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RESEARCH ARTICLE

Assessing Cardiovascular Risk Using the Framingham Risk Score Among People Living with HIV on HAART at Machakos County Referral Hospital, Kenya

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ABSTRACT

The widespread availability of HAART has significantly extended the survival of people living with HIV. With this increased life expectancy, NCDs such as cardiovascular disease have emerged as major health concerns. Both HIV infection and long-term exposure to antiretroviral therapy contribute to metabolic changes and early vascular aging. This study assessed cardiovascular risk using the Framingham Risk Score (FRS) among people living with HIV (PLHIV) receiving HAART at Machakos County Referral Hospital, Kenya, and examined demographic and clinical factors associated with elevated risk. A cross-sectional study was conducted among 406 adult PLHIV who had been on HAART ≤ 3 months. Data was collected through structured questionnaires, interviews, health records review and laboratory analyses. The 10-year CVD risk was estimated using the Adult Treatment Panel III (ATP III) Framingham algorithm, categorizing patients as low, moderate, moderately high, or high risk. Most participants (71.2%) were classified as low cardiovascular risk; 18.5% as moderate risk, 9.8% as moderately high cardiovascular risk and 0.5% as high cardiovascular risk individuals. Older age {25–40 years (AOR = 37.11, 95% CI: 10.12–140.16, p < 0.001), 41–59 years (AOR = 31.01, 95% CI: 9.04–140.16, p < 0.001), and ≥60 years (AOR = 9.75, 95% CI: 7.14–31.74, p < 0.001)}, male gender (AOR = 3.44, 95% CI: 1.67–8.09, p = 0.001), elevated HDL (AOR = 8.23, 95% CI: 3.92–17.26, p < 0.001), smoking (AOR = 6.80, 95% CI: 1.53–31.25, p < 0.001), shorter duration on antiretrovirals (<5 years) (AOR = 5.17, 95% CI: 1.94–13.79, p = 0.001), and systolic BP ≥140 mmHg (AOR = 30.16, 95% CI: 12.43–73.18, p < 0.001) were significantly associated with higher CVD risk. Thus, although most PLHIV on HAART at Machakos County Referral Hospital had low cardiovascular risk, older age, male gender, hypertension, smoking, short duration on antiretrovirals, and dyslipidemia were found to be key contributors to elevated FRS. These findings underscore the need to integrate routine cardiovascular risk screening and lifestyle modification interventions into HIV care programs in Kenya.

Keywords: *HIV, HAART, Framingham Risk Score, cardiovascular risk, Kenya, non-communicable diseases*

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INTRODUCTION

The introduction of highly active antiretroviral therapy (HAART) in the mid-1990s transformed HIV infection from a fatal disease into a manageable chronic condition. Since the rollout of HAART, AIDS-related mortality has declined by nearly 68% globally between 2004 and 2023 (UNAIDS, 2023). In sub-Saharan Africa, where more than two-thirds of the world's people living with HIV (PLHIV) reside, the availability of HAART has significantly improved survival and life expectancy. In Kenya, national HIV estimates indicate that the number of PLHIV currently on treatment exceeds 1.4 million, representing more than 85% treatment coverage, and AIDS-related deaths have reduced by over 70% since 2010 (Kenya Ministry of Health, 2022). As a result, PLHIV are now living longer, but with increasing exposure to non-communicable diseases (NCDs), particularly cardiovascular diseases (CVDs).

Globally, CVD accounts for 32% of all deaths, with over three-quarters occurring in low- and middle-income countries (LMICs) (World Health Organization [WHO], 2022). The African region has experienced a 52% rise in ischemic heart disease and a 42% rise in stroke-related deaths between 2000 and 2019 (WHO, 2022). In Kenya, national health data estimate that CVDs contribute to 13–15% of total mortality, and the prevalence is projected to rise as more PLHIV reach middle and older ages (Kenya Ministry of Health, 2022). Emerging evidence from Kenyan HIV cohorts shows a growing trend in dyslipidemia and hypertension among long-term HAART users (Osoti et al., 2018; Masyuko et al., 2023).

