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Short and Long Term Cardiovascular Risk, Metabolic Syndrome Prevalence and HIV in Tanzania: A Cross-Sectional Study

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Abstract

Objective—To compare short and long term cardiovascular disease (CVD) risk scores and prevalence of metabolic syndrome in HIV-infected adults receiving and not receiving antiretroviral therapy (ART) to HIV-negative controls.

Methods—A cross-sectional study including: 151 HIV-infected, ART-naive, 150 HIV-infected on ART and 153 HIV-negative adults. Traditional cardiovascular risk factors were determined by standard investigations. The primary outcome was ACC/AHA ASCVD Risk Estimator lifetime CVD risk score. Secondary outcomes were ASCVD 10-year risk, Framingham risk scores, statin indication and metabolic syndrome.

Results—Compared to HIV-negative controls, more HIV-infected adults on ART were classified as high lifetime CVD risk (34.7% vs 17.0%, p<0.001) although 10-year risk scores were similar, a trend which was similar across multiple CVD risk models. In addition, HIV-infected adults on ART had a higher prevalence of metabolic syndrome vs HIV-negative controls (21.3% vs 7.8%, p=0.008), with 2 common clusters of risk factors. More than one-quarter (28.7%) of HIV-infected Tanzanian adults on ART meet criteria for statin initiation.

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The authors declare that they have no competing interests.

CONTRIBUTIONS

Authors' contributions: RP, RS, SK, DF and DK designed the study. RS and RP were involved in study enrollment. RP, JRK, EN did the analysis. JRK wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Conclusions—HIV-infected ART-treated individuals have high lifetime cardiovascular risk, and this risk seems to develop rapidly in the first 3–4 years of ART as does the development of clusters of metabolic syndrome criteria. These data identify a new subgroup of low short-term/high lifetime risk HIV-infected individuals on ART who do not currently meet criteria for CVD risk factor modification but require further study.

Keywords

global health; global disease patterns; cardiac risk factors and prevention; metabolic syndrome; systemic inflammatory diseases

BACKGROUND

Data from the US and Europe indicate that HIV-infected adults have a higher incidence of cardiovascular disease. HIV-infected adults have a 2-fold increased incidence of myocardial infarction [1,2] and stroke [3], and a 4-fold increased rate of sudden cardiac death [4]. The reason for the increased cardiovascular disease (CVD) risk in HIV-infected populations is poorly understood but is likely due to a complex interaction between traditional CVD risk factors, drug toxicity of antiretroviral therapy (ART), chronic inflammation and immune activation [5]. Most research has focused on short-term CVD risk but less attention has been paid to long-term risk in HIV-infected adults.

Although 90% of HIV-infected adults live in sub-Saharan Africa (SSA), little is known about CVD risk profiles among the HIV-infected adults in this region [6,7]. Cardiovascular risk factors such as hypertension (HTN) [8,9] and diabetes mellitus (DM) [10] are common among HIV-infected African adults, and CVD risk calculation tools specifically tailored to this population are needed[11]. One recent study reported a 10-year Framingham risk score of >10% in 10% of HIV-infected Ugandan adults [12]. To the best of our knowledge, no published study has yet quantitated the differences in CVD risk profiles between African HIV-infected adults on long-term ART as compared to both HIV-negative adults and to those starting ART.

Therefore, we conducted a controlled cross-sectional, analytical study to compare CVD risk profiles of HIV-infected Tanzanian adults on ART, HIV-infected ART-naïve adults and HIV-negative adults. The objectives of this study were: 1) to quantitate and compare long and short-term CVD risk scores between groups, 2) to compare clustering of cardiovascular risk factors as defined by metabolic syndrome and 3) to determine the proportion of each population who met criteria for statin initiation. Our primary outcomes were American College of Cardiology (ACC/AHA) Atherosclerotic Cardiovascular Disease (ASCVD) lifetime and 10-year risk scores but we also calculated Framingham 10 and 30-year both with and without lipid criteria for the sake of comparison. We hypothesized that the proportion of the population at high lifetime risk according to ASCVD scores would be two-fold greater among HIV-infected adults on ART compared to HIV-negative controls.

METHODS

Study design

This was an analytical, controlled cross-sectional study.

