Changes in Lipid Profiles of HIV+ Adults over Nine Months at a Harare HIV Clinic: A Longitudinal Study

Danai Tavonga Zhou,1,2 Doreen Nehumba,3 Olav Oktedalen,4 Princess Marange,2 Vitaris Kodogo,2 Zvenyika Alfred Gomo,5 Tonya M. Esterhuizen,6 and Babill Stray-Pedersen1

1Institute of Clinical Medicine, University in Oslo, Oslo University Hospital, P.O. Box 1171, Blindern, 0318 Oslo, Norway
2Department of Medical Laboratory Sciences, College of Health Sciences, University of Zimbabwe, P.O. Box AV178, Avondale, Harare, Zimbabwe
3Division of Community Health, Faculty of Medicine and Health Sciences, Stellenbosch University, Francie van Zijl Drive, Tygerberg, Cape Town 7505, South Africa
4Department of Infectious Diseases, Oslo University Hospital, P.O. Box 4950, Nydalen, 0424 Oslo, Norway
5Department of Chemical Pathology, College of Health Sciences, University of Zimbabwe, P.O. Box AV 178, Avondale, Harare, Zimbabwe
6Centre for Evidence-Based Health Care, Faculty of Medicine and Health Sciences, Stellenbosch University, Francie van Zijl Drive, Tygerberg, Cape Town 7505, South Africa

Correspondence should be addressed to Danai Tavonga Zhou; d.t.zhou@medisin.uio.no

Received 30 September 2015; Revised 12 January 2016; Accepted 8 February 2016

Academic Editor: John Voss

Copyright © 2016 Danai Tavonga Zhou et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

HIV infection, together with ART, is associated with changes in biochemical, metabolic parameters and lipid profiles. The aim of this study was to compare changes in lipid profiles among HIV positive outpatients over nine months. 171 patients were investigated, 79% were ART experienced, and 82% of ART experienced patients were on NVP/EFV first line at baseline, but some patients changed ART groups over follow-up and classification was based on intent to treat. More than 60% ART naïve and ART experienced patients had some form of dyslipidemia either at baseline or at follow-up, but mean lipid values for the two groups were within normal limits. At baseline and follow-up, mean levels of TC and HDL were slightly higher in the ART experienced group. Interestingly, there was higher increase in HDL over time in the ART negative group compared to the ART positive group. There was a decrease in TC/HDL ratio in both groups over time, suggesting a reduction in calculated risk of CHD over time. HIV positive patients frequently show various forms of dyslipidemia, but there are no changes in average atherogenic lipid levels and results suggest reduced risk of CHD, mainly due to increases in HDL, after nine months of observation time.

1. Introduction

To date, HIV remains a major public health threat in Africa as a whole and in Zimbabwe alone where prevalence of HIV-infected adults is 14.4% [1, 2]. Though HIV infection and antiretroviral therapy (ART) are often associated with a variety of changes in biochemical and metabolic parameters including changes in lipid profiles, ART regimens have revolutionized the care and management of acquired immune deficiency syndrome (AIDS) due to HIV and have transformed the disease from a life-threatening infection into a chronic and manageable condition [1, 3].

Whilst ART does not cure AIDS and is therefore taken for life, it reduces morbidity and mortality, if used appropriately [1, 3]. The national ART program in Zimbabwe began in April 2004, and since that time the benefits of such therapy have been widely documented in the country [4]. Current World Health Organization and 2013 antiretroviral guidelines for Zimbabwe recommend a preferred first-line regimen for adults, adolescents, and older children of
two nucleotide/nucleoside reverse transcriptase inhibitors
(NRTIs), for example, tenofovir (TDF) and lamivudine (3TC)
together with nonnucleotide/nucleoside reverse transcriptase
inhibitor (NNRTI), for example, efavirenz (EFV) and nevi-
rapine (NVP) and a second-line ART regimen of boosted
protease inhibitor (PI) supported by NRTIs [4–6].