Several algorithms exist to predict cardiovascular risk, including the Systematic Coronary Risk Evaluation (SCORE), the D:A:D risk score, and the Framingham Risk Score (FRS). Among these, the FRS remains one of the most widely used and validated tools for estimating 10-year risk of coronary heart disease (Wilson et al., 1998). It uses easily obtainable clinical and biochemical data, making it more feasible and cost-effective in such contexts. The FRS estimates a 10-year risk for coronary heart disease based on parameters such as age, sex, total cholesterol, high-density lipoprotein (HDL) cholesterol, systolic blood pressure, smoking status, and antihypertensive use. Based on the score, individuals are categorized into low (<10%), intermediate (10–20%), and high (>20%) 10-year risk categories (NCEP, 2002).
Existing literature from high-income settings demonstrates that PLHIV have a 1.5–2-fold higher risk of myocardial infarction compared to HIV-negative individuals, even after controlling for traditional risk factors Freiberg et al. (2013). In sub-Saharan Africa, emerging evidence points to a growing CVD risk burden among PLHIV. In Cameroon, Pefura-one et al. (2019) reported that 13% of People living with HIV (PLWH) adults on ART were classified as moderate-to-high risk by FRS, with higher rates observed in males and older patients. In Uganda, Achila et al. (2022) found that longer ART duration was associated with increased risk scores, reflecting cumulative exposure to metabolic effects of therapy.

Kenyan studies remain relatively sparse. Osoti et al. (2018) assessed People living with HIV (PLWH) adults in Nairobi and reported that up to 12% were in intermediate-to-high FRS categories. Masyuko et al. (2023) recently documented rising cardiometabolic complications in Kenyan cohorts, emphasizing the need for systematic screening. However, these studies have been largely urban-focused, with little data from semi-urban and rural regions such as Machakos County where healthcare resources may be more limited. While Kenya has made significant progress in scaling up HIV care, the integration of cardiovascular disease screening into HIV management remains limited. Current HIV treatment guidelines focus mainly on viral suppression and opportunistic infection control, with minimal emphasis on metabolic or vascular health. As the population of aging PLHIV continues to grow, there is an urgent need to assess their long-term cardiovascular risk and identify modifiable predictors. This study therefore sought to determine the Framingham Risk Score among PLHIV on HAART at Machakos County Referral Hospital and to identify associated demographic and clinical predictors.

METHODS

Study Design

This was a cross-sectional study conducted between April 2022 to June 2022. Data were collected at a single point in time using structured questionnaires and clinical records. Information was obtained on demographic characteristics (age, sex, marital status, level of education, occupation) and clinical parameters (blood pressure, body mass index, lipid profile, and duration on HAART). The FRS was analysed for each participant to estimate their 10-year cardiovascular risk.

Study Location

This was a cross-sectional study conducted between April 2022 to June 2022. Data were collected at a single point in time using structured questionnaires and clinical records. Information was obtained on demographic characteristics (age,

sex, marital status, level of education, occupation) and clinical parameters (blood pressure, body mass index, lipid profile, and duration on HAART). The FRS was analysed for each participant to estimate their 10-year cardiovascular risk.

Study Population

The study included 406 People living with HIV patients receiving care at Machakos County Referral Hospital's Comprehensive Care Centre, one of the key referral centers in Eastern Kenya. Participants were recruited from the hospital's Comprehensive Care Centre (CCC), which serves both rural and semi-urban populations. The selected sample size met the required threshold based on statistical calculation and the feasibility of patient recruitment within the study duration. Participants were selected according to inclusion and exclusion criteria outlined below.

Inclusion Criteria

Study participants were eligible for inclusion if they:

- Were adults PLWHIV aged 20 years or older,
- Had been on HAART for at least three months,
- Provided written informed consent.

Exclusion Criteria

Exclusion criteria comprised:

- Pregnant women due to physiological lipid and metabolic variations.
- Severely ill patients or those requiring emergency care.
- Individuals with incomplete clinical or biochemical records, such as missing lipid or blood pressure data.
- Patients who declined to participate.

Sample Size Determination

The study's sample size was based on Fisher's et al. (2002), formula, using a prevalence rate of 59.9% for dyslipidemia (Temesgen et al., 2021).

$$N = \frac{Z^2pq}{\delta^2}$$

Where;

N = Minimum Sample size

Z = 1.96; standard normal deviation at 95% confidence level.

