https://doi.org/10.48047/AFJBS.7.7.2025.1-19

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

PREVALENCE AND FACTORS ASSOCIATED WITH DIABETES MELLITUS AMONG PEOPLE LIVING WITH HIV ATTENDING RWAMPARA HEALTH CENTER IN RWANDA.

Intwaza Gael[1], Charles Nsanzabera[1,2,]

Affiliation :

1 Department of Public Health, Mount Kenya University, Rwanda

2 African institute of Research for Public Health and Development, Burundi, Rwanda

***Correspondence to intwagael@gmail.com**

Volume 7, Issue 7, July 2025

Received: 15 May 2025

Accepted: 05 Jun 2025

Published: 09 July 2025

doi:10.48047/AFJBS.7.7.2025.1-19

AbstractBackgroundIn 2020, 40 million people had HIV, with over 1.6 million new cases. By 2018, 22 million were on ART, up from 14.1 million in 2011. Globally, 530 million people have diabetes (10.5% of those aged 20–79). In the U.S., diabetes was 3.8% more common among HIV-positive individuals. A study in Brazil showed a 24.4% death rate among PLWH, with higher mortality in those with diabetes. In Rwanda, a study conducted in Rwamagana showed a prevalence of 5.8% of PLWH with diabetes due to ARV-related inflammation. Another study reported that one in six Rwandans aged 15–64 have hyperglycemia. This study aimed to determine the prevalence of diabetes and its associated factors among HIV-positive patients on ART at Rwampara Health Center in Kigali.MethodsA cross-sectional study which involved 369 HIV-positive patients at Rwampara Health Center was conducted from January to December 2023. Secondary data was collected using a checklist and analyzed using SPSS v22. Univariate, bivariate, and multivariate analyses were done, with p-values < 0.05 considered significant. Ethical procedures were followed to support health improvements for HIV patients with diabetes.

ResultsThe findings revealed that 90.8% of the participants are non-diabetic whereas 9.2% are diabetic. Marital status was significantly associated with diabetes (AoR = 11.772, p = 0.04). A family history of diabetes (AoR = 10.870, $p < 0.001$), smoking (AoR = 6.257, p = 0.049), hypertension (AoR = 14.628, p = 0.007), and CVDs (AoR = 9.141, p = 0.01) were also significant. Longer HIV duration (>15 years) greatly increased diabetes risk (AoR = 19.111, p = 0.003). High CD4 count, alcohol intake, and high BMI were not significantly associated.

ConclusionIn conclusion, about one-tenth of HIV-positive patients had diabetes. Key risk factors included marital status, family history, smoking, hypertension, CVDs, and long-term HIV. The study recommends routine diabetes screening for HIV-positive individuals to enable early detection and treatment.

Keywords: Prevalence, Factor, Diabetes Mellitus, Living With HIV, Rwampara Health Center, Rwanda

Introduction

In 2020, 40 million people were living with HIV, with over 1.6 million new cases reported, highlighting the persistent global burden (UNAIDS, 2023). In 2018, 22 million were on ART, an increase of 7.9 million since 2011 (UNAIDS, 2018). Globally, 530 million people have diabetes, affecting 10.5% of those aged 20–79 (Ong et al., 2021).

Diabetes is 3.8% more prevalent in HIV-positive individuals than the general population (Hu et al., 2019). In Brazil, 24.4% of PLWH died, with higher mortality in those with diabetes, especially post-ART introduction (Rodrigo et al., 2016). Despite reduced HIV prevalence in sub-Saharan Africa, ART increases risks for diabetes (Duffy et al., 2018). In 2019, East and South Africa had nearly 20 million HIV cases. Diabetes, once rare in Africa, is now rising due to lifestyle changes (Badacho & Mahomed, 2023).

HIV and NCDs disproportionately affect low- and middle-income countries, causing over 75% of NCD deaths (Tamuhla et al., 2021). SSA reports high diabetes rates among HIV patients (Eckhardt et al., 2022), with both micro- and macrovascular complications (Kanyara et al., 2024). Rwanda's HIV population lives longer due to ART, but faces growing NCD risks like diabetes (MOH, 2023). Rising diabetes among HIV-positive individuals threatens HIV care progress (Abate et al., 2021).

In Zimbabwe, diabetes prevalence reached 14.9% among HIV patients, linked to age, ART duration, tobacco use, and physical inactivity, while exercise reduced risks (Chireshe, 2024). Beyond poor diet and inactivity, HIV itself and ART contribute to diabetes risk, especially in those with a family history (Kanyara et al., 2024). Understanding the HIV-diabetes link is critical (Kanyara et al., 2024). HIV drugs like protease inhibitors and NRTIs are associated with diabetes, insulin resistance, and hyperglycemia (Fang et al., 2022).

Despite the clear link, diabetes among HIV patients in Rwanda is poorly documented. Globally, diabetes is expected to rise from 424 million in 2018 to 628.5 million by 2046 (IDF, 2019). In Rwanda, DM prevalence is 5.8% among PLWH in Rwamagana (Ndayisaba et al., 2020) and hyperglycemia affects one in six people aged 15–64 (Bavuma et al., 2022). Age, ART duration, and lifestyle changes drive rising diabetes among HIV patients (Anne et al., 2015; Animaw, 2017).

This study aims to determine the prevalence and contributing factors of diabetes mellitus among HIV patients at Rwampara Health Center in Kigali, supporting better integrated healthcare.

Methods

Study design and setting

This work was carried out using a cross-sectional study design with quantitative approach, utilizing secondary data from all HIV-positive patients who visited the HIV department at Rwampara Health Center between January 2023 and December 2023.