Study area

The study was conducted between October 2012 and April 2013 in the outpatient HIV clinic of the Bugando Medical Centre (BMC) in Mwanza, Tanzania. BMC is the zonal hospital for the Lake Victoria Zone in northwest Tanzania, serving a population of approximately 13 million. The HIV prevalence in the Lake Zone is 6%, similar to the national average of 5.1% [13]. At the time of the study, the BMC HIV clinic was providing care to 14,432 patients of whom 9,064 are currently receiving ART. Patients are referred to BMC from surrounding community-based voluntary counseling and testing centers in the city of Mwanza. According to Tanzanian national guidelines, all HIV-infected patients must be assigned a treatment partner who is typically a family member, friend or partner. HIV-infected patients fulfilling Tanzanian national criteria for ART are started on treatment and are seen monthly or bi-monthly at the BMC clinic. At the time of the study, Tanzanian criteria for starting ART included World Health Organization (WHO) Clinical Stage III disease with CD4 count <350 cells/μl, Stage IV disease regardless of CD4 count, or CD4 count <200 cells/μl. The first-line ART regimen consisted of either tenofivir/emcitrabine or zidovudine/lamivudine + nevirapine or efavirenz. Protease inhibitors (PIs) were only given as second-line ART, in accordance with Tanzanian national guidelines [14].

Study population

All of the study population was recruited from the BMC HIV clinic. The study included 3 groups of adults (all >18 years old) for the purpose of comparisons:

1. HIV-infected adults on ART for ≥2 years (HIV-infected, on ART),
2. HIV-infected adults newly establishing care in last 3 months, not yet on ART (HIV-infected, ART-naïve) &
3. HIV-negative adult treatment partners (control group).

HIV-negative adult treatment partners were chosen as a control group in order to provide a population with similar socioeconomic status to the 2 groups of HIV-infected adults. All treatment partners who attended the BMC HIV clinic during the study period were eligible for enrollment. Exclusion criteria included pregnancy and failure to attend a follow-up visit on the day after enrollment.

Laboratory analysis

At enrolment, blood samples were obtained and the CD4 count was measured using an automated BD FACS Calibur Machine (BD Biosciences, San Jose, CA, USA). A urine pregnancy test was performed on women whose last menstrual period was >1 month prior to the date of interview. Enrolled study subjects were instructed to return to the clinic the following morning after an overnight fast.

All participants underwent an oral glucose tolerance test (OGTT) according to WHO protocol [15]. After an overnight fast for >8 hours, fasting blood glucose levels were measured from a sterile finger prick blood sample using an automated machine (OneTouch Select, LifeScan, CA, USA). The OneTouch Select reports a plasma glucose equivalent and has been shown to be >90% accurate (compared to venous plasma glucose measurement) in diagnosing diabetes mellitus when used for OGTT in resource-limited settings [16]. Each participant was then given 400mls of Lucozade (Glaxo Smith-Kline, London, UK), which is equivalent to 75g glucose loading dose in water, over a duration of <5 minutes [17]. Blood glucose levels were measured again, 2 hours after ingestion of glucose.

Total cholesterol, high density lipoprotein (HDL) cholesterol, and triglycerides levels were measured using Cobas Integra 400 Plus Analyzer (Roche Diagnostic Limited, Switzerland). Low density lipoprotein (LDL) levels were calculated using the Friedewald equation [18]. LDL levels could not be calculated for one HIV-negative patient because the triglyceride level exceeded 4.52 mmol/L.

Definitions

Ten year cardiovascular risk scores were determined using three equations: Framingham risk score with lipids, Framingham risk score without lipid levels [19], and 2013 ASCVD [20]. ASCVD 10-year risk was calculated using the published formula and including the actual age of the patient. As a sensitivity analysis, we also calculated scores designating those <40 years of age as 40 years old and excluding those with age <40 years. These sensitivity analysis, as expected, did lead to an increase in predicted risk but did not change the overall results or conclusions of the study. Long-term cardiovascular risk scores were calculated using three equations: Framingham 30-year risk formulas using either lipids or body mass index (BMI) [21] and ASCVD lifetime risk. For Framingham risk scores we determined the proportion of each group with low, intermediate, and high risk, which was defined as <10%, between 10 and 20%, and ≥20%, respectively [22]. ASCVD lifetime risk scores were stratified into subgroups published in recent literature and referenced in the 2013 ACC/AHA guidelines [23].

