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Review Article

Comparison of Viral Load, CD4 and Hematological Parameters Amongst HIV, Patients on Tenofovir and Zidovudine-Based ARV Therapy in Nasarawa State, Nigeria

Chinwe Umeozulu[1, *], Nnannah Ibeh[1], Isaac Obafemi[2]

[1]Department of Medical Microbiology, School of Medical Laboratory Sciences, University of Benin, Benin, Nigeria
[2]Department of Prevention, Care and Quality Improvement, Equitable Health Access Initiative, Abuja, Nigeria

Abstract

HIV is a global public health concern and people diagnosed with HIV are treated with Antiretroviral therapy. Until 2017, Tenofovir and Zidovudine-based ART were the two major first line drugs for PLHIVs in Nasarawa Nigeria. This study aims to compare the HIV viral load suppression amongst patients on these two ART combinations in Nasarawa State, Nigeria. The study was conducted in three (3) secondary health facilities in Nasarawa State using one hundred subjects selected randomly from the three facilities comprising 50 HIV Sero-positive individuals on Tenofovir-based ART and 50 HIV sero-positive individuals on Zidovudine-based ART. Ethylene diamine Tetra Acetic (EDTA) blood specimen was obtained from each study participant for Full blood count (FBC) using haematology auto-analyser (Sysmex K21N), CD4 count using Partec Cyflow Counter II and HIV viral load analysis using real-time polymerase chain reaction. The demographic data of study participants shows that more females (72) were involved in the study making up 64% of the subjects on Tenofovir and 80% of those on Zidovuine and most of the subjects were within the ages of 26-35years. There was no significant difference ($p=0.666$) in the viral load of the subjects on any of the regimen. The red blood cells count (RBC) and platelet counts were significantly different ($p<0.0001$) amongst the subjects on the two ART regimen whereas CD4 count, white blood cells count, lymphocytes count, granulocytes count and Packed cell volume (PCV) were not significantly different within the two groups. Age affected some of the haematological parameters (granulocytes, PCV, RBCs and platelets) within the two groups at different ages. Sex only affected the PCV and granulocytes of subjects within the two different groups ($p=0.0069$), occupation, knowledge about HIV/AIDS disease and care, duration of ART treatment and year of initial diagnosis of HIV did not affect the haematological and immunological parameters of subjects on the two ART regimen. Conclusively, there is no significant difference in the virologic and immunological response of patients on the two ART therapy but some haematological parameters of subjects on Zidovudine were statistically different from those on Tenofovir.

Keywords

Tenofovir, Zidovudine, Hematological Parameters, PLHIV, CD4, Viral Load

[*]Corresponding author: cumeozulu@ehainigeria.org (Chinwe Umeozulu)

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1. Introduction

HIV/AIDS is a global health challenge affecting millions of people worldwide, and Nigeria is no exception [7, 59]. The devastating impact of HIV/AIDS infection on the society, its well-being and economic development cannot be overemphasized as there is no milestone achievement in vaccine development against it.

The advent of therapeutic regimen for curtailing viral replication activities has drastically reduced the mortality rate of HIV/AIDS. With this highly active antiretroviral therapy (HAART), HIV is now clinically well managed as HAART inhibits viral replication and suppresses the level of HIV RNA in plasma thereby prolonging life expectancy of the patients and also prevents pregnant women from transmitting the virus to babies. Despite the palpable benefits of HAART, safety of ARVs in pregnancy is still uncertain [16]. Several studies have revealed association between prolonged use of HAART, chronic HIV diseases and the chances of developing long term complications [40, 10, 58]. Some of the reported complications of chronic HIV disease include nephrotoxicity, hepatotoxicity, cardiovascular disease and thromboembolic events [61, 24]. Most Antiretroviral therapies (ART) are made up of different combinations of HAART. They are mainly composed of either Zidovudine (ZDV) or tenofovir disoproxil fumarate (TDF) plus lamivudine (3TC) plus efavirenz (EFV) or nevirapine (NVP).