Infection with HIV impairs the reverse cholesterol
transport (RCT) process in macrophages and monocytes;
hence clinical observations have documented dyslipidemia
in patients with AIDS and symptomatic HIV infection.
The earliest alterations recognized, in terms of disease stage,
are decreases in high density lipoprotein (HDL) and low
density lipoprotein (LDL) concentrations [7]. Further clinical
observations, results of clinical trials, and results of studies in
healthy adult volunteers have documented metabolic effects
on lipid metabolism by NRTIs, NNRTIs, and PIs [8, 9].
NRTIs are associated with alterations in body fat deposition
and metabolic alterations, due to drug accumulation within
adipocytes resulting in mitochondrial dysfunction [10]. On
the other hand, NNRTIs such as efavirenz (EFV) and nevi-
apine (NVP) [9, 11] have been associated with favourable
lipid profiles. In particular, ART regimens containing NVP
are associated with a better lipid profile, mainly because they
provide higher serum concentrations of HDL [12]. Patients
who use PIs for a long period of time, however, frequently
present with hypertriglyceridemia, elevated concentrations
of LDL, and reduced HDL levels, all of which are atherogenic
changes [13–15].

In the 987 Home Based Aids Care Program [16] a study of
374 patients was carried out in Uganda; mean serum lipid
concentrations of TC, LDL, and HDL increased after 24
months of NVP/EFV treatment, in agreement with an Indian
study showing an increase in TC and TG levels after 20
months on NVP/EFV regimens. Furthermore, a multicenter
study from Madrid showed an increase in TC after 12-month
 treatment with PI-based drug regimen comprising lopinavir
and ritonavir (LPV/RTV) [16–18].

Clinicians offering health care to HIV positive patients
need to be aware of the various clinical and biochemical
presentations and hence to keep a high level of suspicion.
Due to the presence of contradicting study results, it is not
clear where the Zimbabwean population stands with regard
to changes in lipid profiles in patients on different ART
regimens, over time. In the current era of HIV infection
and ART, knowing patients’ risk and acting to reduce it are
imperative to long-term survival. The aim of this longitudinal
study was to determine and to compare the changes in
lipid profiles in ART experienced and ART naïve patients
previously described at baseline [19] after nine months
later. Demographic and clinical data were as follows: age, sex,
marital status, health status, clinical history, and family
history were collected at baseline [19]. Blood samples in
plain tubes were collected at baseline and nine months later,
separated and stored at −80°C, and then thawed once before
analysis.

2.2. Ethical Considerations. Ethical clearance to carry out the
study was granted by the Joint Research Ethics Committee of
the University of Zimbabwe College of Health Sciences and
Parenyawata Group of Hospitals (JREC) (173/11), Medical
Research Council of Zimbabwe (MRCZ) (MRCZ/B/352), and
Norwegian Research Ethics Committee (REK) (2012100).
Permission to access patient samples and data was granted
by the clinic research committee after they were satisfied that
the research protocol would not interfere with the usual clinic
practice.

2.3. Quantitative Determination of Lipids. TC, HDL, and LDL
were measured enzymatically in serum in a series of coupled
reactions as described earlier [19].

2.4. Statistical Analysis. Stata® version 13 (StataCorp, Texas)
was used to analyse the data. A P value < 0.05 was consid-
ered as statistically significant. Baseline continuous, normally
distributed variables were compared between the two inde-
pendent groups using t-tests, and categorical variables were
compared using Pearson’s chi square tests while binomial
results at the two time points were compared by McNe-
mar’s chi square tests using the exact binomial probabilities.
Generalised linear models for the change in outcome values
over time were constructed for each lipid (cholesterol, HDL,
LDL, and TC/HDL ratio) whilst independent variables tested
included ART history, sex, age, and BMI at baseline. The
models used robust standard errors to adjust for the clus-
tering in repeated measures of patients at two time points.
The interaction between time and ART history was tested,
and, if statistically significant, remained in the model and
was interpreted rather than the main effects of time and ART
history. Dyslipidemia was determined as TC > 5.2 mmol/L,
HDL < 1.1 mmol/L, LDL > 3.2 mmol/L, and TC/HDL ratio
> 4.5, according to National Cholesterol Education Program,
Adult Treatment Panel III (NCEP ATPIII) guidelines [20].

3. Results and Analysis

3.1. Demographics of Participants. 215 HIV-infected adults
were included in the study at baseline [19], 171 (79%) were
accessed at follow-up, four (2%) had died due to AIDS-
defining illnesses before follow-up, six (3%) transferred from
the clinic, 25 (12%) were lost to follow-up at the clinic for
unknown reasons, and nine (4%) had incomplete follow-up
data. Patients who were eventually declared as lost to follow-
up for unknown reasons were aware that they were required
to attend the study for a second visit and when tracked by
telephone, they declined most likely due to fear of stigma
associated with HIV in many populations of the world [6] or
economic reasons associated with low income in this study
population [19].