Sample size and sampling methods

Yamane's formula determined the sample size. After a 10% non-response adjustment, 369 participants were selected from 2,084 HIV patients. Eligible participants were males and females aged 18–65, attending ART follow-ups, on ART for at least 12 months, and diagnosed with diabetes. Systematic random sampling was used. From an ordered list of patient records, a random start was chosen, then every 6th record selected—calculated by 2084 ÷ 336 (6.02, rounded to 6)—until the sample was complete (Raina, 2015).

Study instruments

A meticulously structured checklist was employed to be sure of the successful achievement of the research objectives. In sum, the data collection tool encompassed various aspects, including sociodemographic factors, antihypertensive use, time of taking antidiabetic, comorbidities, hepatitis B and C, body mass index and HIV) and lifestyle factors. Additionally, the checklist for secondary data collection was validated.

Instrument reliability and validity.

Reliability

A pilot study with 10% of the sample was conducted at Nyiranuma Health Center to verify content coverage and question clarity. Test-retest reliability was used to check checklist consistency by comparing scores from Time 1 and Time 2 yielded scored 0.83.

Validity

To validate the tool, The Content Validity Index was carried out and yielded a 0.71 score, considered valid for the tool. Data collectors were also trained on the checklist before data collection began.

Statistical analysis

Data was collected and initially stored in Microsoft Excel and was transported into SPSS version 22 to be analyzed. Descriptive analysis was conducted using univariate analysis. The correlation between independent and dependent variables were assessed through bivariate analysis on one hand and multivariate analysis on the other hand. Those variables which have a p-value found to be <0.05 based on the bivariate analysis, variables that show a significant association were considered for inclusion in the multivariable logistic regression model to account for any factors that might influence the relationship. Both the p-value and Adjusted Odds Ratio (AOR) were utilized for significance testing. Each variable whose p-value falls below 0.05 within a 95% CI was considered as statistically significant.

Ethical consideration

This study received ethical approval from MKU (Reference number: MKU/ETHICS /23/01/2024)(1) and Rwampara Health Center data collection authorization. Privacy, confidentiality, and data protection were ensured. Participants remained anonymous, and data were used solely for research purposes. Risks were minimized, with no harm expected, while benefits included contributing to improved HIV and diabetes care. All sensitive information was securely stored to safeguard participants' rights and welfare.

Study Findings

Table 1. Socio-Demographic Characteristics of study Respondents

Variable	Frequency (N=369)	Percentage (%)
Age		
>20 Years	3	0.8
20-40 years	111	30.1
41-60 years	225	61.0
>=61 years	30	8.1
Total	369	100.0
Gender		
Male	105	28.5
Female	264	71.5
Total	369	100.0
Marital status		
Never in union	34	9.2
Married	78	21.1
Divorced	6	1.6
Widow	63	17.1
Living together	105	28.5
Separated	83	22.5
Total	369	100.0
Education		
Uneducated	69	18.7
Primary	200	54.2
Secondary	87	23.6
University	13	3.5
Total	369	100.0
Wealth levels		
Level 1	52	14.1
Level 2	190	51.5
Level 3	127	34.4
Total	369	100.0
Occupation		
Unemployed	117	31.7
Public servant	38	10.3
Private servant	200	54.2
Student	14	3.8

Total	369	100.0
Residence		
Urban	369	100.0
Rural	0	0.0
Total	369	100.0
Religion		
No religion	4	1.1
Catholic	230	62.3
Muslims	32	8.7
Protestant	57	15.4
Others	46	12.5
Total	369	100.0
Insurance		
No insurance	5	1.4
Having insurance	364	98.6
Total	369	100.0
Family history of diabetes		
No	329	89.2
Yes	40	10.8
Total	369	100.0

Source: Researcher, 2024

Table 1 summarizes the socio-demographic characteristics of 369 respondents at Rwampara Health Center. Most are aged 41–60 (61%), followed by 20–40 (30.1%), over 61 (8.1%), and under 20 (0.8%), indicating a middle-aged majority. Females dominate at 71.5%, with males at 28.5%. Marital status shows 28.5% living together, 22.5% separated, 21.1% married, 17.1% widowed, 9.2% never married, and 1.6% divorced. Over half (54.2%) have primary education, 23.6% secondary, 3.5% university, and 18.7% are uneducated. Economically, 51.5% are in wealth level 2, 34.4% in level 3, and 14.1% in level 1. Occupations include 54.2% private workers, 31.7% unemployed, 10.3% public servants, and 3.8% students. All reside in urban areas. Religiously, 62.3% are Catholic, 15.4% Protestant, 8.7% Muslim, 12.5% other religions, and 1.1% non-religious. Health insurance is high, with 98.6% covered. Additionally, 10.8% report a family history of diabetes, a relevant factor for assessing diabetes risk.

Table 2. Glycaemic classification among study participants

Variable	Frequency (N=369)	Percentage (%)
Glycaemic level classification		
Normal blood glycose (75-100 mg/dl)	230	62.3
Prediabetes(101-125mg/dl)	105	28.5
Diabetes (>=126 mg/dl)	34	9.2

Total	369	100.0

Source: Researcher, 2024

Table 2 shows the glycemic status of 369 participants at Rwampara Health Center. Most, 62.3% (230), have normal blood glucose (75–100 mg/dl), indicating good control. About 28.5% (105) are prediabetic (101–125 mg/dl), at risk of developing diabetes and needing lifestyle interventions. A smaller group, 9.2% (34), have diabetic glucose levels (≥126 mg/dl), highlighting the need for focused diabetes management among people living with HIV.