We determined the proportion of individuals indicated for statin therapy according to the ASCVD guidelines: current CVD, LDL >=4.91mmol/L (190mg/dL), diabetes and aged 40–75 years, or 10-year cardiovascular risk >=7.5% aged 40–75 years [24].

Diabetes mellitus (DM) used in the CVD risk equations was defined as either a fasting blood glucose ≥7.0mol/l (126mg/dL) or a glucose level ≥11.1mol/l (200mg/dL) 2 hours after a 75g oral glucose load [15]. We determined the prevalence of metabolic syndrome according to both ATPIII and International Diabetes Federation (IDF) definitions. Specifically, ATPIII criteria are three or more of the following: 1) waist circumference >88cm or 102cm in women and men, respectively, 2) triglycerides >150mg/dl, 3) HDL <50mg/dl or <40mg/dl in women and men, respectively, 4) blood pressure >130/85 and 5) fasting glucose >110mg/dl. IDF metabolic syndrome was defined as central obesity plus two of the following: 1) triglycerides >150mg/dl, 2) triglycerides >150mg/dl, 3) HDL <50mg/dl or <40mg/dl in women and men, respectively, 4) blood pressure >130/85 and 5) fasting glucose >100mg/dl [25,26].

Statistical Analysis

The primary outcomes of the study were lifetime and 10-year cardiovascular risk as per ASCVD guidelines. The primary study analysis was comparison of stratified lifetime and 10-year CVD risk scores between each HIV-infected group and the HIV-negative control group. We hypothesized that 50% of HIV-infected on ART vs 30% of HIV-negative controls would be classified as high lifetime CVD risk according to the ASCVD categories. We calculated that a sample size of >150 per group would provide >90% power to detect this difference. Sample size was calculated in Stata using two sample proportions chi squared test and significance was determined with a two-sided p value of <0.05.

Data analysis was done using STATA version 14 (San Antonio, Texas). Descriptive statistics were computed by determining mean and standard deviation for continuous variables and proportions (percentages) for categorical variables. Logistic regression for binary variables and ordinal logistic regression for ordered categorical outcomes. Ordinal logistic regression was used to compare ordinal outcomes, such as categories of cardiovascular risk. P-values were obtained from the likelihood ratio test, with those less than 0.05 considered significant. There were four missing values for the “treated hypertension” variable, which represents 0.8% of that variable. No other variables had missing values.

Ethics Statement

The study was approved by the Institutional Review Boards at Bugando Medical Centre and Weill Cornell Medical College. All study participants were informed about the study by a nurse or doctor fluent in Kiswahili and provided written informed consent before participation. All results were made available to clinicians and recorded in the patients’ files. Disease management was conducted by the health care workers of the HIV clinic according to Bugando Medical Centre and Tanzanian management protocols and practices.

RESULTS

Enrollment

During the study period, 488 adults were screened and 34 were excluded from the study: 7 patients were found to be pregnant (4 HIV-infected on ART and 3 HIV-infected ART-naïve), and 27 did not return the following day (7 HIV-infected on ART, 9 HIV-infected treatment naïve and 11 HIV-negative controls). Therefore, a total of 454 adults were enrolled: 150 HIV-infected adults on ART, 151 HIV-infected treatment naive and 153 HIV-negative controls.

Baseline characteristics

The characteristics of the 3 groups are described in Table 1. Compared to the control group (age 40.5 years, 61.4% female) HIV-infected adults ART naïve and on ART were statististically similar in age (38.5 and 42.6 years, p=0.084 and 0.067, respectively), but HIV-infected on ART adults were more likely to be female (76.7%, p=0.002). Other notable differences included a higher prevalence of central obesity, diabetes mellitus and hypertension but a lower prevalence of smoking in the HIV infected patients on ART than the HIV negative control group. HIV-infected, ART-naïve adults had lower mean BMI and

were more severely immunosuppressed (mean CD4 T-cell count 247.6 (184.4) cells/μL vs. 406.6 (197.9) cells/μL in the group on ART). HIV-infected adults on ART had been using ART for a mean of 53.1 (21.6) months.