P = predictable prevalence of dyslipidemia according to literature

Q = share of target population without dyslipidemia (1 – p)

δ = degree of accuracy set at 0.05

$$= \frac{(1.96^2 \times 0.599 \times 0.401)}{0.05^2} = 369$$

N = 406 (369 + 10% of actual sample size) to account for non-responsive rate.

Research Tools

A structured data collection form, complemented by laboratory test results, was used to obtain comprehensive and reliable information from study participants. The tool captured demographic variables (age, gender, marital status, and duration on HAART), clinical details (antiretroviral regimen and comorbidities), and biochemical parameters (total cholesterol, triglycerides, HDL-C, and LDL-C). Laboratory data sheets were utilized to record lipid profile results. The questionnaire and laboratory forms were developed based on an extensive literature review, standardized data collection tools from previous studies, and expert consultation with clinicians and laboratory personnel to ensure clarity and relevance. To enhance validity and reliability, the instruments underwent pilot testing among 60 participants, allowing for the identification and correction of ambiguities. Content and face validity were established through review by supervisors, a psychometrician, and clinical officers at the Comprehensive Care Clinic. Clear instructions were incorporated to promote consistency during data collection, and all data were entered into a spreadsheet by the principal investigator under supervision to ensure data accuracy and integrity.

Data Collection Procedures

Data was collected between April and June 2022 by the clinicians following a structured and logical process to ensure consistency and data quality. Eligible participants attending routine clinic visits at the Comprehensive Care Centre were first approached, briefed on the study objectives, and invited to participate. Written informed consent was obtained prior to enrollment. Thereafter, each participant completed a structured, interviewer-administered questionnaire that captured sociodemographic information (age, sex, marital status, education level, occupation), clinical history (duration on HAART, smoking, hypertension status), and lifestyle behaviors. Anthropometric and clinical measurements were then taken, including weight, height, and waist circumference, using calibrated equipment, and body mass index (BMI) was subsequently calculated. Blood pressure was measured in a sitting position using a digital sphygmomanometer after at least five minutes of rest. Finally, venous blood samples were collected after an overnight fast for lipid profile analysis, including total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) and triglycerides (TG) using an automated analyzer (Humastar 600). The Friedewald formula measured LDL-C levels (Tremblay et al., 2004). Internal quality control procedures were conducted daily to ensure the accuracy and reliability of laboratory results.

Data Analysis

Data were entered and cleaned in Microsoft Excel and analyzed using SPSS version 25. Descriptive statistics (means, standard deviations, frequencies, and percentages) summarized demographic and clinical characteristics. The prevalence of low, moderate, moderately high and high FRS categories was computed. Associations between demographic/clinical variables and FRS categories which were then categorized to low and high were assessed using chi-square tests for categorical variables and logistic regression for multivariable analysis. A p-value <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from Kenyatta University Ethical Review Committee (KU-ERC) (Ref: PKU/2402/11536). A research permit from National Commission for Science, Technology, and Innovation (NACOSTI) (License No: NACOSTI/P/22/15859) was obtained. Permission to carry out this study and any other information from the participants were obtained from Machakos County Referral Hospital. All participants were only admitted to the study after offering informed consent. No medical services were denied from participants who do not consent to the study. All study participants received their results during subsequent CCC visits.

RESULTS

Sociodemographic Characteristics

A total of 406 PLWHIV receiving HAART were enrolled in the study. The demographic variables assessed included age, gender, level of education, marital status, and BMI. The majority of participants were female (71.4%, n = 290), while males accounted for 28.6% (n = 116) of the study population. The median age of respondents was 46 years (interquartile range [IQR]: 38–55 years). More than half of the participants (55.2%, n = 224) were aged between 41 and 59 years, followed by 24.6% (n = 100) aged 25–40 years, 14.5% (n = 59) aged ≥60 years, and 5.7% (n = 23) aged ≤24 years. Further, 44.3% (n = 180) of the participants had attained primary education or below, 41.1% (n = 167) had secondary education, while 14.5% (n = 59) had completed tertiary education. In terms of marital status, 53.4% (n = 217) were single, whereas 46.6% (n = 189) were married. The median BMI of the study participants was 24.4 kg/m² (IQR: 21.2–28.3). Nearly half of the respondents (48.5%, n = 197) had a normal BMI, while 6.7% (n = 27) were underweight, 28.1% (n = 114) were overweight, and 16.7% (n = 68) were obese (Table 1).