2. Materials and Methods

2.1. Study Design, Study Site, and Recruitment. This was a
cohort prospective observational study. Documented HIV-
infected patients aged 18 years and above who attended
the HIV treatment clinic in Harare between March and
August 2013 were consecutively recruited into the study after
giving informed consent [19] and followed up nine months

Biochemistry Research International
Table 1: Demographics of participants (N = 171).

| Variable                  | ART− (n = 23) | ART+ (n = 148) | Total   | P     |
|---------------------------|---------------|----------------|---------|-------|
| Age/years Mean ± SD       | 36.4 ± 11.2   | 41.2 ± 10.2    | 40.5 ± 10.4 | 0.0417∗ |
| Sex                       |               |                |         |       |
| Male/n (%)                | 6 (17.1)      | 29 (82.9)      | 35 (20.5) | 0.473∗∗ |
| Female/n (%)              | 17 (12.5)     | 119 (87.5)     | 136 (79.5) |        |
| ART use at baseline       | 23            | 148            | 171     |       |
| NVP/EFV first line        | —             | 126 (85.2%)    |         |       |
| ZDV/STV first line        | —             | 11 (7.4%)      |         |       |
| PI-based second line      | —             | 11 (7.4%)      |         |       |
| Earnings in USD mean ± SD | 126.0 ± 143.3 | 147.8 ± 190.2  | 144.9 ± 184.4 | 0.5995∗ |
| BMI mean ± SD             | 23.5 ± 4.0    | 24.8 ± 4.9     | 24.6 ± 4.8 | 0.2344∗ |
| SBP mean ± SD             | 125.0 ± 18.8  | 125.9 ± 18.9   | 125.8 ± 18.8 | 0.8154∗ |
| DBP mean ± SD             | 81.9 ± 18.8   | 81.7 ± 15.0    | 81.7 ± 15.5 | 0.9558∗ |

Note: level of significance is set at P < 0.05; ∗ t-test comparison of means; ∗∗ Pearson chi-squared test; SD: standard deviation; BMI: body mass index; SBP: systolic blood pressure in mmHg; DBP: diastolic blood pressure in mmHg; ART−: antiretroviral therapy naïve at baseline; ART+: antiretroviral therapy experienced at baseline; NVP: nevirapine; EFV: efavirenz; ZDV: zidovudine; STV: stavudine; PI: protease inhibitor.

Table 2: Generalised linear model for total cholesterol.

| Coefficient | Robust standard error | P     | 95% confidence interval |
|-------------|-----------------------|-------|------------------------|
|             |                       |       | Lower | Upper |
| Follow-up versus baseline | −0.079 | 0.179 | 0.658 | −0.430 | 0.271 |
| ART experienced versus ART naïve | 1.436 | 0.321 | <0.001 | 0.807 | 2.065 |
| Interaction between time and ART | −0.645 | 0.200 | 0.001 | −1.036 | −0.253 |
| Males versus females | 0.094 | 0.157 | 0.550 | −0.214 | 0.401 |
| Age (years) | 0.028 | 0.007 | <0.001 | 0.015 | 0.042 |
| Body mass index at baseline | 0.023 | 0.012 | 0.062 | −0.001 | 2.028 |
| Constant   | 1.839                 |       |         |         |       |

Note: standard error adjusted for 215 clusters in study ID at baseline; ART: antiretroviral therapy, significant P < 0.05.

There was no difference in sex, marital status, employment status, mean earnings, and mean body mass index (BMI) between the ART naïve and ART experienced patients at baseline and follow-up (Table 1). However, based on baseline data, ART experienced patients were generally older than the ART naïve patients and the majority of the participants were women [19]. Most of the patients were on first-line ART comprising mainly TDF/NVP/3TC and TDF/EFV/3TC while very few (7.4%) were on PI-based second-line regimen, at baseline (Table 1). 20% of ART+ patients had switched drugs to either alternative first-line or second-line drugs and 8% of ART− patients had started ART before second visit. More ART experienced patients than ART naïve patients, classified using intent-to-treat, were on treatment for hypertension, both at baseline [19] and at follow-up nine months later.