Before the current use of ARVs that consists primarily of dolutegravir based regimen, Zidovudine (ZDV) or tenofovir disoproxil fumarate (TDF) plus lamivudine (3TC) plus efavirenz (EFV) or nevirapine (NVP) form the initial treatment of HIV was adopted as the frontline drugs for managing HIV/AIDS pandemic worldwide [60]. The 2016 World Health Organization (WHO) guidelines also listed TDF plus 3TC or emtricitabine as the preferred nucleoside reverse transcriptase inhibitor backbone. In response to these guidelines, the National Agency for the Control of AIDS in collaboration with the Federal Ministry of Health has expanded the use of TDF [45, 4]. In Abuja Metropolis, 44% of all HIV-infected patients prescribed HAART in 2017 used a regimen containing TDF and 3TC plus EFV or NVP (unpublished data). Although studies comparing TDF- versus ZDV-based regimens for treatment of HIV infection have demonstrated superior safety of TDF- over ZDV-based HAART, data on virologic suppression have yielded mixed results and also to the best of our knowledge there are paucity of data on the viral suppression of these two drugs amongst the Nigerian population hence this study.

1.1. Justification for Study

This study is essential as it will uncover, first, HIV viral load suppression amongst patients on tenofovir and zidovudine-based antiretroviral therapy in Nasarawa state, Nigeria. Secondly, it will help determine if there is a better regimen between the two drug regimen based on clients FBC and viral load parameters and finally, it will contribute to providing better care for people with HIV.

1.2. Research Questions

1) What is the virologic and immunological response of HIV virus to tenofovir and zidovudine-based antiretroviral therapy?
2) What are the changes in Full Blood Count parameters amongst patients on the two drugs?
3) What are the activity of the two drugs-based therapy in terms of their virologic response (Viral load suppression) and host response (hematologic and immunologic)?

1.3. Objectives

1) To determine the virologic and immunological response of HIV virus to tenofovir and zidovudine-based antiretroviral therapy with viral load and CD4 count respectively.
2) To ascertain some changes in Full Blood Count parameters amongst patients on the two drugs.
3) To compare the activity of the two drugs-based therapy in terms of their virologic response (Viral load suppression) and host response (hematologic and immunologic).

2. Literature Review

Human immunodeficiency virus (HIV) is a member of the retrovirus family known as lentivirus which causes acquired immunodeficiency syndrome (AIDS), a condition in humans in which there is a progressive failure of the immune system that allows life-threatening opportunistic infections and cancers to thrive. HIV attacks immune cells such as helper T cells (specifically CD4+ T cells), macrophages, and dendritic cells. HIV infection causes low levels of CD4+ T cells through three major processes: Firstly, direct viral killing of infected cells; secondly, increased rates of apoptosis in infected cells; and thirdly, killing of infected CD4+ T cells by CD8 cytotoxic lymphocytes that recognize infected cells. When CD4+ T cells number reduces below a certain level, cell-mediated immunity is lost, and the body becomes progressively more liable to opportunistic infections [46, 31].

Human Immunodeficiency Virus (HIV) is the etiologic agent of the disease known as acquired immune deficiency syndrome (AIDS). It causes a progressive impairment of the body's cellular immune system by destroying CD4+ T cells, leading to increased susceptibility to various infections. HIV/AIDS is a major public health problem with socio-economic burden and a serious threat to development. Nine out of 10 people living with HIV are in the developing world [46], 60 to 70 % of those are in Sub-Saharan Africa. But

the disease is spreading in every region, with fierce epidemics threatening to tear through countries such as India, China, Russia and the islands of the Caribbean. As HIV spreads, it interacts with other infectious diseases, facilitated by the increase in numbers of immunosuppressed individuals. These interactions can alter the clinical course of both diseases [46].

