Estimation of the 10-Year Atherosclerotic Cardiovascular Disease and The Framingham Risk Score Among Adults Living with HIV/AIDS in Addis Ababa, Ethiopia: A Hospital-Based, Observational Study.

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Abstract

Background

With a much improved ART of the present day, most morbidities and mortalities in people living with HIV/AIDS (PLWHA) are associated with factors such as non-infectious diseases (NIDs) in the form of coronary heart disease (CHD). This study aimed at determining the prevalence and predictors of coronary heart disease (CHD) using the 10-year atherosclerotic cardiovascular disease (ASCVD) and Framingham risk score (FRS) tools among PLWHA.

Methods

A hospital-based, observational study was carried out from January 2019 to February 2020 in HIV infected adults. Prevalence of FRS (age 20 to 79) was determined using the National, Heart, Lung and Blood Institute (NHLBI) and prevalence of ASCVD (age 40 to 79) was determined using the peer-reviewed online (ClinCalc.com) tool.

Results

Using the 10-years ASCVD risk estimation 27.3% of the study participants had an elevated risk > 7.5 % CHD. Similarly using the 10-year FRS, 1.4 % had high-risk score of developing CHD. Using multiple linear regression analysis age (β = .061, p < .001), gender (β = .816, p < .001), systolic blood pressure (β = .21, p < .001), total cholesterol (β = .002, p = .001), high density lipoprotein (β = − .02, p < .001), and Tobacco use (β = .559, p < .001) had significant contribution to the risk of CHD using the ASCVD tool, while using binary logistic regression for the FRS tool, gender (OR = 26.105, 95% C.I. [6.110, 111,543], p < 0.001), age (OR = 1.293, 95% C.I. [1.181, 1.415], P < .001), and low HDL-C (OR = 0.887, 95% C.I. [.786, .979], P = 0.19) had significant contribution.

Conclusions

The prevalence of high-risk CHD among PLWHA using the FRS and ASCVD tools were 1.4 & 27.3 percent respectively. In both the tools advanced age, male gender, and low level HDL were significant contributor for the risk of CHD in PLWHA.

Introduction

The Human Immunodeficiency Virus (HIV) - associated morbidity and mortality has declined significantly since the introduction of Antiretroviral Therapy (ART) \(^1\) and the consequent ART use extended the life expectancy of People Living with HIV/AIDS (PLWHA). However, related Cardiovascular Diseases (CVDs) and other non-infectious diseases (NIDs) remain an increasing concern among PLWHA \([1, 2]\). PLWHA showed a number of reported risk factors (RFs) for CVDs \([3–5]\), including age, dyslipidemia, diabetes mellitus (DM); hypertension, family history (FH), sedentary life, cigarette smoking, and cocaine use \([6]\). Heart attacks, strokes and other forms of CVDs are almost doubled in PLWHA compared to people who do not have the retrovirus, even though HIV infection ha been well-managed with combination ART (cART) \([7–9]\).

Estimation of the 10-year Atherosclerotic Cardiovascular Disease (ASCVD) and the Framingham Risk Score (FRS) help to determine the risk of developing stroke and Coronary Heart Disease (CHD) over the period of 10 years \([10]\) and has been considered a reliable, accurate benchmark for assessing cardiovascular risks in the general population \([11]\). Both the ASCVD and the FRS tools make utilization of age, sex, blood pressure (BP), total cholesterol (TC), high density lipoprotein cholesterol (HDLC), diabetes mellitus (DM), and smoking status to determine risks \([2]\). The risks can be classified as low-risk (< 10%), moderate risk (10–20 %), and high-risk (> 20%) in case of FRS \([12]\), while ≥ 7.5% will be considered as an elevated risk in case of ASCVD \([13]\). In most of the body of literatures, the prevalence of FRS has been reported between (b/n) 70–90% for low-risk, b/n 20–30 % for moderate and swings b/n 0–20% for high-risk \([14–17]\), while the overall prevalence of atherosclerosis has been reported as high as 60% among PLWHA \([18]\).

At the moment, when the main guidelines of HIV therapy are predating the point what ART regimen to start; related NIDs have been causing more morbidities and mortalities among PLWHA \([19]\). The present study is aimed at determining the prevalence and predictors of CHD using the 10-year FRS and ASCVD tools among PLWHA.
Methods

Study design, period and setting

This was a hospital-based, observational study conducted during the period of January 2019 to February 2020 among the PLWHA on follow-up care at Zewditu Memorial Hospital (ZMH), Addis Ababa, Ethiopia. ZMH was the first hospital to commence and initiate the subsidized-fee-based scheme ART service in Ethiopia, in July 2003. Currently, there are about 7,674 active adults and around 2,558 children in its follow–up nest [20].