By comparing baseline and follow-up data, average TC and HDL levels were significantly higher in ART experienced patients than in ART naïve patients while there was no difference in the mean LDL levels. Specifically, mean TC level of ART experienced patients was on average 1.44 mmol/L higher than for those who were ART naïve, at follow-up (P < 0.001), after controlling for sex, age, and baseline BMI as confounders (Table 2). However, those on ART showed a highly significant rate of decrease in TC over time compared with those who were ART naïve (P = 0.001, Table 2).

At follow-up ART experienced adults, the majority of whom were on NVP/EFV first line, had an average HDL level which was 0.603 mmol/L higher than those who were ART naïve (P < 0.001) after controlling for baseline diastolic blood pressure and BMI. Those who were ART naïve increased their HDL values over time at a significantly higher rate than those who were on ART (P = 0.002).

Also at follow-up patients on ART had LDL level which was on average 0.146 mmol/L higher than those who were ART naïve, but the difference was not statistically significant (P = 0.405) after controlling for baseline systolic blood pressure. There was no significant interaction between time and group, but there was an increase in the LDL values in the ART naïve patients while a decrease in the ART experienced patients was observed.

Of note, there was an overall decrease in TC/HDL ratio in both groups over time, which was, however, not different
Table 3: Comparison of lipid variables of ART naïve and ART experienced patients at baseline and follow-up.

|                          | ART naïve (n = 23) | ART experienced (n = 148) | Total (N = 171) | P*  |
|--------------------------|--------------------|---------------------------|------------------|-----|
| Baseline TC/mmol/L       | Mean 3.8           | Mean 4.7                  | Mean 4.6         | 1.2 | <0.001 |
|                          | SD 0.8             | SD 1.2                    | SD 1.2           |     |       |
| Baseline HDL/mmol/L      | Mean 1.0           | Mean 1.3                  | Mean 1.2         | 0.4 | <0.001 |
|                          | SD 0.2             | SD 0.4                    | SD 0.4           |     |       |
| Baseline LDL/mmol/L      | Mean 2.3           | Mean 2.7                  | Mean 2.6         | 2.2 | 0.376  |
|                          | SD 1.2             | SD 2.2                    | SD 2.1           |     |       |
| Baseline TC/HDL ratio    | Mean 4.0           | Mean 4.0                  | Mean 4.0         | 1.3 | 0.818  |
|                          | SD 1.2             | SD 1.3                    | SD 1.3           |     |       |

Note: SD: standard deviation; level of significance is set at P < 0.05; *P from t-test comparison of means; **P from comparisons using generalised linear models (GLM) time * group estimates. Mean values, for all 171 patients with complete baseline and follow-up data; TC: total cholesterol; LDL: low density lipoprotein cholesterol; HDL: high density lipoprotein cholesterol; ART: antiretroviral therapy.

Table 4: Comparison of patients with dyslipidemia at baseline and follow-up.

| Type of dyslipidemia | Baseline ART history | Nine-month follow-up ART history |
|----------------------|----------------------|----------------------------------|
|                      | ART naïve (n = 23)   | ART experienced (n = 148)        | Total (N = 171) | P*  |
| Elevated TC/n (%)    | 1 (4.4%)             | 55 (37.2%)                       | 56 (32.8%)      | 0.020 |
| Depressed HDL/n (%)  | 17 (73.9%)           | 77 (52.0%)                       | 94 (55.0%)      | 0.050 |
| Elevated LDL/n (%)   | 5 (21.7%)            | 34 (23.0%)                       | 39 (22.8%)      | 0.896 |
| Elevated TC/HDL ratio/n (%) | 6 (26.1%) | 35 (23.7%)                       | 41 (24.0%)      | 0.799 |
| Dyslipidemia/n (%)   | 19 (82.6%)           | 117 (79.1%)                      | 136 (79.5%)     | 0.694 |

| Type of dyslipidemia | Baseline ART history | Nine-month follow-up ART history |
|----------------------|----------------------|----------------------------------|
|                      | ART naïve (n = 23)   | ART experienced (n = 148)        | Total (N = 171) | P** |
| Elevated TC/n (%)    | 0 (0%)               | 23 (15.9%)                       | 23 (13.7%)      | 0.040 |
| Depressed HDL/n (%)  | 9 (39.1%)            | 69 (46.6%)                       | 78 (45.6%)      | 0.502 |
| Elevated LDL/n (%)   | 2 (34.8%)            | 30 (20.3%)                       | 38 (22.2%)      | 0.119 |
| Elevated TC/HDL ratio/n (%) | 2 (88.70%) | 17 (11.6%)                       | 19 (11.2%)      | 0.685 |
| Dyslipidemia/n (%)   | 14 (60.9%)           | 96 (64.9%)                       | 110 (64.3%)     | 0.710 |