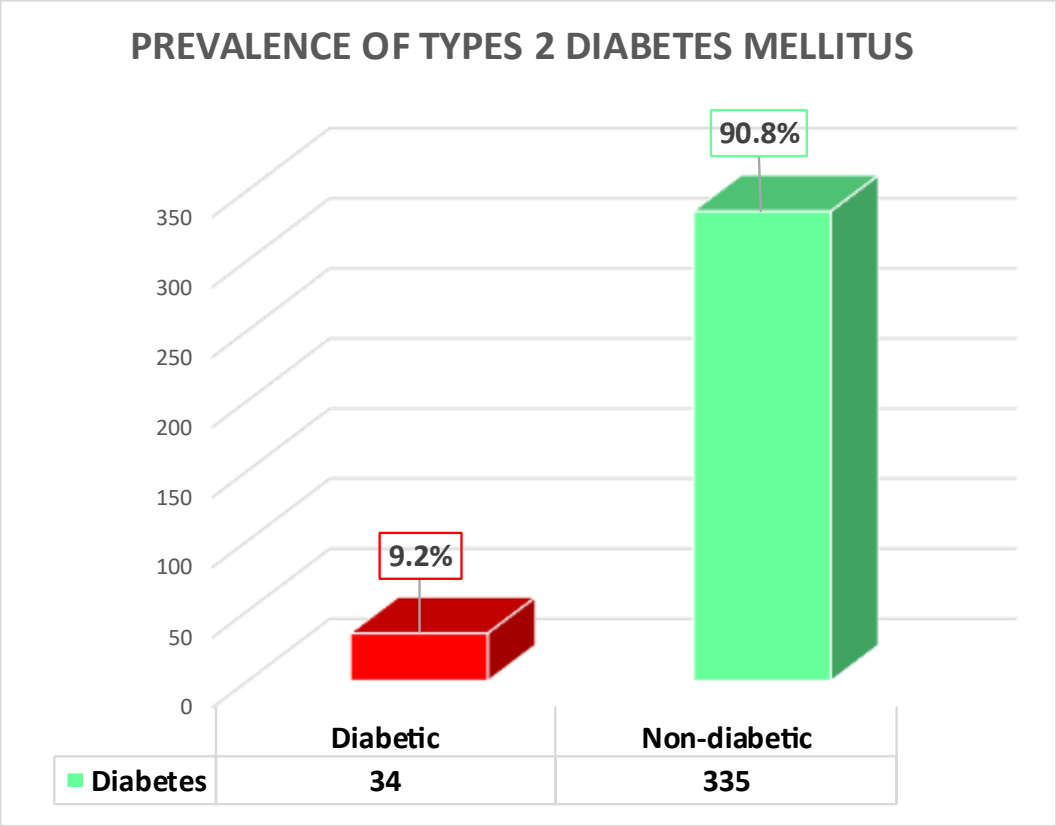

Figure 1: Prevalence of type 2 diabetes mellitus

Figure 1 illustrates that 90.8% of the participants are non-diabetic whereas 9.2% are diabetic. This stark contrast highlights a predominance of non-diabetic individuals within the population, suggesting that type 2 diabetes may not be a widespread issue among the respondents attending the health center. However, the presence of 9.2% diabetic individuals underscores the importance of monitoring and addressing diabetes risk factors in this population to prevent potential health complications associated with the disease.

Table 3. Bivariate analysis of socio-demographic factors associated with Diabetes mellitus among HIV positive on ART therapy attending Rwampara health center.

Variables n=369	**Diabetes mellitus among HIV positive on ART therapy.**			**Chi-square**	**P-value**
	No n (%)	**Yes n (%)**	**Total (%)**		
Age				15.290	**<0.001**
<=45 years	177(48.0)	6(1.6)	183(49.6)		
>45 years	158(42.8)	28(7.6)	186(50.4)		
Total	335(90.8)	34(9.2)	369(100.0)		
Gender				0.017	0.897
Male	95(25.7)	10(2.7)	105(28.5)		

Female	240(65.0)	24(6.5)	264(71.5)		
Total	335(90.8)	34(9.2)	369(100.0)		
Marital status				10.124	0.001
Marred& living together &Widow	215(58.3)	31(8.4)	246(66.7)		
Single& divorced & separated	120(32.5)	3(0.8)	123(33.3)		
Total	335(90.8)	34(9.2)	369(100.0)		
Education				4.570	0.206
Uneducated	59(16.0)	10(2.7)	69(18.7)		
Primary	181(49.1)	19(5.1)	200(54.2)		
Secondary	83(22.5)	4(1.1)	87(23.6)		
University	12(3.3)	1(0.3)	13(3.5)		
Total	335(90.8)	34(9.2)	369(100.0)		
Wealth levels				1.904	0.386
Level 1	49(13.3)	3(.8)	52(14.1)		
Level 2	174(47.2)	16(4.3)	190(51.5)		
Level 3	112(30.4)	15(4.1)	127(34.4)		
Total	335(90.8)	34(9.2)	369(100.0)		
Occupation				6.785	0.079
Unemployed	100(27.1)	17(4.6)	117(31.7)		
Public servant	36(9.8)	2(0.5)	38(10.3)		
Private servant	185(50.1)	15(4.1)	200(54.2)		
Student	14(3.8)	0(0.0)	14(3.8)		
Total	335(90.8)	34(9.2)	369(100.0)		
Religion				5.549	0.235
No religion	4(1.1)	0(0.0)	4(1.1)		
Catholic	208(56.4)	22(6.0)	230(62.3)		
Muslims	26(7.0)	6(1.6)	32(8.7)		
Protestant	53(14.4)	4(1.1)	57(15.4)		
Others	44(11.9)	2(0.5)	46(12.5)		
Total	335(90.8)	34(9.2)	369(100.0)		
Insurance				0.514	0.473
No insurance	5(1.4)	0(0.0)	5(1.4)		
Having insurance	330(89.4)	34(9.2)	364(98.6)		
Total	335(90.8)	34(9.2)	369(100.0)		
Family history of diabetes				1.822	<0.001
No	322(87.3)	7(1.9)	329(89.2)		
Yes	13(3.5)	27(7.3)	40(10.8)		
Total	335(90.8)	34(9.2)	369(100.0)		