Cardiovascular Risk

Tables 2 and 3 display the ASCVD and Framingham risk categories, respectively. Stratified lifetime cardiovascular risk was significantly higher in HIV-infected on ART as compared to HIV-negative (Table 2). The proportion of study participants with high lifetime risk according to ASCVD (high risk if >=1 major risk factor) was 52/150 (34.7%) in the HIV-infected adults on ART vs. 26/153 (17.0%) in the control group ($p<0.001$). Additionally, the proportion of participants with high 30-year Framingham risk was significantly greater in the HIV-infected adults on ART as compared to HIV-negative controls (19.3% vs 13.1% respectively, $p=0.047$) when using lipid-based formulas (Table 3). HIV-infected treatment naïve participants had significantly lower ASCVD lifetime and 10-year risk scores ($p=0.04$ and 0.01, respectively). Per ASCVD guidelines, statin therapy was indicated in 28.7% (43/150) of HIV-infected adults on ART, 10.6% (16/151) of HIV-infected treatment naïve adults and 20.3% (31/153) of HIV-negative controls.

Of note, significantly more HIV-infected adults on ART (64/150 [42.7%], $p=0.045$) and fewer HIV-infected ART naïve (26/151 [17.2%], $p=0.004$) adults fit into a “low 10 year/high lifetime” risk category as compared to HIV-negative (48/153 [31.4%]).

Prevalence of Metabolic Syndrome

Significantly more HIV-infected adults on ART had metabolic syndrome compared to HIV-negative controls (Table 4). According to the ASCVD definition, 17/150 (11.3%) HIV-infected adults on ART had metabolic syndrome 5/153 (3.3%) compared to HIV-negative controls ($p=0.01$). Metabolic syndrome as defined by IDF criteria yielded similar results. Of the 17 HIV-infected adults on ART who met the ASCVD criteria for metabolic syndrome 10 met three criteria and two met four criteria. None met high triglyceride criteria. Proportions of those with metabolic syndrome according to ASCVD who met individual criteria were: high blood pressure (15/17 (88.2%)), low HDL (14/17 (82.4%)), high waist circumference (13/17 (76.8%)), and high fasting blood glucose (11/17 (64.7%)). The most common risk factor clusters were the combination of waist circumference, low HDL and high blood pressure (6 of 17) and high glucose, low HDL and high blood pressure (4 of 17). Other clusters of risk factors were equally distributed.

DISCUSSION

In our study, the first to compare long-term ASCVD risk scores in HIV-infected and HIV-negative adults in Africa, the long-term predicted ASCVD risk scores were significantly and consistently higher among HIV-infected adults on ART compared to HIV-negative controls by multiple calculations. More than a third of HIV-infected adults on ART fit into the two highest ASCVD lifetime risk groups, corresponding to a predicted lifetime risk >37%. Similarly, nearly 50% of HIV-infected, on ART study adults had intermediate or high

Framingham 30-year risk as compared to one third of HIV-negative controls. In contrast, predicted 10-year ASCVD risk scores were relatively low and similar in all groups.

HIV-infected, ART naïve adults, on the other hand, had significantly lower long-term predicted CVD risk scores than HIV-uninfected controls. These data seem to indicate that, among HIV-infected African adults, CVD risk profiles increase dramatically in the first 3–4 years of ART, a finding that is supported by our data regarding metabolic syndrome. Longitudinal studies are needed to test this important hypothesis. In addition, this apparent rapid accumulation of CVD risk factors indicates a dynamic population that deserves public health attention. Systems must be put in place to assure that regular screening for CVD risk factors occurs frequently for HIV-infected adults during the first several years of ART. This is particularly important since our prior reports have indicated that very few of these HIV-infected adults on ART had received even basic investigations for hypertension and diabetes [9,27].