Table 1:

Demographic Characteristics of Study Participants

Demographic factors	Frequency (n)	Percent
Gender		
Male	116	28.6
Female	290	71.4
Age (years)		
Median age (IQR)	46(38 - 55)	
<=24 years	23	5.7
25 - 40 years	100	24.6
41 - 59 years	224	55.2
>=60 years	59	14.5
Marital status		
Single	217	53.4
Married	189	46.6
Education level		
Primary or lower level	180	44.3
Secondary	167	41.1
Tertiary	59	14.5

Occupation		
Unemployed	76	18.7
Employed	68	16.7
Self employed	262	64.5
BMI		
Median (IQR)	24.4(21.2 - 28.3)	
Normal	197	48.5
Underweight	27	6.7
Overweight	114	28.1
Obese	68	16.7
Cigarette smoking		
Yes	22	5.4
No	384	94.6

***IQR**: Interquartile range*

Medical History and Clinical Characteristics of Study Participants

The clinical characteristics of the study participants are summarized in Table 2. Variables assessed included history of hypertension, history of CVD, blood pressure status, history of cigarette smoking, duration on HAART, and treatment regimen. A total of 15.3% (n = 62) of respondents reported a history of hypertension, while 84.7% (n = 344) had no prior diagnosis. Only 6.9% (n = 28) of participants reported a history of cardiovascular disease, whereas 93.1% (n = 378) did not. Regarding smoking status, 5.4% (n = 22) of the participants were current or former smokers, and 94.6% (n = 384) had no history of cigarette smoking. Based on blood pressure measurements, 17.0% (n = 69) of participants were hypertensive, while the majority (83.0%, n = 337) had normal blood pressure at the time of assessment. The duration on HAART ranged from six months to 20 years, with a median of 9 years (IQR: 5–13 years). Most participants (73.6%, n = 299) had been on HAART for more than five years. When categorized by treatment duration, 22.2% (n = 90) had used HAART for less than five years, 36.7% (n = 149) for 5–10 years, and 41.1% (n = 167) for more than 10 years. Further, majority of respondents (93.1%, n = 378) were on first-line HAART regimens, while 6.9% (n = 28) were on second-line regimens. The most frequently prescribed regimen was TDF/3TC/DTG (89.7%, n = 364), followed by AZT/3TC/ATV/r (3.2%, n = 13), TDF/3TC/EFV (1.5%, n = 6), ABC/3TC/DTG (0.7%, n = 3), and ABC/3TC/ATV/r (0.5%, n = 2).

Table 2*:*

Medical History and Clinical Characteristics of Study Participants

Medical history and clinical factors	Frequency (n)	Percent (%)
History of hypertension		
Yes	62	15.3
No	344	84.7
History of cardiovascular		
Yes	28	6.9
No	378	93.1
Systolic Blood Pressure		
≥140 mmHg	69	17.0
<140 mmHg	337	83.0

Diastolic Blood Pressure		
≥90 mmHg	69	17.0
<90 mmHg	337	83.0
Duration of ARV drug use (years)		
Median (IQR)	9(5 -13)	
< 5 years	90	22.2
5 – 10 years	149	36.7
> 10 years	167	41.1
HAART Treatment line		
First line	377	92.9
Second line	29	7.1
HAART Regimen type		
ABC/3TC/ATV/r	2	0.5
ABC/3TC/DTG	3	0.7
AZT/3TC/ATV/r	13	3.2
AZT/3TC/DTG	1	0.2
AZT/3TC/LPV/r	1	0.2
AZT/3TC/NVP	1	0.2
AZT3TC/LPV/r	1	0.2
D4T/3TC/NVP	1	0.2
TDF/3TC/ATV/r	12	3.0

Values are expressed as mean ± standard deviation or frequency (%). Abbreviations: ***ARV****: Antiretroviral,* ***IQR****: Interquartile range,* ***HAART****: Highly active antiretroviral therapy,* ***ABC****: Abacavir,* ***3TC****: Lamivudine, ATV/r: Atazanavir/ritonavir,* ***DTG****: Dolutegavir,* ***AZT****: Azidothymidine,* ***LPVlr****: Lopinavir/ritonavir,* ***D4T****: Stavudine,* ***NVP****: Nevirapine,* ***TDF****: Tenofovir disoproxil fumarate,* ***EFV****: Efavirenz*

Distribution of Framingham Risk Scores

Based on the FRS assessment, the majority of participants (71.2%, n = 289) were categorized as having low cardiovascular risk. In comparison, 18.5% (n = 75) had moderate risk, 9.8% (n = 40) exhibited moderately high risk, and 0.5% (n = 2) were classified as having high cardiovascular risk (Table 3).