According to WHO fact sheets [61], the standard is that clients who test positive are immediately started on ARVs (antiretrovirals), also known as Highly Active Antiretroviral Therapy (HAART in addition to other services like HIV adherence counselling, baseline and routine periodic laboratory investigation, management of opportunistic infections (OIs), routine treatment monitoring and follow-up. The usual HAART regimen combines three or more different drugs such as two nucleoside reverse transcriptase inhibitors (NRTIs) and a protease inhibitor (PI), two NRTIs and a non-nucleoside reverse transcriptase inhibitor (NNRTI) or other such combinations [52, 48].

2.1. Goals of Antiretroviral Therapy

1) Reduction in morbidity and mortality resulting from advanced HIV disease. Prior to the advent of ARVs, mortality rates due to advanced HIV disease was unacceptably high, exceeding 87% in most cases [17, 50].
2) Allow infected individuals to carry on a healthy existence which otherwise would have been negatively affected with illness as a result of an advancing case of HIV infection and therefore other opportunistic infections.
3) A viral suppression that is sustained through drug adherence [49]. VL suppression can reach <400 copies/ml by week 24 [5].
4) An increase in CD4 cell count which leads to improved immunity against HIV. CD4 cell count can increase of 50 to 100 cells/µl /year with proper intake of ARVs [3].
5) The risk of transmitting the HIV virus from mother to child during and even after pregnancy is substantially reduced with ART intake. Transmission to sexual partners is also less likely. [60, 13].

2.1.1. Classes of ARVs and Their Mechanisms of Action

There are 6 notable classes currently available for treatment

1) Non-nucleoside Reverse Transcriptase Inhibitors (NNRTIs)- Examples of these are nevirapine and efavirenz. They stop transcription of RNA or DNA by the direct binding to the enzyme reverse transcriptase.
2) Protease Inhibitors (PIs), these stop assembly and the release of HIV from the CD4, an example is Atazanavir.
3) Nucleoside/Nucleotide Reverse Transcriptase Inhibitors (NRTIs/NtRTIs). They disrupt the building process of the viral DNA by incorporate themselves into the DNA of the virus, example of these are Lamivudine.
4) Fusion inhibitors binds viral gp41 on the T-cell memebrane and prevent penetration of the virus. An example is enfuvirtide.
5) Integrase Inhibitors prevent the integration of viral DNA into the T-cell DNA, this prevents both reproduction and transcription, example is raltegravir [60, 13].
6) Chemokine receptors antagonists halt viral attachment by blocking the CCR5 or CXCR4 on the T cell surface. Example, Maraviroc.

2.1.2. Antiretroviral Drugs-Induced Oxidative Stress as Cause of Cellular Abnormality

Drug-induced oxidative stress is implicated as a mechanism of toxicity in numerous tissues and organ systems, including liver, kidney, ear, and cardiovascular and nervous systems. Well-characterized drugs associated with adverse events to which oxidative stress may contribute include examples of cancer therapies, non-steroidal anti-inflammatory drugs (NSAID), antiretroviral agents, antipsychotics, and analgesics [41, 15].

Taking Azidothymidine (also known as zidovudine) as an example, in addition to generating ROS following drug exposure, mitochondria are also a toxicity target of Azidothymidine. Evidence suggests that mitochondrial dysfunction due to oxidative stress is implicated in toxicities observed following long-term administration of azidothymidine (AZT). AZT was the first antiretroviral drug approved for treatment of HIV. As a potent nucleoside reverse transcriptase inhibitor, AZT prevents DNA synthesis from viral RNA and thus prevents viral replication. AZT is administered chronically in combination with other antiretroviral drugs in “Highly Active Antiretroviral Therapy” regimens [15].