It is possible that cardiovascular risk prediction tools underestimate risks in some high-risk groups, specifically in HIV-infected populations who have elevated MI risks [7]. Interestingly, we are the first to report that a significant proportion of HIV-infected adults on ART in our study, a group also proven to have both higher predicted cardiovascular risk and higher cardiovascular outcomes than actually predicted, fit into the category of low 10-year risk but high lifetime risk. This category has been proven to have higher atherosclerotic risk in non-HIV populations [28,29], but has received limited attention in previous studies of CVD disease in HIV adults. The relatively young age of both our study population and HIV-infected African adults in general is of critical importance since age is the factor most strongly weighted in most cardiovascular risk prediction scores. This category of adults will continue to grow in importance as HIV-infected African adults live longer on ART. Further study of this group is urgently needed and may provide a valuable subgroup of HIV-infected patients from which to gain valuable insights into adjustment of current cardiovascular risk models.

Metabolic syndrome was significantly more prevalent in HIV-infected on ART participants in our study as compared to HIV-negative. In addition, we found that 60% of participants in this group exhibit one of only two risk factor cluster groups. High blood pressure was the most commonly associated criteria, with 88% of metabolic syndrome patients exhibiting HTN. This finding suggests that close monitoring of hypertension may provide a simple, effective strategy for metabolic syndrome surveillance in low-resource settings. HIV-infected adults with high blood pressure would then deserve careful investigation for other risk factors.

Our study is also the first to report the prevalence of HIV-negative and positive subgroups in LMIC settings currently indicated for statin initiation for risk factor modification per the recently established ACC/AHA guidelines [20]. We show that according to current guidelines, ~30% of the HIV-infected adults on ART meet criteria for statin therapy. Statins are now available in most developing countries after recent changes in the WHO essential drug list, but the most widely available statin in Africa (simvastatin) is contraindicated in most patients on ART due to drug-drug interactions. Statins with lower risk of drug-drug

interaction (such as pravastatin) should be added to the WHO List of Essential Medicines and made available in HIV clinics in Africa.

Limitations exist in this study. While the similarity of findings between multiple short and long-term risk scores support our findings, it should be noted that these scores may not be accurate in our population. The Framingham risk model in particular, derived from a population of mostly white men in a limited geographic region in the northeastern US, may not be generalizable to our study subjects. Clearly more work is needed to validate existing CVD risk models and/or develop new models for HIV-infected African adults. In addition, while our cross-sectional study generates many interesting hypotheses, longitudinal and interventional studies are now needed to test these hypotheses. Finally, post-partum women were included in this study but we did not record data regarding prior pregnancies. Such data should be included in future studies.

In conclusion, HIV-infected ART treated persons in our Tanzanian study group had a significantly higher lifetime cardiovascular risk compared to HIV-negative adults. In addition, two important high risk subgroups were identified among HIV-infected adults on ART: 1) those with low 10 year/high lifetime CVD risk according to ASCVD guidelines who are currently receiving little preventive attention and 2) particular patterns of metabolic syndrome clustered groups. Nearly 30% of HIV-infected Tanzanian adults on ART had indications to start statin therapy. In addition, CV risk seems to increase rapidly after the time of ART initiation. Together, these findings indicate that HIV-infected African adults deserve careful monitoring for the development of CVD risk factors in the first few years after ART initiation. New CVD risk factors should be treated quickly and aggressively, although care must be taken with regard to possible drug-drug interactions. Further research is needed to determine the best approach to adults with low 10-year but high lifetime CVD risk.

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ABBREVIATIONS

ACC	American College of Cardiology
AHA	American Heart Association
ART	antiretroviral therapy
ASCVD	2013 ACC/AHA ASCVD Risk Estimator Guidelines
ATP	adult treatment panel

BMC	Bugando Medical Centre
CVD	cardiovascular disease
DM	diabetes mellitus
HDL	high density lipoprotein
HTN	hypertension
IDF	International Diabetes Foundation
LDL	low density lipoprotein
OGTT	oral glucose tolerance test
SSA	sub-Saharan Africa
TC	total cholesterol
WHO	World Health Organization

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KEY QUESTIONS

What is already known about this subject?

Data from the US and Europe demonstrate that HIV-infected adults have an increased incidence of myocardial infarction, stroke, and sudden cardiac death; however, data regarding the cardiovascular disease (CVD) risk in African populations is scant. Recently, leading researchers in this field have called for in depth study of risk and risk predictors in the understudied, low and middle income country population.

What does this study add?