Table 3*:*

The Framingham Risk Score Among HIV-Positive Patients on HAART at MCRH

Framingham risk score	Frequency	Percent
Low	289	71.2
Moderate	75	18.5
Moderately high	40	9.8
High	2	0.5

DISCUSSION

This study evaluated the 10-year CVD risk among PLWHIV patients on HAART at Machakos County Referral Hospital using the FRS. Majority of participants (71.2%) were classified as low risk, while 18.5% had moderate risk, 9.8% had moderately high risk, and 0.5% were at high risk. The predominance of low FRS may be attributed to the fact that most participants were non-smokers and normotensive. Smoking and elevated systolic pressure were among the factors significantly associated with increased cardiovascular risk in this study. These findings align with global and regional evidence showing that PLHIV are experiencing a dual burden of infectious and NCDs, emphasizing the importance of integrating CVD risk screening into HIV care.

Table 4:

Association Between Patient Characteristics and Risk of Cardiovascular Disease

Factors	FRS risk		OR (95%CI)	P-value	AOR (95%CI)	P-value
	High risk n(%)	Low risk n(%)				
Age						
≤4 years	1(0.9)	22(7.6)	Ref		Ref	
25 - 40 years	8(6.8)	92(31.8)	3.62(1.99 - 6.59)	<0.001	37.11(10.12 - 140.16)	<0.001
41 - 59 years	71(60.7)	153(52.9)	19.34(7.91 - 47.32)	<0.001	31.01(9.04 - 106.34)	<0.001
≥60 years	37(31.6)	22(7.6)	37.0(4.66 - 293.90)	0.001	9.75(4.08 – 23.30)	<0.001
Gender						
Male	57(48.7)	59(20.4)	3.70(2.33 - 5.88)	<0.001	3.44(1.67 - 7.09)	0.001
Female	60(51.3)	230(79.6)	Ref		Ref	
Total Cholesterol (TC)						
Yes	41(35.0)	77(26.6)	1.49(0.94 - 2.35)	0.093	1.43(0.72 - 2.85)	0.313
No	76(65.0)	212(73.4)	Ref		Ref	
HDL						
High	75(64.1)	109(37.7)	2.95(1.89 - 4.61)	<0.001	8.23(3.92 - 17.26)	<0.001
Low	42(35.9)	180(62.3)	Ref		Ref	
Cigarette smoking						
Yes	19(16.2)	3(1.0)	18.48(5.35 - 63.81)	<0.001	6.80(1.53 - 31.25)	<0.001
No	98(83.8)	286(99.0)	Ref		Ref	
Duration on HAART						
Less than 5 years	19(16.2)	71(24.6)	2.15(1.19 - 3.90)	0.012	5.17(1.94 - 13.79)	0.001
5 - 10 years	37(31.6)	112(38.8)	1.74(1.07 - 2.84)	0.026	1.78(0.87 - 3.64)	0.113
>10 years	61(52.1)	106(36.7)	Ref		Ref	
Systolic pressure						
≤140 mmHg	51(43.6)	19(6.6)	10.98(6.08 - 19.84)	<0.001	30.16(12.43 - 73.18)	<0.001
<140 mmHg	66(56.4)	270(93.4)	Ref		Ref	

Reference category (Ref) *= category of the independent variable which each other category is compared. Low risk = participants having low risk of CVD according to FRS analysis. High risk = participants having moderate, moderately high and high risk of CVD according to FRS FRS: Framingham risk score, OR: Odds ratio, AOR: Adjusted odds ratio, TC: Total cholesterol, HDL: High density lipoprotein cholesterol, HAART: Highly active antiretroviral therapy. CI = Confidence Interval; p < 0.05 considered statistically significant.*