Unfortunately, chronic administration of AZT is associated with several side effects including neuropathy, cardiac dysfunction, and skeletal myopathy. Clinically, in addition to the myopathy associated with HIV infection, AZT causes pathological changes in skeletal muscle, consistent morphologically with mitochondrial abnormality [8, 25]. In cultured human muscle cells in vitro, AZT decreased proliferation, increased lactate production, and decreased cytochrome c oxidase activity [9], indicating further the potential for AZT to affect mitochondrial function. Transgenic mice under- or overexpressing SOD have been used to characterise AZT-induced oxidative stress in vivo. Depletion of SOD was associated with enhanced cardiomyopathy, whilst the heart was protected in mice over expressing SOD or expressing mitochondrion-targeted catalase. This implicates hydrogen peroxide, as an oxidative product of dismutation, in AZT-induced toxicity. More recently, direct detection and quantification of ROS and RNS in response to AZT have been reported using a mouse macrophage model system, which enabled identification of specific reactive species. In this study, cells responded to incubation with AZT by releasing reactive species including peroxide and peroxinitrate [4]. Interestingly, thymidine alone did not increase the release of ROS/RNS in the same way, suggesting the azido moiety is important in oxidative stress. This finding is supported by

studies in human aortic endothelial cells, in which oxidative stress, decreased mitochondrial membrane potential, increases in lactate release (an indicator of impaired mitochondria producing energy by cytosolic glycolysis), and cell death were observed when incubated for several weeks with AZT, but not when incubated with d4T (stavudine) which lacks the azido group [4].

Reactive species causes cellular damage and other pathological conditions through their reaction with cellular biomolecules such as carbohydrates, proteins, lipids and ultimately nucleic acids. Generally, oxidative stress has been linked to the pathogenesis of numerous diseases including asthma (mitochondrial dysfunction) [56], atherosclerosis (oxidative modification of LDL) [20], endothelial cardiovascular disease, which is more prompt to inactivation of NO and ROS, thus predispose of these reactive molecules. The disease is characterized by altered anticoagulant and anti-inflammatory properties [39], a cancer in which cells present mitochondria alterations at the level of mitochondrial DNA, oxidative phosphorylation and energy metabolism, all these activates the pro-oxidants and causes mitochondrial injury [26], inflammatory skin diseases in which Rho GTPases regulate the ROS production under the control of Rac protein in fibroblast, psoriasis and vitiligo [22]. Infertility to male due to impairment of spermatogenesis, caused by retention of cytoplasm in sperm mid-piece causing increased activities of cytoplasmic enzymes like Glucose-6-Phosphate dehydrogenase, which in turn produce more NADPH and finally increases the production of O2- (ROS) [53]. Peroxynitrite reacts with body fluids and form nitrotyrosine in glial cell, which causes neurodegenerative diseases like Alzheimer's disease, in which Cu (I/II) involve the aggregation of amyloidogenic peptide with the production of Reactive Oxygen Species. Parkinson's disease is actually the neural degeneration due to the loss of pigmented neurons in substantia nigra, produces Mitochondrial Permeability Transition Pore (MPTP) which inhibits the complex I in Electron transport chain, thus results in decrease in the production of ATP.

Iron changes is seen in multiple sclerosis, spastic paraplegia in which iron causes secondary changes and accumulation of iron is related to gliosis, which produces ROS. ROS is also generated in type I pneumocytes on alveolar epithelium and causes destruction to cells. High glucose level in Diabetes and palmitic acid stimulate ROS through Protein kinase C dependant NADPH oxidase in smooth muscle cells and endothelial cells [35].

2.1.3. CD4-T Cells and HIV

CD4+ T helper cells are often referred to as CD4 cells, T-helper cells or T4 cells. They are white blood cells which play important role in the human immune system. The CD4 T cells send signals to other immune cells such as CD8 killer cells that destroy the foreign antigens. In untreated HIV infection, the CD4 cells decreases. Also, before transplant, due to immune suppression the CD4 cells deplete. As a result the body is left exposed to a variety of infections that it would have been able to combat. CD4 is a co-receptor assists the T cell receptor (TCR) in sending signal with an antigen-presenting cell. CD4 amplifies the signal generated by the TCR through its intracellular domain by an enzyme, tyrosine kinase Lck. This enzyme becomes essential in activating several molecular components of the signalling cascade of an activated T-cells. The CD4 through its extracellular domain can interacts with MHC class II molecules on the surface of the antigen-presenting cell. In a Greek major topology, the extracellular domain accepts an immunoglobulin-like beta-sandwich with seven strands in 2 beta sheets. The viral envelope protein known as gp120 attacks the CD4 in order to gain entry into the host T-cells.