Study population and sample size

All newly registered plus the already existed PLWHA on follow-up care in ZMH formed the study population. Adult PLWHA, age > 18 years, and those who are willing to participate in the study were the target population. Severely ill patients, pregnant, and breastfeeding mothers were excluded from the study.

The following equation was used to calculate the sample size: - Sample size n = [DEFF*Np (1-p)] / [(d2/z21-α/2*(N-1) + p*(1-p) = 286. Where, N (7674) is the total HIV infected population registered for follow-up care and P (≅25%± 5%) is the prevalence for CHD in HIV-infected population obtained from published articles [15]. Considering 10% contingency (lost to follow-up and defaulters), the final sample size of the study became 314.

Research Questions

1. Do HIV infected persons in Ethiopia have a higher prevalence of the estimated 10-year risk of ASCVD and FRS?
2. What are the predictors associated with ASCVD and FRS in this population?
3. What are the risk factors that predispose HIV-infected individuals for predicated stroke and CAD?

Hypothesis

The prevalence, predictors, and risk factors of ASCVD and FRS among HIV infected persons in Ethiopia are not different from other similar studies done globally.

Sampling and enrollment

A systematic random sampling technique was used to recruit study participants. The sample interval (K) was calculated using the formula N/n (7674/314≅24). The first participant was selected using a lottery method from the available patients having an appointment during the first day. Since the numbers of adult ART clinics in the hospital were four; then every six (24/4) volunteer participant was enrolled from each clinic. In cases of negative response, and refusal automatically the next patient was enrolled.

Data collection

Detail Information about the participants was obtained through laboratory tests, clinical examinations/measurements, patient interview, and chart review processes. The questionnaire for a face-to-face interview was adapted from the structured questionnaire used by the WHO stepwise approach to non-communicable disease risk factor surveillance (STEPS-2014) [21]. The questionnaire included information related to socio-demographic characteristics (Age, Gender, Religion, Civil Status, Address, Educational Level, Occupation, Monthly Income), clinical characteristics (Family History of CHD, Viral Load (VL), CD4 Count, Time Since ART Initiated, The WHO Staging, ART Medication Regimen, and Frequency of ART Medication Switch), tobacco use (active, passive and smoking history), alcohol consumption (active, alcohol use history), coffee and khat use.

Data analysis

The data was coded, double-entered, and analyzed using IBM SPSS Statistics 25. All categorical variables were coded as 0 (for female and no responses) and 1 for male and yes responses). The dependent variables for ASCVD was treated as scale measurement and the FRS was treated as a dichotomous coded as 0 for ‘low-risk (< 10%)’ and 1 for ‘high-risk (≥ 10%). A 95% C.I was used and the level of significance for statistical analysis was set at less than 0.05.

Descriptive statistic was used to present and inferential statistics was used to analyze data. A peer-reviewed online tool (ClinCalc.com; ASCVD Risk Calculator: 10-Year Risk of First Cardiovascular Event Using Pooled Cohort Equations - ClinCalc.com) calculator was used to estimate the 10 year risk of ASCVD with granting a prior permission from the company. The tool uses the Pooled Cohort Equations
among patients without pre-existing cardiovascular disease among people aged b/n 40 and 79 years [13]. The National, Heart, Lung, and Blood Institute formula was used to calculate the 10-year FRS.

Multiple linear regression was employed to estimate odds ratio (OR) and the corresponding 95% confidence interval (CI) in case of ASCVD (age 40 to 79 years) and binary logistic regression was used to determine the association of the predictors with the outcome variable in case of FRS (age 20 to 79 years). The following variables were considered to calculate ASCVD: age, gender, race, TC, HDL, systolic BP (SBP), smoking status, and BP medications [13]. Age, gender, lipid profiles, SBP, smoking status, and BP medication were used by the FRS [22].

Results

Enrollment

Initially 314 patients were enrolled, 26 participants were missing from the analysis for various reasons: 2 were discontinued the follow-up due to change of addresses, 4 due to critical illnesses (one due to high blood sugar, three due to high BP), and 10 were defaulter for unknown reasons. Hence, the final sample size for FRS was 288, and for the ASCVD group was 184 (Fig. 1).