Source: Researcher, 2024

Table 3 shows socio-demographic factors linked to diabetes among HIV-positive ART patients at Rwampara Health Center. Age is strongly associated with diabetes ($p < 0.001$), with 7.6% prevalence in those over 45 versus 1.6% in younger participants. Gender is not significant ($p = 0.897$), with similar diabetes rates for males (2.7%) and females (6.5%). Marital status is significant ($p = 0.001$); married, cohabiting, or widowed individuals have higher diabetes rates

(8.4%) than singles, divorced, or separated (0.8%). Education (p = 0.206), wealth (p = 0.386), religion (p = 0.235), and insurance status (p = 0.473) show no significant links to diabetes. Occupation is borderline (p = 0.079), with unemployed having the highest diabetes prevalence (4.6%). The family history of diabetes strongly predicts diabetes risk (p < 0.001), with 7.3% prevalence versus 1.9% in those without family history.

Table 4. Bivariate analysis of biological and HIV treatment factors associated with Diabetes mellitus among HIV positive on ART therapy attending Rwampara health center.

Variables n=369	**Diabetes mellitus among HIV positive on ART therapy.**			**Chi-square**	**P-value**
	No n (%)	**Yes n (%)**	**Total (%)**		
ART line of treatment				0.374	0.541
Line 1	317(85.9)	33(8.9)	350(94.9)		
Line 2	18(4.9)	1(0.3)	19(5.1)		
Total	335(90.8)	34(9.2)	369(100.0)		
Type of drugs				30.776	<0.001
abc+3tc+dtg	11(3.0)	1(0.3)	12(3.3)		
tdf+3tc+dtg	313(84.8)	30(8.1)	343(93.0)		
tdf+3tc+efv	0(0.0)	3(0.8)	3(0.8)		
abc+3tc+atv/r	2(0.5)	0(0.0)	2(0.5)		
azt+3tc+atv/r	4(1.1)	0(0.0)	4(1.1)		
tdf+3tc+atv/r	5(1.4)	0(0.0)	5(1.4)		
Total	335(90.8)	34(9.2)	369(100.0)		
T2DM Duration in years				36.902	<0.001
No diabetes	335(90.8)	0(0.0)	335(90.8)		
<= 4 years	0(.0)	23(6.2)	23(6.2)		
> 4 years	0(0.0)	11(3.0)	11(3.0)		
Total	335(90.8)	34(9.2)	369(100.0)		
Creatinine level				0.303	0.582
>=1.1mg/dl	318(86.2)	33(8.9)	351(95.1)		
>1.1mg/dl	17(4.6)	1(0.3)	18(4.9)		
Total	335(90.8)	34(9.2)	369(100.0)		
SGOT U/L				0.102	0.750
>=40 U/L	334(90.5)	34(9.2)	368(99.7)		
>40 U/L	1(0.3)	0(0.0)	1(0.3)		
Total	335(90.8)	34(9.2)	369(100.0)		
HIV Viral load per detectable category <20 copies/ml=Indetectable >20 copes/ml detectable				0.088	0.767
<20 copies/ml: indetectable	300(81.3)	31(8.4)	331(89.7)		
> 20copies/ml: detectable	35(9.5)	3(0.8)	38(10.3)		
Total	335(90.8)	34(9.2)	369(100.0)		

CD4 category >500 <500				6.093	0.014
<=500 CD4 cells/mm^3	142(38.5)	7(1.9)	149(40.4)		
>500 CD4 cells/mm^3	193(52.3)	27(7.3)	220(59.6)		
Total	335(90.8)	34(9.2)	369(100.0)		
HIVduration				30.334	<0.001
<=15 years	236(64.0)	8(2.2)	244(66.1)		
>15 years	99(26.8)	26(7.0)	125(33.9)		
Total	335(90.8)	34(9.2)	369(100.0)		

Source: Researcher, 2024

Table 4 shows that significant factors associated with diabetes among HIV-positive ART patients at Rwampara Health Center include ART drug type ($p < 0.001$), with the highest diabetes prevalence (8.1%) observed in those on the tdf+3tc+dtg regimen. CD4 count was also significant ($p = 0.014$), with higher diabetes rates in patients having CD4 counts >500 cells/mm³ (7.3%) compared to those with ≤500 (1.9%). Duration of HIV infection was strongly associated with diabetes ($p < 0.001$), showing greater prevalence among individuals living with HIV for over 15 years (7.0%) versus 15 years or less (2.2%). Duration of diabetes was another significant factor ($p < 0.001$). Non-significant factors included ART line of treatment ($p = 0.541$), creatinine levels ($p = 0.582$), SGOT levels ($p = 0.750$), and HIV viral load status ($p = 0.767$).

Table 5: Bivariate analysis of behavioral factors associated with Diabetes mellitus among HIV positive on ART therapy attending Rwampara health center.