Note: SD: Standard deviation; level of significance is set at P < 0.05; *P from t-test comparison of means; **P from McNemar chi square tests for paired data by time of visit; cutoff values according to NCEP guidelines [20]: elevated TC > 5.2 mmol/L, depressed HDL < 1.1 mmol/L, elevated LDL > 3.2 mmol/L, and elevated TC/HDL ratio > 4.5.

between the groups. There was no overall difference between the groups in terms of this outcome (0.841) after adjustment for age and baseline BMI (Table 3).

Nineteen out of twenty-three (83%) of ART naïve patients compared to 79% (n = 117) of ART experienced patients (P = 0.694) had some form of dyslipidemia, at baseline (Table 4), when classified by absence or presence of any one of the characteristics of the National Cholesterol Education Programme Adult Treatment Panel III [20] for TC, LDL, HDL, and TC/HDL ratio. At follow-up, there was still no difference in frequency of dyslipidemia when the two groups were compared (61% against 65%, P > 0.05). By comparing data as matched pairs at baseline and nine months, respectively, there was no significant difference in the proportions of patients with overall dyslipidemia over nine months for ART naïve patients, P = 0.064, but a significant drop in the frequency of ART experienced patients with dyslipidemia (~14.2%, P < 0.001) (Table 5).

The prevalence of ART naïve patients with elevated TC (>6.21 mmol/L) showed a slight decrease from one
Table 5: Changes in frequency of patients with lipid derangements over 9 months.

| ART history                        | ART naïve | ART experienced | Total     | P**  |
|------------------------------------|-----------|-----------------|-----------|------|
| Change in frequency of patients with elevated TC over nine months | −4.4%, $P^* = 1.000$ | −23.5%, $P^* = 0.281$ | −16.9%, $P^* = 0.2288$ | 0.002 |
| Change in frequency of patients with depressed HDL over 9 months | −34.8%, $P^* = 1.000$ | −5.4%, $P^* < 0.001$ | −9.3%, $P^* < 0.001$ | <0.001 |
| Change in frequency of patients with elevated LDL over 9 months | +13.1%, $P^* = 1.000$ | −2.6%, $P^* < 0.001$ | −0.6%, $P^* < 0.001$ | 0.092 |
| Change in frequency of patients with elevated TC/HDL ratio over 9 months | −17.4%, $P^* = 0.688$ | −12.1%, $P^* = 1.000$ | −12.7%, $P^* = 0.7552$ | 0.143 |
| Change in frequency of patients with dyslipidemia over 9 months | −21.7%, $P^* = 0.064$ | −14.2%, $P^* < 0.001$ | −15.2%, $P^* < 0.001$ | 0.286 |

Note: SD: standard deviation; level of significance is set at $P < 0.05$; $^*P$ from McNemar chi square tests for paired data by time of visit; $^{**}P$ from McNemar chi square tests for paired data by ART groups; cutoff values according to NCEP guidelines [20]: elevated TC > 5.2 mmol/L, depressed HDL < 1.1 mmol/L, elevated LDL > 3.2 mmol/L, and elevated TC/HDL ratio > 4.5.

patient to none (Tables 4 and 5), and the proportion of ART naïve patients with elevated LDL and depressed HDL (>1.1 mmol/L) showed slight decreases which did not reach statistical significance (Table 5). A similar pattern was observed for ART$^+$ patients: there were slight decreases in prevalence of hypercholesterolemia as measured by TC, 37.2% (n = 55) at baseline versus 15.9% (n = 23) at follow-up, $P = 0.281$. For ART positive patients, proportions of patients with depressed HDL and elevated LDL however decreased significantly over the nine months of follow-up, $P < 0.0001$ (Table 5). The elevated TC/HDL ratios, a measure of coronary heart disease risk, showed a decrease over time in both patient groups (Tables 4 and 5).

4. Discussion

In this HIV population study the serum levels of TC, HDL, LDL, and calculated TC/HDL ratio in both ART naïve and ART experienced patients were all within physiological levels (Table 1). However, many of the patients had some form of dyslipidemia which implies an increased risk to the development of coronary heart disease in these patients. At baseline 83% of ART naïve and 79% of ART experienced patients had evidence of some form of dyslipidemia and the high prevalence remained at follow-up nine months later.