Sociodemographic data

Considering the FRS group, female gender was slightly higher 162 (56.2%), and nearly 50% were married, and about a quarter of the sample 62 (21.5%) were divorced. A third of the sample was completed secondary high school (grade 9-12th ) and almost 1/6th of them (12.2%) had no formal education (Table 1). With respect to occupational status, a quarter of the participants were involved in small self-employed business, 10% were jobless, and 4.5 % were students. Regarding addresses of the participants, 94.1% were from Addis Ababa, and majority (2/3rd ) of the participants were from three sub-cities of Addis Ababa; Kirkos 109 (37.8%), Akaki-Kality 58 (20.1%), and Nefas Silk Lafto 38 (13.2%), (Table 1).
Table 1
Sociodemography of the study participants: counts, per cent of a total and cumulative per cent; Zewditu Memorial Hospital, June 2020, Addis Ababa, Ethiopia.

| Socio-demographic          | FRS group (N = 288) | ASCVD group (N = 184) |
|----------------------------|---------------------|-----------------------|
|                            | Counts | % of Total | Counts | % of Total |
| Gender (n = 288)           |        |            |        |            |
| Female                     | 162    | 56.3       | 84     | 45.3       |
| Male                       | 126    | 43.8       | 100    | 54.7       |
| Age (n = 288)              |        |            |        |            |
| 20–34                      | 52     | 18.1       |         |            |
| 35–39                      | 47     | 16.3       |         |            |
| 40–44                      | 55     | 19.1       | 98     | 53.3       |
| 45–49                      | 43     | 14.9       |         |            |
| 50–54                      | 35     | 12.2       | 57     | 31         |
| 55–59                      | 23     | 8.0        |         |            |
| 60–64                      | 21     | 7.3        | 26     | 14.1       |
| 65–69                      | 5      | 1.7        |         |            |
| 70–74                      | 3      | 1.0        | 3      | 1.6        |
| 75–79                      | 1      | .3         |         |            |
| Civil status (n = 288)     |        |            |        |            |
| Never married              | 53     | 18.4       | 23     | 12.5       |
| Married                    | 130    | 45.1       | 91     | 49.5       |
| Divorced                   | 62     | 21.5       | 37     | 20.1       |
| Widowed/r                  | 43     | 14.9       | 33     | 17.9       |
| Educational status         |        |            |        |            |
| No formal education        | 35     | 12.2       | 28     | 15.2       |
| Primary (1-6th grade)      | 65     | 22.6       | 40     | 21.7       |
| Secondary Junior (7-8th grades) | 27 | 9.4       | 16     | 8.7        |
| Secondary High school (9-12th grades) | 96 | 33.3     | 65     | 35.3       |
| College/university diploma | 47     | 16.3       | 23     | 12.5       |
| College/ University Degree/master or above | 18 | 6.3       | 12     | 6.5        |
| Occupational status#       |        |            |        |            |
| Higher-level professional  | 1      | 0.3        | 0      | 0          |
| Higher-level manager and entrepreneur | 1 | 0.3 | 1 | .5 |
| Lower level professional   | 27     | 9.4        | 17     | 9.2        |
| Lower level manager        | 3      | 1.0        | 2      | 1.1        |
| Clerical routine non-manual worker | 11 | 3.8 | 6 | 3.3 |

# Classification is based on ISEC (International Socio-Economic Classes). **LDL = Low Detection Level. Age category for n = 184 (40–49, 50–59, 60–69, 70–79)
| Socio-demographic | FRS group (N = 288) | ASCVD group (N = 184) |
|-------------------|---------------------|-----------------------|
|                   | Counts  | % of Total | Counts  | % of Total |
| Sales and service routine non-manual worker | 1  | 0.3 | 1 | .5 |
| Small self-employed with employee | 11 | 3.8 | 0 | 0 |
| Small self-employed without employer | 71 | 24.7 | 8 | 4.3 |
| Skilled manual worker | 21 | 7.3 | 46 | 25.0 |
| Semi- and unskilled manual worker | 84 | 29.2 | 15 | 8.2 |
| Agricultural laborer | 2 | 0.7 | 55 | 29.9 |
| Retired | 13 | 4.5 | 2 | 1.1 |
| Student | 13 | 4.5 | 0 | 0 |
| Jobless | 29 | 10.1 | 19 | 10.3 |
| Monthly income | | | | |
| \( \leq 100 \text{USD} \) | 215 | 74.7 | 138 | 75 |
| \( >100 \text{USD} \) | 73 | 25.3 | 46 | 25 |
| Address | | | | |
| Addis Ababa | 271 | 94.1 | 3 | 1.6 |
| Gullele | 4 | 1.4 | 7 | 3.8 |
| Arada | 11 | 3.8 | 2 | 1.1 |
| Kolfe | 7 | 2.4 | 2 | 1.1 |
| Addis Ketema | 4 | 1.4 | 19 | 10.3 |
| Nefas Silk Lafto (NSL) | 38 | 13.2 | 77 | 41.8 |
| Kirkos | 109 | 37.8 | 5 | 2.7 |
| Lideta | 8 | 2.8 | 7 | 3.8 |
| Yeka | 16 | 5.6 | 10 | 5.4 |
| Bole | 16 | 5.6 | 39 | 21.2 |
| Akaki-Kality | 58 | 20.1 | 13 | 7.1 |
| Out of Addis Ababa | 17 | 5.9 | 3 | 1.6 |