Comparable results have been reported in other African countries. In Cameroon, Pefura-one et al. (2019) found that 87% of PLHIV had low FRS, while Achila et al. (2022) in Uganda reported that 82% were in the low-risk category. In Indonesia, Lindayani et al. (2021) also reported a predominance of low-to-moderate risk (68.0%), similar to our findings. The younger age structure of the current study population may partly explain these results, as CVD risk factors tend to accumulate with age. In contrast, studies from Ghana reported higher CVD risk distributions, with 41.5%, 28.1%, and 30.4% of participants in low, medium, and high FRS categories respectively (Nyiambam et al., 2020). The higher risk observed in the Ghanaian cohort could be due to the older age of participants (mean 54 years) and the use of hospital record-based data, which likely included patients with pre-existing metabolic conditions. These differences underscore the need for context-specific validation of CVD risk algorithms in HIV populations.

The present study identified age, gender, HDL levels, cigarette smoking, systolic blood pressure, and duration on HAART as key predictors of high FRS. Age was the most prominent determinant: participants aged 25–40, 41–59, and ≥60 years were significantly more likely to have higher FRS compared to those ≤24 years. This finding aligns with studies from Cameroon (Pambou et al., 2022), Ethiopia (Woldeyes et al., 2022), and Nigeria (Ekun et al., 2021), which consistently show that cardiovascular risk escalates with age due to vascular stiffening, endothelial dysfunction, and accumulation of metabolic abnormalities. In addition, older PLHIV often have longer ART exposure, compounding their risk through cumulative drug-induced metabolic effects.

Gender differences were also evident, with male participants being 3.4 times more likely to have high FRS compared to females. Our results agree with findings from Ethiopia, where male gender was a strong predictor of elevated FRS (Woldu et al., 2021), and with Woldeyes et al. (2022), who found that older age and longer HAART duration among males accounted for their higher risk. Conversely, Lindayani et al. (2021) reported higher CVD risk among women, possibly due to higher rates of obesity and family history of CVD in female participants. Similarly, Vigny et al. (2020) found that metabolic syndrome a major CVD determinant was more prevalent among women, likely due to hormonal and anthropometric factors. These discrepancies may arise from differences in sample sizes, ART regimens, and population structure across studies.

Hypertension emerged as one of the strongest independent predictors of elevated FRS. Participants with systolic blood pressure ≥140 mmHg were 25.9 times more likely to have high CVD risk than those with lower pressures. Hypertension is a well-recognized modifiable CVD risk factor, and similar associations have been reported in other African HIV cohorts (Masyuko et al., 2023; Wu et al., 2019). The association may be influenced by the predominance of integrase strand transfer inhibitor (INSTI)-based regimens in this cohort, which have been linked to weight gain and increased risk of hypertension compared to NNRTI-based regimens (Byonanebye et al., 2022; Eckard & McComsey, 2020).

Smoking was another strong predictor, with smokers being 15 times more likely to have elevated FRS than non-smokers. This finding corresponds with reports from Grand et al. (2019) and Wu et al. (2019), where smoking, high blood pressure, and dyslipidemia were leading CVD risk factors. Smoking promotes endothelial dysfunction, vascular inflammation, and atherogenesis (Messner & Bernhard, 2014). Evidence indicates that smoking cessation interventions can reduce 10-year CVD risk by 20–35% (Wu et al., 2019), highlighting the importance of integrating cessation programs into HIV care.

Interestingly, patients who had been on HAART for less than five years were more likely to have high FRS compared with those treated for over 10 years. This contrasts with some studies linking longer ART duration to higher metabolic risk (Agu et al., 2019; Gupta et al., 2020). The difference may stem from the widespread use of newer INSTI-based regimens (TDF/3TC/DTG) in this population, which have lower dyslipidemic potential compared to older protease inhibitor (PI) or NRTI-based regimens. Similar to our findings, Grand et al. (2020) reported that HAART duration was not significantly associated with increased CVD risk. However, Juma et al. (2019) demonstrated that NRTI-based regimens were linked to elevated total cholesterol, emphasizing that regimen composition plays a crucial role in metabolic outcomes.