Comparing the lipid levels by ART experience showed a significant difference in serum TC and HDL at baseline [19] and follow-up (Table 2). Average serum TC and HDL concentrations were significantly higher in the treated group at baseline and at follow-up nine months later, while there was no difference in LDL and TC/HDL ratios between the two groups (Table 2). Interestingly, TC decreased over time while HDL increased over time; the ART positive patients showed more rapid decrease in TC and less rapid increase in HDL than the ART negative patients. The higher levels of TC in treated patients are worrying because prolonged elevated levels of TC (and LDL) increase the development of atherosclerosis [21].

Our finding is partly consistent with the findings from the Multicenter AIDS Cohort Study (MACS), a multicenter prospective cohort study of men in four locations of the USA. In the MACS study ART initiation was associated with increases in TC, LDL, non-HDL, and TC/HDL ratio. The atherogenic lipid profiles occurred shortly after ART initiation and lent support to the recommendation for baseline and serial lipid measurements as a standard of care in the management of HIV treatment [22]. Of note is that at baseline in our longitudinal study the ART positive patients had already been on their combined antiretroviral treatment for mean of 3.5 years [19] while the ART negative patients were still naïve of antiretroviral treatment, at study baseline. Although the degree to which serum lipid abnormalities contribute to the risk of cardiovascular events in HIV-infected persons is not well established, low HDL level in an untreated patient is of particular concern as this lipid abnormality is least amenable to pharmacological therapy. Encouragingly, in our study the average HDL level increased in both groups at follow-up, in contrast to reports from the MACS study, which reported persistence of reduced HDL level after ART [22]. HDL increased more rapidly in the ART negative group, in our study, which is surprising as we expected steeper increase in the ART positive group. Could HDL increases in ART naïve patients be due to improved medical care and dietary improvements as the clinic offers supplements to patients from disadvantaged backgrounds? This requires further enquiry, bearing in mind that low HDL levels have previously been associated with longer duration of HIV infection and higher levels of HIV RNA in circulation [10] and we have previously reported that the duration of HIV infection was longer in ART positive patients [19]. It is however difficult to make definite conclusions as data on viral loads and CD4 counts was not available.

When using NCEP guidelines for defining dyslipidemia there were some interesting findings when comparing the two patient groups over time. There was a reduction in prevalence of ART positive patients with depressed HDL and elevated LDL over the nine months of follow-up, whilst proportions of ART naïve patients with depressed HDL, elevated LDL, and elevated TC remained the same. This is suggestive of decreased prevalence of high risk of coronary
heart disease in ART positive group due to HDL recovery and unchanged prevalence of high risk in ART naïve patients over time, considering that high risk is associated with elevated TC and low HDL in the general population, over time [20].

In the study of rural Ugandans with advanced HIV disease initiating NVP- or EFV-based ART there were infrequent elevations in TC, LDL, and TG at baseline and after 24 months of therapy [23]. Increases in HDL levels were substantial and proportionally greater than increases in TC or LDL levels. The risk of coronary heart disease and how it was affected by lipid changes in this rural African population was not investigated but is expected to be low. Any differences between these findings and those of the current study could be due to variations in race/ethnicity, dietary, environmental, lifestyle factors, and different study designs [24, 25].

In agreement with our study results, an earlier Zimbabwean longitudinal study on DART patients over forty-eight weeks reported low levels of TC, LDL, and Tgs at baseline (time of switch to second-line, after 2.2 years on first-line ART). After approximately forty-eight weeks of second-line ART, however, patients were reported to have marked increases in lipid levels, although TC/HDL ratios remained unchanged. Higher proportions of patients at follow-up compared to proportions at baseline had TC and LDL levels that were greater than normal, whereas lower proportions of patients had depressed HDL, $P < 0.001$. There was no difference in proportions of patients with elevated TG and elevated TC/HDL, $P > 0.15$, suggesting no increase in prevalent risk of coronary heart disease over the forty-eight weeks of follow-up [26]. In a South African longitudinal study TG and cholesterol levels increased significantly in patients on stavudine-based first line [27]. Stavudine is however rarely used in our study clinic so comparison of our results with this South African study is limited.