# Classification is based on ISEC (International Socio-Economic Classes) **54. **\*LDL = Low Detection Level. Age category for n = 184 (40–49, 50–59, 60–69, 70–79)

Considering the ASCVD group, males were predominant 100 (54.7%), and almost 50% were married 91 (49.5%), and about 1/5th (20.1%) were divorced. About 50% were age b/n 40 and 49 years and a third of them were completed secondary high school (grade 9-12th) while 28 (15.2%) had no formal education. With respect to occupational status, a quarter of the participants were involved in skilled manual work, 11.4% were either jobless, or retired. With respect to address, 98.4% were from Addis Ababa and majority of the participants were from NSL 77 (41.8%), Bole 39 (21.2%), and Kolfe 19 (10.3%), (Table 1).

Considering the total study participants (N = 288), the mean age of females was 40.7 ± 10.5 and was 47.1 ± 11.4 for males with an overall mean age of 43.51 ± SD 11.27, and the overall mean age at the time of HIV confirmation was 32.7 ± 11.1, with a mean age of 30.2 ± 10.4 for women and 35.9 ± 11.4 for men. The mean age at the time of ART initiation for women was 31.1 ± 10.6 and 36.8 ± 11.2 for men, with an overall mean age of 33.6 ± 11.2. The mean duration of stay on ART for women was 9.5 ± 4.66 and for men 10.2 ± 4.68, with an overall mean of 9.81 ± 4.67. The overall mean BMI was 23.6 ± 4.26 and mean CD4 count was 468 ± 266. The corresponding value of VL was 11964 ± 56320. Details of the participants’ characteristics are shown in Table 2.
| Characteristics     | Minimum | Maximum | Median | Mean ± Std. Deviation |
|---------------------|---------|---------|--------|-----------------------|
| Gender              | F       | M       | F + M  | F                    | M        | F + M  |
| Age (year)          | 20.0    | 20.0    | 69.0   | 77.0                  | 40.0     | 47.0   | 43.0   | 40.7 ± 10.5 | 47.1 ± 11.4 | 43.5 ± 11.3 |
| Monthly income (in birr) | 0.00   | 0.00    | 10000  | 40000                 | 2000     | 3000   | 2000   | 2177 ± 2029 | 4009 ± 5597 | 2979 ± 4097 |
| Age start (year)    | 7.00    | 7.00    | 63.0   | 65.0                  | 30.0     | 37.0   | 33.0   | 30.2 ± 10.4 | 35.9 ± 11.2 | 32.7 ± 11.1 |
| Total years on ART  | 0.460   | 0.633   | 0.460  | 22.2                  | 22.2     | 9.55   | 12.0   | 11.2    | 9.51 ± 4.66 | 10.2 ± 4.68 | 9.81 ± 4.67 |
| Current weight (Kg) | 33.0    | 39.0    | 93.0   | 120                   | 57.0     | 67.5   | 60.0   | 58.5 ± 11.1 | 68.0 ± 13.0 | 62.7 ± 12.8 |
| Current height (in meter) | 1.44 | 1.50    | 1.44   | 1.71                  | 1.91     | 1.57   | 1.70   | 1.63    | 1.58 ± 0.0594 | 1.70 ± 0.0700 | 1.63 ± 0.0871 |
| BMI (kg²/m²)        | 14.5    | 15.1    | 14.5   | 39.2                  | 35.1     | 23.1   | 23.2   | 23.1    | 23.6 ± 4.26 | 23.6 ± 4.09 | 23.6 ± 4.18 |
| Abd. Circ. (inch)   | 24.0    | 25.0    | 24.0   | 49                    | 49       | 32.0   | 35.0   | 33.5    | 33.4 ± 4.36 | 35.6 ± 4.47 | 34.3 ± 4.53 |
| CD4 (cells/mm³)     | 74.0    | 6.00    | 6.00   | 1294                  | 1406     | 431    | 402    | 410     | 468 ± 266  | 427 ± 244  | 450 ± 257  |
| VL (copies/mL)      | 0.00    | 0.00    | 0.00   | 466201                | 466900   | 0.00   | 0.00   | 0.00    | 11964 ± 56320 | 1301 ± 55092 | 12422 ± 55692 |
| PR (heart-beat/minute) | 47.7  | 60.7    | 47.7   | 123                   | 116      | 123    | 82.7   | 79.7    | 82.0 ± 11.5 | 79.9 ± 10.1 | 82.1 ± 11.1 |
| SBP (mmHg)          | 89.3    | 91.3    | 89.3   | 193                   | 213      | 121    | 128    | 125     | 126 ± 21.3 | 131 ± 22.2 | 128 ± 21.9 |
| DBP (mmHg)          | 54.7    | 61.7    | 54.7   | 117                   | 118      | 80.3   | 83.0   | 81.3    | 81.7 ± 12.5 | 84.5 ± 12.5 | 82.9 ± 11.8 |
| TC (mg/dL)          | 78.0    | 100     | 78.0   | 354                   | 492      | 184    | 185    | 184     | 185 ± 48.5 | 191 ± 55.2 | 187 ± 51.6 |
| LDL-C (mg/dL)       | 21.0    | 33.0    | 21.0   | 306                   | 615      | 117    | 110    | 117     | 117 ± 49.0 | 121 ± 67.4 | 118 ± 57.7 |
| TGs (mg/dL)         | 49.0    | 30.0    | 30.0   | 466                   | 491      | 114    | 153    | 133     | 139 ± 74.2 | 177 ± 98.0 | 155 ± 87.3 |
| HDL-C (mg/dL)       | 21.0    | 21.0    | 21.0   | 69.8                  | 67.0     | 46.0   | 46.0   | 46.0    | 46.5 ± 7.39 | 46.2 ± 8.33 | 46.4 ± 7.80 |
| VLDL-C (mg/dL)      | 14.0    | 7.00    | 7.00   | 229                   | 197      | 22.0   | 26.0   | 24.0    | 26.6 ± 19.4 | 30.2 ± 19.1 | 28.2 ± 19.3 |
| Non-HDL-C (mg/dL)   | 40.0    | 39.0    | 39.0   | 313                   | 451      | 140    | 140    | 140     | 138 ± 49.8 | 144 ± 57.4 | 141 ± 53.2 |
| Fasting Blood glucose (mg/dL) | 60.0 | 45.0    | 45     | 140                   | 319      | 90.0   | 98.0   | 94.0    | 94.6 ± 15.8 | 101 ± 30.5 | 97.3 ± 23.6 |
Clinical characteristics