We report 10-year, 30-year and lifetime cardiovascular risk scores calculated with Framingham and current ACC/AHA ASCVD guidelines in African HIV-infected patients. Our data is the first to identify that many African HIV-infected patients have a high lifetime risk of CVD, which develops rapidly within the first four years of ART initiation, but do not meet current treatment criteria due to low short-term risk scores.

How might this impact on clinical practice?

We provide clinicians with a newly identified, high-risk subpopulation of HIV-infected individuals in SSA who may be candidates for closer CVD risk factor monitoring. Furthermore, we demonstrate that blood pressure measurement may be an efficient way to screen for metabolic syndrome in severely resource limited settings.

TABLE 1

Baseline characteristics of the 454 Tanzanian adult study participants

Variable n (%) Mean (SD)	HIV-negative Control (n=153)	HIV-infected, ART-naive (n=151)	HIV-infected, on ART (n=150)
Female	94 (61.4%)	89 (58.9%)	115 (76.7%)^
Age (years)	40.5 (11.6)	38.5 (9.6)	42.6 (8.3)
Mode of Transportation			
Walking or bicycle	130 (85.0%)	110 (72.9%)	117 (78.0%)
Motorized vehicle	23 (15.0%)	41 (27.1%)	33 (22.0%)
Current Smoker	5 (3.3%)	4 (2.7%)	0
Body Mass Index (BMI) (kg/m^2)	24.1 (3.6)	22.5 (3.9)	24.8 (4.6)
<18.5 kg/m^2	5 (3.3%)	18 (11.9%)	4 (2.7%)
18.5–24.9 kg/m^2	104 (68.0%)	113 (74.8%)	80 (53.3%)
25–29.9 kg/m^2	33 (21.6%)	9 (6.0%)	45 (30.0%)
≥30 kg/m^2	11 (7.2%)	11 (7.3%)	21 (14.0%)
Waist-hip ratio	0.84 (0.05)	0.85 (0.06)	0.86 (0.06)
Central obesity (ATPIV *)	25 (16.3%)	14 (9.3%)	38 (25.3%)
Central obesity (IDF **)	48 (31.4%)	45 (29.8%)	72 (48.0%)
Current CD4 T-cell count (cells/μL)	NA	247.58 (184.42)	406.63 (197.88)
ART duration * (months)**	NA	NA	53.09 (21.63)
Protease Inhibitor use	NA	NA	18 (12.0%)
Diabetes Mellitus	8 (5.2%)	1 (0.7%)	27 (18.0%)
Hypertension#	25 (16.3%)	8 (5.3%)	43 (28.7%)
Hypertension on treatment	4 (2.6%)	1 (0.7%)	10 (6.7%)

* ATP IV central obesity: Adult Treatment Panel IV, >88cm and >102cm for women and men, respectively

** IDF: International Diabetes Federation, >80cm and >94cm for women and men, respectively

*** ART duration: Antiretroviral therapy duration

Hypertension: systolic >140 mmHg or diastolic >90 mmHg

^ p=0.002 (significant p-values reported for non-modifiable risk factors of age and sex)

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TABLE 2

Stratified lifetime and 10-year ASCVD risk among 454 study participants

Variable	HIV-negative Control (n=153)	HIV-infected ART-naïve (n=151)	p-value vs. control*	HIV-infected on ART (n=150)	p-value vs. control*
	n (%)	n (%)		n (%)	
Stratified lifetime ASCVD risk scores**					
All optimal risk factors#	44 (28.8%)	56 (37.1%)	**0.04 (0.02)**	24 (16.0%)	**<0.001 (<0.001)**
1+ Not optimal risk factor+	54 (35.3%)	63 (41.7%)		43 (28.7%)	
1+ Elevated risk factor^	29 (19.0%)	13 (8.6%)		31 (20.7%)	
1 Major risk factor~	20 (13.1%)	19 (12.6%)		39 (26.0%)	
2+ Major risk factors	6 (3.9%)	0 (0.0%)		13 (8.7%)	
Stratified 10-year ASCVD risk scores					
Low (<5%)	119 (77.8%)	136 (90.1%)	0.10 **(0.01)**	111 (74.0%)	0.60 (0.47)
Intermediate (5–7.5%)	14 (9.2%)	4 (2.7%)		17 (11.3%)	
High (>7.5%)	20 (13.1%)	11 (7.3%)		22 (14.7%)	