The number of CD4 cells reduces progressively with HIV infection. Medical experts use CD4 count to determine when to commence treatment for HIV infected persons. CD4 cell count is a laboratory test that measures the number of CD4 T-cells. The normal range is between 500 to 1500 cells/mm^3. Clinicians use this test to monitor the destruction of CD4 cells, and it also monitors the effectiveness of the antiretroviral treatment (ART) [59]. The CD4 cell counts are used to assess the immune system of the HIV infected individuals. Albeit CD4 counts are not a direct HIV test since they do not detect the presence of viral DNA, neither the specific antibodies against HIV. According to Center for Disease Control and Prevention (CDC), when CD4 cell count drops below 200 cells/mm^3, it is indicative of AIDS. The decline of CD4 T cells can lead to opportunistic infections, and it increases mortality.

2.1.4. Immunological Staging of HIV Infection

Clinical staging can be used effectively without access to CD4 or other laboratory testing. However, CD4 testing is useful for determining the degree of Immuno-compromise, and where CD4 facilities are available they should be used to support and reinforce clinical decision-making. Data on CD4 levels are not a prerequisite for starting ART and should only be used in conjunction with consideration of the clinical stage [47, 60]. Table 1 presents CD4 levels in relation to the severity of immunosuppression. For clinical purposes long term prognosis has been shown to be related to the nadir or lowest-ever value of CD4. It should be noted that the immunological staging of disease reverses with successful ART [60, 13].

Table 1. *CD4 Levels in Relation to the Severity of Immunosuppression.*

Not significant immunosuppression	>500/mm^3
Mild immunosuppression	350 – 499/mm^3
Advanced immunosuppression	200 – 349/mm^3
Severe immunosuppression	<200/mm^3

(WHO, 2005; Bofil et al., 1992).

2.2. Effect of Haart on CD4 Cell Count

It has been shown that HIV positive persons presenting late (late presenters) are often diagnosed with late HIV disease which corresponds to severe immune suppression, defined as CD4 count <200 cells/ml [29, 43]. Those with a low CD4 count at baseline besides having a higher risk of clinical events [18], are less likely to have a sustained virological response when commenced on highly active antiretroviral therapy (HAART) compared to those commencing treatment at higher CD4 cell counts [28]. Thus the use of HAART help to protect CD4 cells from further attack by HIV, hence increase in CD4 cell population is usually observed during treatment with HAART. In the work of Ebonyi and colleague, the median absolute CD4 count was increased by 28.2%, after 9 months of treatment with HAART [27].

2.3. Effect of Haart on Platelet Count (Thrombocytopaenia)

Thrombocytopenia is defined as a platelet count of less than 150 × 103per µL. It is often discovered incidentally when obtaining a complete blood count during an office visit. The aetiology usually is not obvious, and additional investigation is required. Patients with platelet counts greater than 50 × 103per µL rarely have symptoms. A platelet count from 30 to 50 × 103per µL rarely manifests as purpura. A count from 10 to 30 × 103per µL may cause bleeding with mini¬mal trauma. A platelet count less than 5 × 103per µL may cause spontaneous bleeding and constitutes a hematologic emergency. Patients who present with thrombocytopenia as part of a multisystem disorder usually are ill and require urgent evaluation and treatment [14].