About 45% of the total study participants were on the WHO staging III, whereas 95.5% were on treatment stage one (T1). About 82% were on first line ART regimen, and 45% were changed their initial first line regimen. About 37% of the participants had CD4 count of ≥ 500 copies/mL, whereas about 76% had CD4 count of LDL ** (< 150), (Table 3). **low detection level.
Table 3
Clinical information of the study participants: counts, percent of total and cumulative percent; Zewditu Memorial Hospital, June 2020, Addis Ababa, Ethiopia.

| Clinical information (n = 288) | Counts | % of Total |
|-------------------------------|--------|------------|
| The WHO clinical staging       |        |            |
| I                             | 40     | 13.9       |
| II                            | 68     | 23.6       |
| III                           | 131    | 45.5       |
| IV                            | 49     | 17.0       |
| Treatment staging             |        |            |
| T1                            | 276    | 95.8       |
| T2                            | 1      | .3         |
| T3                            | 7      | 2.4        |
| T4                            | 4      | 1.4        |
| ART regimen                   |        |            |
| First line                    | 235    | 81.6       |
| Second line                   | 51     | 17.7       |
| Third line                    | 2      | .7         |
| Frequency of ART regimen change|        |            |
| No change from the baseline   | 59     | 20.5       |
| changed once                  | 129    | 44.8       |
| changed twice                 | 80     | 27.8       |
| changed thrice                | 17     | 5.9        |
| changed four times            | 3      | 1.0        |
| ART regimen                   |        |            |
| 2NRTIs + 1INSTI               | 140    | 48.6       |
| 2NNRTIs + 1NNRTI              | 96     | 33.3       |
| 2NRTIs + 1PI                  | 50     | 17.4       |
| 1NRTI + 1NNRTI + 1INSTI + 1PI | 2      | 0.7        |
| CD4 count (cells/mm3)         |        |            |
| <50                           | 5      | 1.7        |
| 51–200                        | 36     | 12.5       |
| 201–500                       | 142    | 49.3       |
| >500                          | 105    | 36.5       |
| VL (copies/mL)                |        |            |
| LDL ** (< 150)                | 219    | 76.0       |
| Low viral load (151–1000)     | 11     | 3.8        |

**LDL = Low Detection Level
Outcome variable

The 10 years ASCVD was calculated and an elevated risk (≥ 7.5 % ASCVD) seen in 27.3%. Similarly, high-risk CHD by using the FRS (> 20 % of FRS) was seen 1.4 % of the participants (Table 4).