* Ordinal regression, using Likelihood ratio test: first p-value is adjusted for age and sex, second (in parentheses) is unadjusted

** Primary outcome

Optimal risk factors include: total cholesterol <4.7mmol/L, untreated blood pressure <120/80mmHg in non-smokers without diabetes

+ Not optimal risk factors include: total cholesterol 4.8–5.1mmol/L, untreated systolic blood pressure 120–139mmHg in non-smokers without diabetes

^ Elevated risk factors include: total cholesterol 5.2–6.1mmol/L, untreated systolic blood pressure 140–159mmHg in non-smokers without diabetes

~ Major risk factors include: treated hyperlipidemia, total cholesterol >6.2mmol/L, treated hypertension, untreated systolic pressure >160mmHg, current smoker, diabetes

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Table 3

Stratified 10-year and 30-year Framingham cardiovascular risk among 454 study participants

Variable	HIV-negative Control (n=153)	HIV-infected ART-naïve (n=151)	p-value vs. control[#]	HIV-infected on ART (n=150)	p-value vs. control[#]
	n (%)	n (%)		n (%)	
Framingham 10-year CVD risk (BMI)					
Stratified					
Low *	131 (85.6%)	143 (94.7%)	0.12	133 (88.7%)	0.13
Intermediate **	16 (10.5%)	5 (3.3%)	**(0.01)**	12 (8.0%)	(0.44)
High ***	6 (3.9%)	3 (2.0%)		5 (3.3%)	
Framingham 10-year CVD risk (lipid)					
Stratified					
Low	138 (90.2%)	142 (94.0%)	0.96	130 (86.7%)	0.053
Intermediate	10 (6.5%)	5 (3.3%)	(0.22)	17 (11.3%)	(0.38)
High	5 (3.3%)	4 (2.7%)		3 (2.0%)	
Framingham 30-year CVD risk (lipid)					
Stratified					
Low	101 (66.0%)	114 (75.5%)	0.31	83 (55.3%)	**0.001**
Intermediate	32 (20.9%)	26 (17.2%)	(0.06)	38 (25.3%)	**(0.047)**
High	20 (13.1%)	11 (7.3%)		29 (19.3%)	
Framingham 30-year CVD risk (BMI)					
Stratified					
Low	97 (63.4%)	108 (71.5%)	0.59 (0.11)	89 (59.3%)	**0.01** (0.45)
Intermediate	34 (22.2%)	29 (19.2%)		36 (24.0%)	
High	22 (14.4%)	14 (9.3%)		25 (16.7%)	

* Low: <10%

** Intermediate: 10–20%

*** High: >20%

#Ordinal regression, using Likelihood ratio test: first p-value is adjusted for age and sex, second (in parentheses) is unadjusted

Table 4

Prevalence of metabolic syndrome according to ASCVD and IDF definitions among 454 study participants

Variable	HIV-negative Control (n=153)	HIV-infected ART-naïve (n=151)	p-value vs. control[#]	HIV-infected on ART (n=150)	p-value vs. control[#]
Prevalence of metabolic syndrome	n (%)	n (%)		n (%)	
ASCVD definition*	5 (3.3%)	3 (2.0%)	0.63(0.49)	17 (11.3%)	**0.04(0.01)**
IDF definition	12 (7.8%)	5 (3.3%)	0.13(0.10)	32 (21.3%)	**0.01(0.001)**

[*] Primary outcome

[#] Logistic regression, using Likelihood ratio test: first p-value is adjusted for age and sex, second (in parentheses) is unadjusted

IDF – International Diabetes Federation – central obesity plus any 2 of the following: HDL <40mg/dL (men)/<50mg/dL(women), systolic blood pressure >=130mmHg, diastolic blood pressure >=85mmHg, fasting blood glucose >=100mg/dL

ASCVD – 2013 American College of Cardiology/American Heart Association ASCVD Guidelines − >=3 of the following: waist circumference >88cm(women)/>102cm(men), triglycerides >=150mg/dL, HDL <50mg/dL(women)/<40mg/dL(men), blood pressure >=130/85mmHg, fasting glucose >=110mg/dL