Contrary to expectations, total cholesterol levels were not significantly associated with FRS in this study. Most participants had normal TC levels, possibly due to the metabolic safety of INSTI-based regimens. Prior studies suggest that integrase inhibitors and CCR5 antagonists exhibit lower CVD toxicity than PI- and NNRTI-based therapies (Vos & Venter, 2021). Similar results were observed by Agu et al. (2019), where TC was not predictive of peripheral arterial disease. Conversely, Hedayatnia et al.

(2020) found that elevated TC was significantly associated with higher CVD risk, although their study involved a much larger and HIV-negative cohort. These contrasting findings emphasize the need for longitudinal monitoring of lipid changes in PLWHIV populations on different ART regimens.

Overall, despite most participants being classified as low risk, the presence of moderate-to-high risk subgroups warrants proactive management. Integrating CVD risk screening into HIV care offers a cost-effective opportunity for early prevention. Routine measurement of blood pressure, lipid profiles, and BMI, combined with smoking cessation support and lifestyle counseling, should become standard practice in HIV clinics. In addition, periodic review of ART regimens may be necessary for patients at high metabolic risk. Kenya's current HIV treatment guidelines primarily focus on viral suppression and opportunistic infection control (Kenya Ministry of Health, 2022). However, as the HIV population ages, national guidelines should expand to include metabolic and cardiovascular risk management. Similar calls have been made across sub-Saharan Africa to address the emerging burden of NCDs among PLHIV. Strengthening integration between HIV and NCD services can reduce long-term morbidity and mortality, enhance quality of life, and reduce health system costs.

Strengths and limitations

This study contributes valuable data from a semi-urban Kenyan population, filling an important gap in the literature. The use of standardized FRS calculations and robust data collection enhances the reliability of findings. However, certain limitations must be acknowledged. First, the cross-sectional design limits causal inference; associations observed cannot establish temporal relationships. Second, the FRS was developed in a predominantly Caucasian population and may underestimate risk in African cohorts, where traditional and non-traditional risk factors may interact differently (Dimala & Blencowe, 2018). Third, dietary patterns and physical activity, important contributors to CVD risk, were not assessed. Finally, the relatively low prevalence of smoking and alcohol use may have limited the power to detect associations with these factors.

Conclusion(s)

Majority of participants (71.2%) were classified as low risk, while 18.5% had moderate risk, 9.8% had moderately high risk, and 0.5% were at high risk. Older age, male gender, HDL levels, cigarette smoking, systolic blood pressure, and duration on HAART were significantly associated with elevated CVD risk scores. These findings highlight the emerging challenge of cardiovascular disease among people living with HIV in Kenya, even in semi-urban settings. As HIV care continues to extend life expectancy, cardiovascular complications will play an increasing role in morbidity and mortality. The integration of cardiovascular risk assessment into HIV treatment programs is crucial to ensure comprehensive and sustainable care for this population.

Recommendations

This study recommends:

1. Routine CVD Risk Screening: Incorporate Framingham Risk Score or similar validated tools into HIV clinics for periodic assessment of patients, especially those on long-term ART.
2. Integrated HIV–NCD Care: Expand HIV guidelines in Kenya to include management of hypertension, dyslipidemia, and obesity in People living with HIV (PLWH) patients.
3. Lifestyle Interventions: Implement counseling on nutrition, physical activity, weight management, smoking cessation, and alcohol moderation as part of HIV care packages.
4. Pharmacological Review: Consider regimen adjustments for patients at high cardiovascular risk, avoiding ART drugs with known metabolic toxicity where feasible.
5. Health System Strengthening: Train healthcare providers in CVD risk assessment and management within HIV programs.

Recommendation for Further Study

The finding that high HDL cholesterol was associated with increased cardiovascular risk among patients on HAART is unexpected and contradicts the traditional view of HDL as the 'good lipid' unlike LDL. Further studies are recommended to investigate the underlying mechanisms of this relationship, particularly the role of ART regimens and HIV infection in altering HDL function and its impact on cardiovascular risk.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Sarah Malinda Syengo personally financed the study and was responsible for conceptualization, study design, data collection, data analysis, interpretation of findings, and drafting of the manuscript. Scholastica Gatwiri Mathenge contributed to the design of the study and provided critical feedback on the manuscript. Nelson Chengo Menza participated in study design, supported data analysis, and assisted in manuscript revision. The collaboration of all three authors was integral to the successful completion of the study.

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