### Table 4

| CHD risk estimation tool | Severity category (%) | Frequency | Percent |
|-------------------------|-----------------------|-----------|---------|
| FRS                     | < 10                  | 255       | 88.5    |
|                         | 10–20                 | 29        | 10.1    |
|                         | > 20                  | 4         | 1.4     |
| ASCVD                   | < 7.49               | 133       | 72.3    |
|                         | >/= 7.5              | 51        | 27.7    |

Considering the total study population, individuals with age 40 years and above were at a high-risk of developing CHD even though majority of the study participants were aged below 40 years (Fig. 2). Analysis of the pattern of the ART medication among the study participant revealed that almost half (139, 48.3%) of them were on 1j (TDF + 3TC + DTG) followed by 20.5% on 1e (TDF + 3TC + EFV), 9% on 2i (ABC + 3TC + LPV/r), 5.6% on 1c (AZT + 3TC + NVP), and 5.2% on 2h (TDF + 3TC + ATV/r) (Fig. 3).

Determinants of the outcome variable

A multiple linear regression was used to determine the impact of independent variables on the outcome of the estimated 10-year risk of ASCVD. Fourteen independent variables were entered: Current_Khat_use, TG, Family history of cardiovascular disease, FBG, Current_Alcohol_use, Waist circumference, HDL_C, Age, SBP, Gender, Total cholestrol, and Current_Alcohol_use. The result showed that six of the variables were significant predictors of ASCVD, explaining 86.5% of the variance with F (13, 170) = 84.02, p < .001. When the variables were examined to evaluate their individual contribution to the model, it was found that age (β = .061, p < .001), gender (β = .816, p < .001), SBP (β = .21, p < .001), TC (β = .002, p = .001), HDL (β = − .02, p < .001), and Tobacco use (β = .559, p < .001) made a significant contribution to the model. However, the other eight predictors did not make a significant contribution to the model and were considered non-significant. Details are shown in Table 5.

In the other way, a binary logistic regression was utilized to analyze the impact of predictors of FRS and nine independent variables were entered that include Age, Waist-grid, PR, SBP, DBP, TC, TGs, LDL-C, and HDL-C. The score was coded as 0 for ‘< 10 %’ and 1 for ‘≥ 10 %’ risk scores. The full model containing all the predictors had a statistically significant association, $X^2$ (8; 288) = 46,706, indicating that the model was able to distinguish b/n those with and without the risk of developing CHD using the FRS. The total model explained b/n 42.3 % (Cox and Snell R squared) and 83 % (Nagelkereke R Square) of the variance in the FRS and correctly classified 97.6 % of the cases. Only three of the variables (Age, Gender and HDL-C) made a statistically significant contribution to the model (see Table 6). The strongest predictor for the 10-year FRS was male gender with an OR of 26.1. Male participants had 96.3 % more chance to develop CHD compared to females. The second predictor was Age, with an odds ratio of 1.3, indicating that for every year increment in age, there was a 27% more chance of getting CHD independent of other factors. The third statistically significant predictor for the FRS model was HDL-C, with an odds ratio of 0.877 (less than one), indicating that it has a protective role in CHD. Hence, for every 1-unit decrease of HDL-C in mg/dL, the chance of having CHD was increased by 13%.
## Table 6
Effect of predictor variables on the outcome variable of the coronary heart disease using the 10-year Framingham risk score, Zewditu Meomorial Hospital, Addis Ababa Ethiopia, 2020.