Association between thrombocytopenia and HIV infection have been documented.. There are many aetiological factors; the commonest cause is immune thrombocytopenic purpura (ITP). This occurs in 30% of patients with 0AIDS, however, it typically arises early in the course of HIV infection and can be seen before any other manifestation of AIDS. Unlike primary ITP, it is more frequently seen in men. The antibody is believed to be induced by HIV glycoprotein 120 which cross-reacts with platelet GPIIIa. These antibodies can be found even in a patient with normal platelet count. Platelet kinetic studies have shown shortened platelet survival as well as HIV induced apoptosis of megakaryocytes. Zidovudine therapy has improved platelet count without changing platelet survival and this suggests improved production. Megakaryocytes are infected by HIV virus and HIV viral particles have been documented in the megakaryocytes by electron microscopy. HIV p24 antigen has also been documented in the megakaryocytes by immunohistochemical techniques while HIV RNA was detected Treatment is unnecessary unless patient is symptomatic or platelet count drops below 30,000/cmm. Almost 20% of patients with HIV-associated thrombocytopenia undergo spontaneous remission. The most effective treatment is the use of HAART therapy, however, historical treatment with AZT alone was also effective [19]. Other modalities of treatment include corticosteroids, IV anti-D therapy, splenectomy etc. None of these immunomodulatory treatments have shown any obvious increase in the risk of progression of HIV infection to symptomatic AIDS) [51].

Thrombotic thrombocytopenic purpura (TTP) is another well documented complication of HIV infection. It was recorded in 1.5% of affected patients prior to introduction of HAART therapy [32]. It is possible that TTP is provoked by HIV-related endothelial cell perturbation. HAART has therefore helped to protect both platelets and platelet precursors. Thrombocytopenia could result from increased platelets destruction and decreased platelet production by the HIV-infected megakaryocytic cells.

However some drugs use in HAART has been documented to cause thrombocytopaenia in HIV infection through decrease production of platelets, some of these include Trimethoprim-sulfamethoxazole, Pentamidine, Pyrimethamine, Ganciclovir, Fluconazole, Alpha-interferon, Rifabutin, Clarithromycin, Didanosine, Amphotericin B, Indinavir, Ritonavir, Delavirdine, Nelfinavir [32]. Saquinavir and Interferons cause thrombocytopaenia through increased destruction/sequestration of platelets, though the mechanisms by which these drugs cause thrombocytopaenia remain poorly understood [32].

2.4. Effect of Haart on Platelet Factor-3 Availability

The platelets are of great importance in the coagulation of blood. They have the potential of functioning in the clotting process at different points: They participate in the activation of prothrombin, when in combination with platelet cofactor I or with the plasma thromboplastin component (PTC) [12]; they accelerate the activation of prothrombin and the interaction of thrombin and fibrinogen, they inhibit heparin and fibrinolysin [38] and contain a substance that can be clotted with thrombin. Moreover, they are necessary for clot retraction, and exert a vasoconstrictor action. There is as yet not enough information to use as a basis for defining all these properties in terms of different substances, but it is evident that the factor 1 and 3 functions are associated with separate platelet substances.

Platelet factor-3 is a blood coagulation factor derived from platelets and chemically, a phospholipid lipoprotein that acts with certain plasma thromboplastin factors to convert prothrombin to thrombin. Shortening of the clotting time of intact platelet rich plasma (PRP) by incubation with Celite or kaolin is believed to result from activation of the Hageman and plasma thromboplastin antecedent (PTA) coagulation factors and from release of platelet factor 3 (PF3) [20]. Studies of the platelet coagulant activity which has been termed platelet factor 3 availability (PF3-A) have revealed abnormalities in a

variety of congenital and acquired conditions [21, 34]. However, changes in platelet factor-3 activity in HIV infection and in patients on HAART have not been well documented to determine the prevalence of AHD and its associated risk factors in order to develop effective prevention and management strategies.

PLHIV in rural settings, which can inform the development of effective interventions and policies to improve the quality of care and reduce the morbidity and mortality rates among PLHIV in Nigeria.