Variables n=369	**Diabetes mellitus among HIV positive on ART therapy.**			**Chi-square**	**P-value**
	No n (%)	**Yes n (%)**	**Total (%)**		
Alcohol intake				38.729	<0.001
No	257(69.6)	9(2.4)	266(72.1)		
Yes	78(21.1)	25(6.8)	103(27.9)		
Total	335(90.8)	34(9.2)	369(100.0)		
Smoking				83.411	<0.001
No	310(84.0)	13(3.5)	323(87.5)		
Yes	25(6.8)	21(5.7)	46(12.5)		
Total	335(90.8)	34(9.2)	369(100.0)		

Source: Researcher, 2024

Table 5 shows behavioral factors linked to diabetes among HIV-positive ART patients at Rwampara Health Center. Alcohol intake is significantly associated with diabetes ($p < 0.001$), with higher prevalence in drinkers (6.8%) versus non-drinkers (2.4%) and a chi-square of 38.729. Smoking is also significant ($p < 0.001$), with smokers having higher diabetes rates (5.7%) compared to non-smokers (3.5%), and a chi-square of 83.411. These results highlight alcohol and smoking as major diabetes risk factors in this population.

Table 6: Bivariate analysis of comorbidity factors associated with Diabetes mellitus among HIV positive on ART therapy attending Rwampara health center.

Variables n=369	Diabetes mellitus among HIV positive on ART therapy.			Chi-square	P-value
	No n (%)	Yes n (%)	Total (%)		
Having Hypertension				117.512	<0.001
No	316(85.6)	11(3.0)	327(88.6)		
Yes	19(5.1)	23(6.2)	42(11.4)		
Total	335(90.8)	34(9.2)	369(100.0)		
CVDs				74.037	<0.001
No	325(88.1)	20(5.4)	345(93.5)		
Yes	10(2.7)	14(3.8)	24(6.5)		
Total	335(90.8)	34(9.2)	369(100.0)		
Obesity				9.655	0.002
No	331(89.7)	31(8.4)	362(98.1)		
Yes	4(1.1)	3(0.8)	7(1.9)		
Total	335(90.8)	34(9.2)	369(100.0)		
HVB				0.405	0.525
No	330(89.4)	33(8.9)	363(98.4)		
Yes	5(1.4)	1(0.3)	6(1.6)		
Total	335(90.8)	34(9.2)	369(100.0)		
HVC				0.102	0.750
No	334(90.5)	34(9.2)	368(99.7)		
Yes	1(0.3)	0(0.0)	1(0.3)		
Total	335(90.8)	34(9.2)	369(100.0)		
Cancer				0.102	0.750
No	334(90.5)	34(9.2)	368(99.7)		
Yes	1(0.3)	0(9.2)	1(0.3)		
Total	335(90.8)	34(9.2)	369(100.0)		
BMI				7.001	0.008
Healthy weight	204(55.9)	13(3.6)	217(59.5)		
Overweight& obesity	127(34.8)	21(5.8)	148(40.5)		
Total	335(90.8)	34(9.2)	369(100.0)		

Source: Researcher, 2024

Table 6 shows bivariate analysis of comorbidities linked to diabetes among HIV-positive ART patients at Rwampara Health Center. Hypertension was associated with diabetes ($p < 0.001$), with 6.2% diabetic among hypertensive vs. 3.0% non-hypertensive (chi-square 117.512). CVDs also significantly link to diabetes ($p < 0.001$), with higher prevalence in those with CVDs (chi-square 74.037). Obesity was significantly related to diabetes ($p = 0.002$), as is BMI ($p = 0.008$), with overweight/obese showing higher diabetes rates (chi-square 9.655 and 7.001). HBV, HCV, and cancer show no significant association. Managing hypertension, CVDs, and BMI is key to lowering diabetes risk in this group.

Table 7: Multivariate analysis of factors associated with Diabetes mellitus among HIV positive on ART therapy attending Rwampara health center.

Variables	Type 2 DM among HIV Patients (n=364)		P-value
	AoR	95%CI	
Marital Status (Married& Living together& widow)			
No	Ref		
Yes	11.772	2.072-16.204	**0.04**
Family History			
No	Ref		
Yes	10.870	3.583-21.250	**<0.001**
Smoking			
No	Ref		
Yes	6.257	0.991-14.287	**0.049**
Hypertension			
No	Ref		
Yes	14.628	2.237-25.665	**0.007**
CVDs			
No	Ref		
Yes	9.141	1.544-18.110	**0.01**
HIV duration (>15 years)			
No	Ref		
Yes	19.111	3.671-36.735	**0.003**
CD4 (>500 cells/mm^3)			
No	Ref		
Yes	6.220	0.944-13.988	0.057
Alcohol intake			
No			
Yes	2.904	0.496-4.221	0.2
BMI (Overweight& Obesity)	Ref		
No			
Yes	0.461	0.077-2.759	0.3

Source: Researcher, 2024

Table 7 portrayed the multivariate analysis of factors associated with diabetes mellitus (DM) among HIV-positive patients on ART therapy attending Rwampara Health Center in Nyarugenge District. The findings revealed several significant associations. First, marital status plays a key role, with patients who are married, living together, or widowed being significantly more likely to develop diabetes compared to those who are not (AoR = 11.772, 95% CI: 2.072-16.204, p = 0.04). This suggests that marital and living conditions may influence the risk of diabetes in this population. Additionally, having a family history of diabetes is strongly associated with an increased risk of diabetes among HIV-positive patients (AoR = 10.870, 95% CI: 3.583-21.250, p < 0.001). This highlights the hereditary nature of the disease and suggests that individuals with a family history should be monitored more closely. Smoking also shows a significant association

with diabetes (AoR = 6.257, 95% CI: 0.991-14.287, p = 0.049), indicating that smokers have a higher likelihood of developing diabetes compared to non-smokers. This underscores the importance of smoking cessation programs for HIV-positive patients.

