be an independent predictor of poor glycemic control among people living with HIV and diabetes in Soroti and Mbale Hospitals, Eastern Uganda. The odds of having poor glycemic control were four times higher among participants with a tertiary level of education compared to those with no formal education (aOR = 3.9, 95% CI: 1.1-14.2, p = 0.037). This was statistically significant. The detailed associations are reported in Table 4.

Table 4: Factors associated with poor glycemic control in Mbale and Soroti hospitals, Eastern Uganda.

Variable	aOR (95% CI)	P-value	aOR (95% CI)	P-value
Age (years)				
20-34	1		1	
35-49	2.2(0.6, 7.3)	0.185	0.9(0.2, 3.7)	0.932
50+	7.8(2.5, 24.4)	<0.001	3.5(0.9, 13.0)	0.066
How many children do you have?				
None	1		1	
1-2	3.5(0.7, 18.0)	0.131	2.1(0.4, 13.0)	0.411
3-4	7.9(1.6, 38.2)	0.011	5.2(0.9, 13.0)	0.071
5+	7.5(1.6, 35.3)	0.010	3.7(0.6, 21.5)	0.142
Educational level				
Absence of formal education (1)	1		1	
Primary Education (2)	3.1(1.01, 9.5)	0.048	3.2(0.9, 10.3)	0.055
Secondary Education (3)	1.5(0.5, 4.8)	0.479	1.9(0.6, 6.6)	0.299
Tertiary Education [4]	3.8(1.2, 12.7)	0.028	3.9(1.1, 14.2)	0.037
Have you ever drunk alcohol?				
No	1		1	
Yes	0.6(0.3, 1.1)	0.122	0.6(0.3, 1.2)	0.131

Discussion

This study found that the prevalence of poor glycemic control among survey participants in Mbale and Soroti Hospitals in Eastern Uganda was significantly high, 52.9%. The factors positively associated with poor glycemic control in this study include: the age group above 50 years, a tertiary level of education, and having more than five children. Only the tertiary level of education had a statistically significant association at a 95% confidence interval. These results indicate that a significantly high number of PLWH and diabetes, specifically those who are elderly, with more than five children and have tertiary education, struggle to maintain healthy blood glucose levels. This highlights the need for targeted interventions (Positive Deviance Mentorship and integrated management of HIV) to improve glycemic control in this subpopulation.

These results expand on the existing evidence that the prevalence of poor glycemic control is associated with older age and is significantly higher in developing countries [1,12,13]. A study in Ethiopia reported a higher prevalence of uncontrolled glycemia and additionally revealed gaps between real-world diabetes management and the recommended treatment targets, especially among PLWH in achieving the

recommended glycemic targets [1]. The findings of this study are also in agreement with a systematic review, Poor glycemic control and its predictors among people living with diabetes in low- and middle-income countries, which reported a significantly higher pooled prevalence of poor glycemic control in low-income countries [12].

The potential explanations for the high prevalence of poor glycemic control observed in this study are as follows: Firstly, a significant percentage of the participants (58.4%) in this study demonstrated low diabetes knowledge, which is essential for patients to achieve optimal glycemic control. [14] Secondly, almost half of the participants (46.30%) were unaware that the recommended diabetes diets are essential for achieving optimal glycemic control. Thirdly, Diabetes drugs in Uganda are not affordable; most patients rely on free diabetes drugs supplied by the government Hospitals and stop administration immediately when what is provided is over [15].

The generalizability of this finding is limited by selection bias; only participants registered in both Hospitals (Mbale and Soroti Hospitals) were targeted. The study missed PLWH and diabetes who are not registered in Hospitals (Mbale and Soroti) and who use herbal remedies. Future research should consider PLWH and diabetes that are not registered in government hospitals.

The high prevalence of poor glycemic control among PLWHIV and diabetes is a significant public health problem and is linked with increased prevalence of diabetes complications and high mortality [16-18].

Poor glycemic control among PLWH and diabetes predisposes clients to various macrovascular complications (stroke, myocardial infarction), microvascular complications (nephropathy, retinopathy), and increased risk of opportunistic infections. The occurrence of these complications within our populations of people living with HIV and diabetes results in a diminished quality of life [18]

In contrast to the finding of this study, which revealed a significant association between poor glycemic control and tertiary level of education, some studies have reported the contrary results. [11,19,20] A systematic review in Ethiopia reported that the absence of formal education was associated with poor glycemic control [20]. Another study in Uganda reported that a majority of the participants with inadequate glycemic control had low educational levels, which hurt their knowledge of diabetes [11].

The potential reasons for this study's unexpected finding regarding the link between inadequate glycemic control and tertiary-level education are outlined as follows. Firstly, most of the participants with a tertiary level of education had lived with diabetes for over 7 years (long duration with the disease). Secondly, most of the participants with tertiary education had other comorbidities in addition to HIV and diabetes. The study team reviewed case notes of all registered participants and noted essential information about their past medical histories. Long duration of diabetes and presence of comorbidities among PLWH and diabetes are known to be associated with inadequate glycemic control [11,18,19].

The generalizability of this unexpected study result (the link between the tertiary level of education and inadequate glycemic control) is limited by the cross-sectional design and selection bias; only participants registered in both Hospitals (Mbale and Soroti) were targeted. The study missed PLWH and diabetes who are not registered in both Hospitals (Mbale and Soroti) and who use herbal remedies. Future research should consider PLWH and diabetes that are not registered in government hospitals and employ experimental research designs.

Chronic non-communicable diseases among PLWH are becoming a major public health problem in low and middle-income countries globally. Diabetes remains the most prevalent non-communicable disease (NCD) among all the NCDs in PLWH. The prevalence of poor glycemic control remains significantly high among PLWH and diabetes in most developing countries. There is an overarching need for sustainable, evidence-based strategies to address the problem of poor glycemic control among PLWH and diabetes in developing countries.

Study strengths and limitations

This study provides baseline information for future studies and interventions among PLWH and diabetes in Eastern Uganda and other developing countries. Previous scholars mainly researched and reported on glycemic control among patients with only one disease (Diabetes). This study is the first in Eastern Uganda to determine the prevalence of poor glycemic control and associated factors among PLWH and diabetes in the Eastern Ugandan region. The cross-sectional design of the study will mean that causality between exposure factors and outcomes cannot be established. Additionally, this study was also limited by selection bias; only registered adult people living with HIV and diabetes in hospitals Mbale and Soroti were considered.

Conclusion

The prevalence of poor glycemic control among clients living with HIV and diabetes at Mbale and Soroti Hospitals in Eastern Uganda is significantly high at 52.9%. Age groups above 50 years, having more than three children, and a high level of education were independently associated with poor glycemic control. Routine HbA1c testing and evidence-based management of PLWH and diabetes through a multidisciplinary team that includes physicians and dietitians should be encouraged. Strong peer mentorship programs (positive deviance mentorship) in the communities are necessary to support those living with the dual disease burden of HIV and diabetes.

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