3. Methods

3.1. Study Design

STUDY LOCATION/AREA:

The study was conducted in three (3) secondary health facilities (Our Ladies of Apostle Hospital, Akwanga; General Hospital, Akwanga and General Hospital, Nasarawa Eggon) in Nasarawa state very close to the Federal Capital Territory of Nigeria located at latitude 9o 4' 60N and longitude 7o 31' 60E which has an undulating terrain and 3 marked weather conditions of rainy season, dry season and a brief interlude of harmattan with an annual rainfall ranging between 1100mm and 1600mm and an average annual temperature of between 27 ℃ – 30 ℃.

3.2. Sample Size Determination

The formula n=Z2PQ/d2 [37] was used to derive the sample size used in this study. Where n is the required sample size, P is the expected prevalence in the target population, Q is 1-P, Z is 1.96; standard error, d is the level of statistical significance (0.05). A P-value of 3.2% was used representing maximum uncertainty for Nigeria as reported by Awofala and Ogundele (2016) [6].

Substituting into the formula;

$$n = \frac{(1.96)^2 \text{x } 0.032 \text{ x } (1-0.032)}{(0.05)^2}$$

n = 47.56

Therefore, approximately 50 samples were used.

3.3. Study Population and Recruitment

The population used in this study were one hundred (100) subjects comprising fifty (50) HIV sero-positive individuals on Tenofovir-based antiretroviral therapy and 50 HIV sero-positive individuals on Zidovudine-based antiretroviral therapy.

The recruitment process used in this study was initiated using the informed consent form (Appendix I) at the PEPFAR clinic four (4) hospitals within Abuja Metropolis.

3.4. Ethical Consideration

Ethical approval is sort from the Ethics and Research Committee of Nasarawa state with consideration to the four (4) pillars/principles of research ethics.

3.5. Inclusion Criteria

Any HIV patient who was already on any of the two HAART therapies and was willing to enrol and be followed up for the duration of the research was recruited into the study.

3.6. Exclusion Criteria

HAART naïve HIV patients, patients who have not used any of the HAART therapy for up to one year as well as those who are not willing to provide informed consent were excluded.

3.7. Data Collection

Data were collected at the point of enrolment with the aid of a questionnaire (Appendix II) and other relevant information of the participant such as weight, height, drug regimen and medical history was abstracted from each participant's folder.

3.8. Specimen Collection

From each participant, 5mls of blood will be collected and dispensed into EDTA containers. The sample in EDTA container will be mixed and used for full blood count and CD4 analysis while the leftover will be centrifuged and the plasma therefrom would be used for the HIV viral load quantification.

3.9. Laboratory Analysis

Full Blood Count

The full blood count of the subjects was done using haematology auto analyser – Sysmex K2IN (Sysmex Corporation, Kobe, Japan) by following the manufacturer's instruction. The haematological parameters analyzed include haematocrit value (PCV), Total White Cell Count (WBC) concentration, Red Blood Cell (RBC), platelet count (PLT) and WBC Differential counts.

Principle of Test:

The XP-300 employs three detector blocks and two kinds of reagents for blood analysis. The white blood cell (WBC) count is measured by the WBC detector block using the direct count (DC) detection method.

The red blood cell (RBC) count and platelets are taken by the RBC detector blocks, also using the DC detection method. Differentials are measured employing the electrical impedance, also known as the Coulter Principle whereby change in impedance is proportional to cell volume, resulting in a cell count and measure of volume.

Procedure:

Whole blood was collected in a 5 ml EDTA anticoagulant vacutainer tubes avoiding hemolysis and clots and placed on a sample rocker. The equipment was powered on and routine machine checks carried out. WBC mode was selected and quality control sample ran and passed. The stopper was removed from the sample tube and the tube was set to the probe and start button pushed, it beeps twice and the sample was removed from the sample probe. Results are read both from the monitor and the thermal printer after 60 seconds.

CD4 Cell Count Estimation

The CD4 count was done using the Cyflow partec II equipment, the process involves flowcytometry. Parameter analyzed is the CD4+T cells that are white blood cells bearing the unique receptor favorable to the HIV virus. The cyflow operation is a true volumetric absolute counting. It counts only 0.2mls of the prepared sample. For CD4 T-lymphocyte absolute count, the important value is the count/µl of blood obtained.