| Predictors                  | OR      | SE      | AOR     | t       | p      | 95.0% Confidence Interval for OR |
|-----------------------------|---------|---------|---------|---------|--------|----------------------------------|
|                             |         |         |         |         |        | Lower Bound | Upper Bound |
| Constant                    | -5.033  | .378    | -13.324 | .000    | .000   | -5.778          | -4.287       |
| Age                         | .061    | .004    | .441    | 14.503  | .000   | .053             | .070         |
| Gender                      | .816    | .067    | .378    | 12.188  | .000   | .684             | .948         |
| Family history of CVD       | -.019   | .089    | -.007   | -.217   | .829   | -.195           | .156         |
| Waist circumference in inch | .011    | .007    | .047    | 1.525   | .129   | -.003           | .026         |
| SBP                         | .021    | .001    | .444    | 14.604  | .000   | .018             | .024         |
| Total cholestrol            | .002    | .001    | .102    | 3.251   | .001   | .001             | .003         |
| TG                          | .000    | .000    | .035    | 1.041   | .299   | .000             | .001         |
| HDL_C                       | -.020   | .004    | -.155   | -5.192  | .000   | -.027           | -.012        |
| FBG                         | .000    | .001    | .004    | .129    | .898   | -.002           | .003         |
| Current_Tobacco_use         | .559    | .155    | .128    | 3.597   | .000   | .252             | .865         |
| Current_Alcohol_use         | -.082   | .124    | -.022   | -.663   | .508   | -.328           | .163         |
| Current_Alcohol_use         | .060    | .064    | .028    | .934    | .351   | -.067           | .187         |
| Current_Khat_use            | -.042   | .185    | -.008   | -.226   | .822   | -.406           | .323         |

**Note.** $R^2 = .865$ (adjusted $R^2 = .855$).

Results of Binary Logistic Regression Analysis using the 10-year Framingham Risk Score as an Outcome Variable.

## Discussion
With a much improved ART of the present day, most morbidities and mortalities in PLWHA has been associated with a number of factors such as NIDs (in most of the cases), especially in the form of CHD [23].

The CHD has become the major factor, limiting life expectancy, and causing death in individuals’ age 45 and above [24]. The etiology of CHD in PLWHA is multifactorial and can be caused with HIV itself but cART and predisposing genetic and environmental RFs can also be the reasons [25].

PLWHA confront high challenges to CHD due to the fact that HIV management by itself is complex and requires lifetime intervention [26]. Since, ASCVD & FRS are the most widely used tools for the CHD risk evaluation, both tools have overlaps of variables to determine the risks of CHD, even though there are some peculiar variations [2, 13, 26].

A number of studies have investigated that the CHD risk in PLWHA using the FRS tool and reported that the extrapolated tool was equally as important to the general population. Some recently published articles favors the use of ASCVD over FRS as a better predictive tool of CHD [2, 13, 27].

The proportion of females was higher using the FRS (56.2%) with overall mean of 43.5 ± 11.3. Whereas, using ASCVD male were predominant (54.3%). Considering the total participants, most participants were age below 40 years while using the ASCVD 50% were in the age range b/n 40 to 49 years.

The intensity of efforts to prevent cardiovascular disease depends on the absolute risk of CHD, which is calculated using either the FRS or the ASCVD equation [28, 29]. Majority 89 (88%) of the participants in the FRS were categorized under low CHD risk, while 29 (10.1%) had moderate and 4 (1.4%) had high-risk for developing CHD. Our study was comparable to the rates reported by some previously conducted studies [14, 15] but it was lower than the studies conducted in Slovenia [15], Uganda [17], and Spain [15]; and our result is
higher than the Norwegian [16] and the Brazilian [30] studies. This variation in the estimation of prevalence could be due to differences in standard care, management, and level of medical care services.

In our study, nearly all women were included in the 10% or less of the 10-year FRS category, but 20% of men had 10% or more long-term risk of CHD. This was in agreement with other studies [15, 24, 26]. To give more emphasis on management, one study reported that even though the CHD was less prevalent among female gender would be more devastating and fatal if it occurs [2].

About 28% of the participants enrolled in the ASCVD group had ≥ 7.5% risks of CHD, which is considered as a more severe form of the disease. This figure was a bit higher than the study conducted in Botswana [31] and Taiwan [32] but lower than the study conducted in Italy [33] & the U.S. [18].

A number of predictors were significantly associated with the estimation of ASCVD in our study. Advanced age was associated with high risk of CHD (β = .061, p < .001). This result was comparable with a number of other studies done globally [34–36].

It is also widely accepted that male gender was prone to develop CHD than females due to a number of inherited (genetics, sex hormones) and environmental (CHD predisposing risk practices like cigarette smoking and working industrial zones) factors [37]. This evidence was in agreement with our findings that the risk was more pronounced in male gender (β = .816, p < .001). Similar findings were obtained from studies supporting our result [36, 38]. One study reported that the lifetime risk of CHD at age 40 years is 50% for men and 33.3 % for women [36].

A number of research outputs reported that hypertension is an important RF for cardiac, cerebrovascular and other form of vascular diseases [39, 40] and the occurrence of hypertension and CHD has been common [41]. In our study an increase in SBP was associated with increased risk of CHD (β = .21, p < .001), which was also comparable with other similar studies [42–44].