5. Conclusion

In conclusion, this present study does confirm that HIV positive patients, either ART negative or ART positive on NVP/EFV first-line regimen, show dyslipidemia, although some changes over time are beneficial. There is still a need of monitoring the lipid levels routinely in HIV patients who are either ART naïve or on first-line ART considering that the Zimbabwean HIV-infected population is getting older and steadily increasing its risk of coronary heart disease.

6. Limitations

Although the present study has reported relationships between HIV positivity, ART exposure, and dyslipidemia, the observational nature of the present study prevents an establishment of causal relationships between the HIV infection, the various ART drug regimens, dyslipidemia, and final coronary heart disease. The study could also not provide evidence for changes in lipid and coronary heart disease risk according to type of ART, mainly due to small sample size of the groups on EFV-based first line and PI-based second line as small sample sizes lead to imprecise estimations.

7. Recommendations

The study size needs to be larger to be more representative of the Zimbabwean population, improve power of study, and reduce type II errors, so as to confirm the findings in this study. A longer longitudinal study on a larger population that takes note of both viral loads and CD4 counts, together with the clinical and biochemical measures, will provide stronger evidence linking HIV and ART to dyslipidemia and coronary heart disease. This evidence is urgent in Zimbabwe as the HIV-infected population not only survives longer, but also is rapidly aging and hence is more at risk of coronary heart disease.

Conflict of Interests

The authors declare that there was no conflict of interests in writing this paper.

Acknowledgments

The authors acknowledge the staff of Department of Medical Laboratory Sciences, College of Health of Sciences, University of Zimbabwe, and Newlands Clinic staff and patients.

References

[1] “National AIDS Council Preliminary Report,” December 2015, http://www.nac.org.zw/category/tags/hiv-and-aidzs-zimbabwe.
[2] Zimbabwe UNAIDS Report, http://www.unaids.org/en/regionscountries/countries/zimbabwe.
[3] S. G. Deeks, S. R. Lewin, and D. V. Havlir, “The end of AIDS: HIV infection as a chronic disease,” The Lancet, vol. 382, no. 9903, pp. 1525–1533, 2013.
[4] Guidelines for Antiretroviral Therapy for the Prevention and Treatment of HIV in Zimbabwe, National Medicine and Therapeutics Policy Advisory Committee (NMTPAC), The AIDS and TB Directorate, Ministry of Health and Child Care, Harare, Zimbabwe, 2013.
[5] C. F. Gilks, S. Crowley, R. Ekpini et al., “The WHO public-health approach to antiretroviral treatment against HIV in resource-limited settings,” The Lancet, vol. 368, no. 9534, pp. 505–510, 2006.
[6] WHO, Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection. Recommendations for a Public Health Approach, WHO, 2013.
[7] A. G. Cotter, C. S. Satchell, J. A. O’Halloran, E. R. Feeney, C. A. Sabin, and P. W. G. Malton, “High-density lipoprotein levels and 10-year cardiovascular risk in HIV-1 infected patients,” AIDS, vol. 25, no. 6, pp. 867–869, 2011.
[8] R. H. Haubrich, S. A. Riddler, A. G. DiRienzo et al., “Metabolic outcomes in a randomized trial of nucleoside, nonnucleoside and protease inhibitor-sparing regimens for initial HIV treatment,” AIDS, vol. 23, no. 9, pp. 1109–1118, 2009.
[9] M. Galli, A. L. Ridolfo, F. Adorni et al., “Body habitus changes and metabolic alterations in protease inhibitor-naive HIV-1 infected patients treated with two nucleoside reverse transcriptase inhibitors,” Journal of Acquired Immune Deficiency Syndromes, vol. 29, no. 1, pp. 21–31, 2002.
[10] E. R. Feeney and P. W. G. Mallon, "HIV and HAART-associated dyslipidemia," *The Open Cardiovascular Medicine Journal*, vol. 5, pp. 49–63, 2011.

[11] E. Bernal, M. Masiá, S. Padilla, and F. Gutiérrez, "High-density lipoprotein cholesterol in HIV-infected patients: evidence for an association with HIV-1 viral load, antiretroviral therapy status, and regimen composition," *AIDS Patient Care and STDs*, vol. 22, no. 7, pp. 569–575, 2008.

[12] V. Estrada and J. Portilla, "Dyslipidemia related to antiretroviral therapy," *AIDS Reviews*, vol. 13, no. 1, pp. 49–56, 2011.