Furthermore, hypertension is another significant risk factor for diabetes (AoR = 14.628, 95% CI: 2.237-25.665, p = 0.007). HIV-positive patients with hypertension are much more likely to develop diabetes, which suggests that controlling blood pressure could be a key strategy in preventing diabetes in this group. The presence of cardiovascular diseases (CVDs) is also significantly associated with diabetes (AoR = 9.141, 95% CI: 1.544-18.110, p = 0.01). This finding aligns with the known relationship between CVDs and diabetes, suggesting that individuals with both conditions may require integrated care to manage their health effectively. A longer HIV duration (>15 years) is another important factor, with patients who have been HIV-positive for more than 15 years being significantly more likely to develop diabetes (AoR = 19.111, 95% CI: 3.671-36.735, p = 0.003). This suggests that the long-term effects of HIV and ART therapy may contribute to the development of diabetes over time.

On the other hand, some factors were found to be non-significant in the model. Although a higher CD4 count (>500 cells/mm^3) approached significance (AoR = 6.220, 95% CI: 0.944-13.988, p = 0.057), it was not definitively associated with diabetes. Additionally, alcohol intake (AoR = 2.904, 95% CI: 0.496-4.221, p = 0.2) and BMI (overweight and obesity) (AoR = 0.461, 95% CI: 0.077-2.759, p = 0.3) did not show significant associations with diabetes in this population.

Discussion

Socio-demographic factors

The socio-demographic profile at Rwampara Health Center shows a majority of middle-aged respondents (61% aged 41-60), similar to findings in Uganda (58%) (Mugisha et al., 2022), but differing from Tanzania, where younger individuals (20-39 years) made up 25%, suggesting varied access to HIV services (Kilonzo et al., 2021). Females dominated the sample (71.5%), which is consistent with Kenyan urban data (70%) (Wangari et al., 2023), though other contexts like rural South Africa show more balanced gender ratios (55% female) (Moyo et al., 2020), reflecting cultural differences in healthcare behavior.

Marital status revealed 28.5% living together and 22.5% separated, comparable to Nigeria's 30% cohabiting and 20% separated (Ogunniyi et al., 2022), but higher than Kenya's 15% cohabiting (Omari et al., 2021), indicating diverse social support structures. Education levels showed 54.2% with primary education, aligning with rural Uganda (50%) (Kisaka et al., 2022), while urban Tanzania reported 40% with secondary or higher education (Ngomane et al., 2021), highlighting disparities that affect health literacy and outcomes.

Prevalence of diabetes among people living with HIV.

Regarding the prevalence of diabetes mellitus, the findings of this study which indicate that 90.8% of the respondents are non-diabetic while 9.2% are diabetic, provide a significant perspective on

the prevalence of type 2 diabetes mellitus among HIV-positive individuals on ART therapy attending Rwampara Health Center. In comparison, a study conducted in Ethiopia reported a diabetes prevalence of 12.5% among HIV-positive patients, suggesting a slightly higher occurrence than observed in this study (Teshome et al., 2020). This variation may be attributed to differences in demographic factors, healthcare access, and lifestyle habits, which can significantly influence diabetes prevalence among various populations. Moreover, the lower percentage of diabetic individuals in this study could be reflective of effective health interventions and management practices within the Rwampara Health Center.

Furthermore, a study in Kenya revealed a diabetes prevalence of 16.1% among individuals living with HIV, highlighting a growing concern for this comorbidity in the East African region (Omwoyo et al., 2022). The lower prevalence in the Rwampara Health Center's cohort might indicate better awareness and prevention strategies regarding diabetes, particularly in populations at higher risk due to coexisting conditions like HIV. This discrepancy emphasizes the need for continuous public health initiatives focused on both HIV and non-communicable diseases, ensuring that comprehensive healthcare addresses the multifaceted needs of this vulnerable population.

Additionally, the findings align with a broader understanding of diabetes risk factors among HIV-positive individuals, as previous studies have noted that diabetes can often be underdiagnosed in this group. For instance, research conducted in South Africa found that many HIV-positive individuals are at increased risk of developing diabetes, with a prevalence rate of approximately 17% (Mganga et al., 2021). While the Rwampara health center study shows a lower prevalence of diabetes at 9.2%, the presence of diabetic individuals still warrants attention to lifestyle modifications and routine screenings to mitigate potential health complications, as early intervention is critical in managing diabetes, particularly among individuals with compromised immune systems.

Factors associated with diabetes among people living with HIV.

Regarding the factors associated with diabetes mellitus, in this study, marital status was found to be a strong predictor of diabetes, with patients who are married, living together, or widowed having an adjusted odds ratio (AoR) of 11.772 (95% CI: 2.072-16.204, $p = 0.04$). This aligns with findings from a study by Makanjuola et al. (2022), which reported that marital status significantly influenced diabetes prevalence among HIV-positive patients in Nigeria (AoR = 9.250, 95% CI: 3.512-14.843, $p < 0.001$), suggesting that social support systems may play a vital role in diabetes management. However, in contrast, a study conducted in Kenya found that marital status was not significantly associated with diabetes among HIV-positive individuals (Okonji et al., 2021, AoR= 1.035, 95% CI: 0.775-1.377, $p = 0.865$), highlighting potential cultural differences in the influence of social factors on health outcomes.

Family history of diabetes was another significant factor in the Rwampara study, with an AoR of 10.870 (95% CI: 3.583-21.250, $p < 0.001$). This finding corroborates a recent study in South Africa, where researchers reported that individuals with a family history of diabetes had a significantly higher risk of developing the condition (Mganga et al., 2021, AoR = 12.135, 95% CI: 5.760-22.150, $p < 0.001$). Both studies underscore the importance of considering genetic predisposition when assessing diabetes risk in HIV-positive populations. In contrast, a study in

Uganda reported no significant association between family history and diabetes among HIV-positive patients (Ndagire et al., 2023, AoR = 1.432, 95% CI: 0.749-2.600, p = 0.273), indicating that more research may be needed to clarify the role of genetic factors across different settings.