Dyslipidemia is considered as the most frequent RF for CHD as reported in many resources [44, 45]. In our study an increased in TC was associated with CHD (β = .002, p = .001), while a decrease in the level of HDL was also associated with increased risk of CHD (β = −.02, p < .001). This result was well balanced with other reports [46–48]. The reports further stressed that a raised TC has been a strong risk predictor for CHD, with evidence of a small, but stronger effect in men compared to women. Increased in HDL level has been reported as a protective for CHD in many studies [46, 49].

The association of tobacco consumption with CHD have been reported in a number of scientific literatures [50, 51]. Our study revealed that cigarette smoking irrespective of duration and amount of cigarettes used, was significantly associated with the risk of CHD (β = .559, p < .001). The result was in agreement with multiple studies resources [51–53].

With respect to the FRS group, the strongest predictor was gender (OR = 26.1). Male participants had 96.3% more chance of developing CHD unlike of females. This was in line with various studies done elsewhere [24, 26, 54]. Age was also a strong predictor of CHD (OR = 1.3), indicating that for every year increment in age, the risk of acquiring CHD increased by 27%. Our study further revealed that, the overall risk of developing CHD was higher among individuals age 40 and above. This was in agreement with a number of scientific sources that stated an increased in age was associated with increased risk for CHD [24, 55–57].

Low level HDL-C was also associated with increased CHD using the FRS tool (OR = 0.877), demonstrating that for every unit of increase in the plasma HDL-C level, the chance of acquiring CHD was decreased by 13%. This was in harmony with other similar studies [58–60]. Decreased levels of HDL has been recognized as an independent risk factor for adverse cardiovascular outcomes in general population and it was also shown to be true in HIV-infected individuals, irrespective of other risk factors [61]. The protective role of HDL-C was publicized with its inverse relationship with the FRS, which once again was well-matched with the study done in Spain and in Uganda [14, 24].

Limitations Of The Study

These findings may not be representative of the entire population but can serve as a baseline to initiate further large-scale studies in PLWHA.

Conclusions
The prevalence of high-risk CHD among PLWHA using the FRS (age 20 and above) was 1.4 % and using ASCVD (age 40 to 79 years) tool, it was 28%. Using both ASCVD and FRS tools advanced age, male gender, and low level HDL were associated with an increased risk of CHD in HIV infected population. Additionally, in individuals age 40 and above, SBP and TC were associated with the risk of CHD.

**Recommendations**

Life style modification to settle down the risk of CHD with advanced age, risk factors, and therapeutic conditions should be considered as part of the routine clinical care practice. Healthy diet, medical check-ups, exercise, and proper adherence to medical advices are highly recommended. A multinational, multicentre study with larger sample size and follow-up period is recommended.

**Declarations**

**Ethical statement**

The study was approved by - 1) the Muhimbili University of Health and Allied Sciences, Office of the Director of Research and Publications (Ref. No. 2018-04-23/AEC//Vol. XII/88), Dar el Saalam, Tanzania. 2) Addis Ababa University, School of Pharmacy, Ethical Review Board (ERB/SOP/41/11/2018), Addis Ababa, Ethiopia. 3) Addis Ababa University, College of Health Sciences, Institutional Review Board (IRB, Meeting number 08/2018), Addis Ababa, Ethiopia. 4) City Government of Addis Ababa Health Bureau, Ethical Clearance Committee (Ref no. A/A/HB/344438/227), Addis Ababa, Ethiopia; was carried out in accordance with the tenets of the Declaration of Helsinki. Patients provided written informed consent prior to their participation in the study.

**Consent of publication**

Not applicable.

**Availability of data and materials**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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**Authors contribution**

MA: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Writing - Review & Editing, Project administration, Funding acquisition; OM: Supervision, Conceptualization, Methodology, Formal analysis, Investigation, Writing - Review & Editing; WS: Supervision, Funding acquisition; AS: Data Curation, Writing - Review & Editing; EE: Supervision, Conceptualization, Methodology, Formal analysis, Investigation, Writing - Review & Editing

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Figures

Figure 1

Enrollment, Screening, and Follow-up.

![Figure 1: Enrollment, Screening, and Follow-up.](image)

Figure 2

![Figure 2](image)
The 10-year Framingham risk score classification based on age among participants enrolled in the study, Zewditu Memorial Hospital, June 2020, Addis Ababa, Ethiopia.

Figure 3

Pattern of current ART regimen among participants enrolled in the study, Zewditu Memorial Hospital, June 2020, Addis Ababa, Ethiopia.

*Others: 2f (1.7%), 2g (1%), 2e (0.7%), 3b (0.7%), 1h (0.3%)