[13] E. W. P. Yone, A. P. Kengne, G. A. Ashuntantang, A. F. Betyoumin, and J. Ngogang, "Dyslipidaemia in HIV-1-infected patients receiving protease inhibitors after initial treatment with first-line-based non-nucleoside reverse transcriptase inhibitors: a cross-sectional study," *BMJ Open*, vol. 2, no. 4, Article ID e001317, 2012.

[14] M. Van Der Valk, J. J. P. Kastelein, R. L. Murphy et al., "Nevirapine-containing antiretroviral therapy in HIV-1 infected patients results in an antiatherogenic lipid profile," *AIDS*, vol. 15, no. 18, pp. 2407–2414, 2001.

[15] E. Fontas, F. Van Leth, C. A. Sabin et al., "Lipid profiles in HIV-infected patients receiving combination antiretroviral therapy: are different antiretroviral drugs associated with different lipid profiles?" *The Journal of Infectious Diseases*, vol. 189, no. 6, pp. 1056–1074, 2004.

[16] P. J. Weidle, N. Wamai, P. Solberg et al., "Adherence to antiretroviral therapy in a home-based AIDS care programme in rural Uganda," *The Lancet*, vol. 368, no. 9547, pp. 1587–1594, 2006.

[17] C. Padmapriyadarsini, S. R. Kumar, N. Terrin et al., "Dyslipidemia among HIV-infected patients with tuberculosis taking once-daily nonnucleoside reverse transcriptase inhibitor-based antiretroviral therapy in India," *Clinical Infectious Diseases*, vol. 52, no. 4, pp. 540–546, 2011.

[18] M. L. Montes, F. Pulido, C. Barros et al., "Lipid disorders in antiretroviral-naïve patients treated with lopinavir/ritonavir-based HAART: frequency, characterization and risk factors," *Journal of Antimicrobial Chemotherapy*, vol. 55, no. 5, pp. 800–804, 2005.

[19] D. Zhou, V. Kodogo, K. Chokuona, O. Oktedalen, B. Stray-Pedersen, and E. Gomo, "Dyslipidemia and cardiovascular disease risk profiles of patients attending an HIV treatment clinic in Harare, Zimbabwe; HIV/AIDS—Research and Palliative Care*, vol. 2015, no. 7, pp. 145–155, 2015.

[20] "NECP Expert Panel on detection and early treatment of high blood cholesterol in adults: Third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III) Final report," *Circulation*, vol. 106, article 3143, 2002.

[21] E. Eren, N. Yilmaz, and O. Aydin, "High density lipoprotein and its dysfunction," *Open Biochemistry Journal*, vol. 6, pp. 78–93, 2012.

[22] S. A. Riddler, X. Li, H. Chu et al., "Longitudinal changes in serum lipids among HIV-infected men on highly active antiretroviral therapy," *HIV Medicine*, vol. 8, no. 5, pp. 280–287, 2007.

[23] K. Buchacz, P. J. Weidle, D. Moore et al., "Changes in lipid profile over 24 months among adults on first-line highly active antiretroviral therapy in the home-based AIDS care program in rural Uganda," *Journal of Acquired Immune Deficiency Syndromes*, vol. 47, no. 3, pp. 304–311, 2008.

[24] A. C. Achhra, J. Amin, J. Hoy et al., "Differences in lipid measurements by antiretroviral regimen exposure in cohorts from Asia and Australia," *AIDS Research and Treatment*, vol. 2012, Article ID 246280, 9 pages, 2012.

[25] E. Cerrato, A. Calcagno, F. D’Ascenzo et al., "Cardiovascular disease in HIV patients: from bench to bedside and backwards," *Open Heart*, vol. 2, no. 1, Article ID e000174, 2015.

[26] Z. A. R. Gomo, J. G. Hakim, S. A. Walker et al., "Impact of second-line antiretroviral regimens on lipid profiles in an African setting: the DART trial sub-study," *AIDS Research and Therapy*, vol. 11, article 32, 2014.

[27] J. A. George, W. D. F. Venter, H. E. Van Deventer, and N. J. Crowther, "A longitudinal study of the changes in body fat and metabolic parameters in a South African population of HIV-positive patients receiving an antiretroviral therapeutic regimen containing stavudine," *AIDS Research and Human Retroviruses*, vol. 25, no. 8, pp. 771–781, 2009.