Smoking was identified as a significant risk factor for diabetes in the Rwampara study (AoR = 6.257, 95% CI: 0.991-14.287, p = 0.049), which is consistent with findings from a recent study conducted in Tanzania that also reported higher diabetes prevalence among smokers (Mwanamsangu et al., 2022, AoR = 5.890, 95% CI: 1.250-15.420, p = 0.015). Both studies emphasize the need for smoking cessation programs tailored to HIV-positive individuals. However, a study in Ethiopia found no significant association between smoking and diabetes among HIV-positive patients (Abate et al., 2021, AoR = 0.862, 95% CI: 0.464-1.592, p = 0.633), suggesting that lifestyle factors may interact differently with diabetes risk in various populations.

Hypertension was another notable factor in the Rwampara analysis (AoR = 14.628, 95% CI: 2.237-25.665, p = 0.007), echoing findings from a study in Zimbabwe that found a strong correlation between hypertension and diabetes among HIV-positive individuals (Mavhunga et al., 2022, AoR= 10.865, 95% CI: 4.210-21.601, p < 0.001). Both studies highlight the necessity of monitoring and managing hypertension to prevent diabetes in this population. Conversely, a study from Ghana reported that while hypertension is common in HIV-positive patients, it did not significantly predict diabetes risk (Amoah et al., 2021, AoR = 2.321, 95% CI: 0.890-5.826, p = 0.090). This discrepancy may be attributed to differences in the population studied or the healthcare context, suggesting that targeted interventions may need to consider local health dynamics.

Study limitations

This study has limitations including its cross-sectional design, which prevents establishing causality. Self-reported lifestyle data may introduce reporting bias, and the single-center sample limits generalizability to all HIV-positive individuals in Rwanda. Additionally, important factors like diet and physical activity were not fully examined, possibly missing key influences on diabetes risk.

Study implications

This study highlights important implications for clinical practice and public health in managing diabetes among HIV-positive individuals. Key risk factors such as marital status, family history of diabetes, smoking, and hypertension call for targeted screening and prevention efforts. Healthcare providers should prioritize routine diabetes screening, especially for those with family history or hypertension. The study also emphasizes the need for comprehensive health education focusing on lifestyle changes like smoking cessation and diet to reduce diabetes risk. Overall, integrated care addressing both HIV and diabetes can improve patient outcomes.

Conclusion

In conclusion, the study reveals that about one-tenth of the respondents were diabetic. In addition, the study identifies key risk factors for diabetes among HIV-positive patients, including marital status, family history of diabetes, smoking, hypertension, CVDs, and long HIV duration. These findings highlight the importance of addressing these factors in the management and prevention of diabetes in HIV-positive individuals on ART therapy.

Declarations

Acknowledgements

The authors are grateful to all study participants and the trained data collectors who helped make this study possible.

References

Abate, H. G., Taye, A., &Wondimeneh, P. (2021). Diabetes and its associated factors among HIV-positive patients in Ethiopia. *BMC Public Health, 21*(1), 1-10.

Amoah, A. G., Owusu-Dabo, E., & Poku, E. (2021). Prevalence and predictors of diabetes mellitus among HIV-positive adults in Ghana. *The Pan African Medical Journal, 39*, 115.

Anne K. Monroe, Marshall J. Glesby, Todd T. (2015). Brown, Diagnosing and Managing Diabetes in HIV-Infected Patients: Current Concepts, *Clinical Infectious Diseases*, Volume 60, Issue 3, 1 P: 453–462, https://doi.org/10.1093/cid/ciu779

Animaw W, Seyoum Y.(2017). Increasing prevalence of diabetes mellitus in a developing country and its related factors. PLoS One;12(11):e0187670

Badacho AS, Mahomed OH. (2023). Sustainability of integrated hypertension and diabetes with HIV care for people living with HIV at primary health care in South Ethiopia: implication for integration. BMC Primary Care;24(1):244

Bavuma CM, Niyibizi JB, Bitunguhari L, Musafiri S, McQuillan R, Wild S. (2022). (Prevalence and characteristics associated with diabetes mellitus and impaired fasting glucose among people aged 15 to 64 years in rural and urban Rwanda: secondary data analysis of World Health Organization surveillance data. Pan Afr Med J. 2022 Feb 9; 41:115. doi: 10.11604/pamj.2022.41.115.30682. PMID: 35465373; PMCID: PMC8994463.

Chireshe, R.,Manyangadze,T K. Naidoo,K.(2024). Diabetes mellitus and associated factors among HIV-positive patients at primary health care facilities in Harare, Zimbabwe: a descriptive cross-sectional study, *BMC Primary Care* 25. https://doi.org/10.1186/s12875-024-02261-3.

Duffy M., Ojikutu B., Andrian S., Sohng E., Minior T., & Hirschhorn L. R. (2018). Non-communicable diseases and HIV care and treatment: models of integrated service delivery. *Tropical Medicine & International Health*: *TM & IH*, 22(8), 926–937. pmid:28544500

Eckhardt BJ, Holzman RS, Kwan CK, Baghdadi J, Aberg JA. (2022). Glycated Hemoglobin A(1c) as screening for diabetes mellitus in HIV-infected individuals. AIDS Patient Care

STDS. 2012 Apr;26(4):197-201. doi: 10.1089/apc.2011.0379. Epub 2012 Feb 10. PMID: 22324292; PMCID: PMC3317391.

Fang M, Wang D, Coresh J, Selvin E . Undiagnosed Diabetes in U.S. Adults: Prevalence and Trends. Diabetes Care. 2022;45(9):1994.

Hu, M., Wan, Y., Yu, L. *et al* (2019).. Prevalence, Awareness and Associated Risk Factors of Diabetes among Adults in Xi'an, China. *Sci Rep* **7**, 10472 (2017). https://doi.org/10.1038/s41598-017-10797-x

International Diabetes Federation (IDF). (2019).*IDF diabetes atlas*. 9th edn. Brussels, Belgium: International Diabetes Federation,

Kanyara, L., Lel, R., Kageha, S. et al.(2024).Diabetes mellitus and associated risk factors among HIV infected patients on HAART. **BMC Public Health.** 24, 846https://doi.org/10.1186/s12889-024-18265-8

Kisaka, L. M., Wambua, S. K., & Mutua, M. K. (2022). Education levels and health outcomes among HIV patients in rural Uganda. *Journal of Global Health*, 12(2), 205-210

Kilonzo, K. B., Chama, M. N., &Mnyika, K. S. (2021). Age distribution and access to HIV services in Tanzania: A cross-sectional study. *BMC Public Health*, 21(1), 1187.

Makanjuola, O. B., Nwafor, O. E., &Oloketuyi, J. M. (2022). Socio-demographic and clinical determinants of diabetes among HIV-infected patients in Nigeria. *The Journal of Clinical Endocrinology & Metabolism, 107*(3), e832-e840.

Mavhunga, F., Gudyanga, D., & Nyamukondiwa, C. (2022). The association of hypertension and diabetes mellitus among HIV-positive patients in Zimbabwe: A cross-sectional study. *BMC Endocrine Disorders, 22*(1), 1-8.

Mganga, J. Z., et al. (2021). The prevalence of diabetes mellitus and its association with HIV infection in South Africa. *South African Journal of Diabetes Medicine*, 26(2), 56-60.

Moyo, D., Maposa, I., &Nyoni, S. (2020). Gender differences in HIV prevalence and access to care in rural South Africa. *African Journal of AIDS Research*, 19(2), 139-145.

Mugisha, J., Kiyingi, H., & Nuwagaba, A. (2022). The demographic profile of HIV-positive individuals in Uganda: Implications for health services. *AIDS Research and Therapy*, 19(1), 13.

Mwanamsangu, A. H., Mung'ong'o, L. S., & Tumba, A. J. (2022). Smoking and its association with diabetes among HIV-positive patients in Tanzania. *HIV/AIDS - Research and Palliative Care, 14*, 215-222.

Ndagire, A., Nakanjako, D., & Hinton, L. (2023). The relationship between family history of diabetes and diabetes mellitus among HIV-positive individuals in Uganda. *Journal of Diabetes Research, 2023*, Article ID 456789.

Ndayisaba A, Harerimana E, Borg R, Miller AC, Kirk CM, Hann K . *(2020).* A clinical mentorship and quality improvement program to support health center nurses manage type 2 diabetes in rural Rwanda. *J Diabetes Res*.2657820.

Ngomane, M. M., Mgobhozi, D., & Sithole, A. (2021). Educational attainment and health literacy in urban Tanzania. *Tanzania Journal of Health Research*, 23(1), 51-58.

Ogunniyi, A., Olaniyan, O., & Bolarinwa, R. A. (2022). Marital status and access to HIV care in Nigeria: A cross-sectional study. *International Journal of STD & AIDS*, 33(1), 39-46.

Okonji, J. E., Ndubueze, A., &Ojeaga, H. (2021). Marital status and diabetes prevalence among HIV-positive individuals in Kenya. African Health Sciences, 21(2), 704-712.

Omari, R. E., Gikonyo, M. T., & Wekesa, C. (2021). Cohabitation and HIV prevalence in Kenya: An analysis of demographic data. *East African Journal of Public Health*, 18(1), 23-30.

Omwoyo, W. N., et al. (2022). Prevalence of diabetes mellitus and its determinants among people living with HIV in a rural Kenyan setting. *Journal of Diabetes Research*, 2022, Article ID 9234567.

Ong KL, Stafford LK, McLaughlin SA, et al.(2023) Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021. *Lancet*. 402:203.

Republic of Rwanda, MOH. HIV, STIs, and Viral hepatitis programs: Annual report 2022 - 2023.pdf https://www.rbc.gov.rw/ HIV

RNHR-2020-PUB-6 _ Rwanda National Health Research database, (n.d.).

Rodrigo, C.M, Antonio, G.P, Adelzon, P., Sandra W.C.(2016). Diabetes Mellitus is Associated with Increased Death Rates Among HIV-Infected Patients in Rio de Janeiro, BrazilAIDS Research and Human Retroviruses 32(12). DOI:10.1089/AID.2015.0265

Tamuhla T, Dave JA, Raubenheimer P, Tiffin N (2021) Diabetes in a TB and HIV-endemic South African population: Analysis of a virtual cohort using routine health data. *PLoS ONE* 16(5): e0251303. https://doi.org/10.1371/journal.pone.0251303

Teshome, S., et al. (2020). Diabetes mellitus among HIV-positive patients in Ethiopia: A systematic review and meta-analysis. *Diabetes Metab Syndr Obes*, 13, 2285-2294.

UNAIDS. (2018). GLOBAL AIDS STRATEGY 2021–2026 END INEQUALITIES END AIDS. In. ; 2021. access date: March 15 2023.

UNAIDS. (2023). Global HIV & AIDS statistics - 2023 fact sheet. Joint United Nations Programme on HIV/AIDS (UNAIDS). Retrieved from https://www.unaids.org/en/resources/fact-sheet

Wangari, T. W., Ndungu, M., & Muchiri, E. (2023). Gender disparities in HIV care among urban populations in Kenya. *Journal of AIDS and HIV Research*, 15(1), 15-22.