Principle of test:

Flowcytometry is a method by which cells or micro particles in suspension is differentiated and counted according to the cell size and internal structure. In the cyflow-partec, the fluorescent monoclonal antibodies binds to the CD4 antigen on the mononuclear cell (T-lymphocytes and monocytes) and in a buffer suspension, the complex is passed through the flow cuvette in a single stream of flow. The complex is excited by the solid state laser light at a wavelength of 532nm causing the complex to emit light which is captured by a photomultiplier tube and transmitted into digital read out as count.

Procedure:

20microL of CD4 monoclonal antibody was introduced into a Rohren test tube, 20microL of well mixed whole blood collected within 6hrs was added. It was mixed and incubated in dark for 15minutes at room temperature, 800 microliter of CD4 buffer was added and tubes mixed. The prepared sample was plugged to the port of the cyflow and allowed for acquisition and data analysis. The cyflow starts from pre-run, run, count & stop. The cyflow counts a known volume of the sample and stops. The value is read off the monitor and also printed out.

Viral Load Determination Using Real Time Polymerase Chain Reaction (Rt-Pcr)

The test was carried out with COBAS® AmpliPrep/COBAS® TaqMan® HIV-1 Test, an in vitro nucleic acid amplification test for the quantitation of Human Immunodeficiency Virus Type 1 (HIV-1) RNA in human plasma.

Principle of Test:

Map (magnetic glass principle): This involves Lysis, stabilization and deprotenation. Addition of lysis buffer results in complete lysis of the sample. DNA and RNA are released and simultaneously stabilized. Degradation of inhibitory proteins and RNase by protease digestion and inactivation of nucleases by chaotropic salt, reducing agent and detergent.

Capture; Total nucleic acids bind to silica surface of added magnetic glass particles (MGP).

Wash: Wash buffer removes unbound substances and allow impurities like denatured protein, cellular debris, potential PCR inhibitors.

Elute; Purified total nucleic acids are released at elevated temperature (80%), high PH conditions and low salt concentration.

Work flow is then carried out in a designated instrument. The k-tubes are transferred to the COBAS Tagman for amplification. The results are read in the amplink as copies/ml.

Procedure:

Specimen was vortexed for 3-5 seconds, 1050µl of each specimen and control was transfered to the input -5 tube using a micropipettor. Controls were transferred starting with high(+) c, low(+) c, negative(-) c, then this was followed by specimen transfer to the sample/control rack. The rack was then loaded according to their rack positions onto the COBAS AmpliPrep instrument and the instrument is then started using the AMPLILINK software. Monitor displayed results was printed out at the end of the analysis run.

3.10. Data Presetation and Analysis

Data was reported as mean + SEM (for continuous variables), numbers and percentages (for categorical variables). Continuous variables were compared between groups using student's t-test and one way Anova in some cases The statistical software INSTAT® version 2.05 for Windows 7 (Graph Pad Software Inc, La Jolla CA, USA) was used. The various tests were carried out as two tailed and the outcomes with probability value equal to or below 0.05 were considered as significant.

4. Results and Discussions

A total of one hundred (100) subjects were recruited into the study out of which fifty (50) were on Tenofovir ART regimen and the other fifty (50) were on Zidovudine ART regimen. The demographic data of the study participants as presented in tables 2 and 3 shows that more females (72) were involved in the study females making up 64% of the subjects on Tenofovir and 80% of those on Zidovudine. Most of the subjects were within the ages of 26-35years (34% for Tenofovir and 26% for Zidovudine) whereas jects >65years of age were the least represented in the study followed by 16-25years which has 4% and 8% respectively for Tenofovir and none for Zidovudine. Most of the study participants have their HIV diagnosed within the last 4-6years before the study (36% for Tenofovir and 34% for Zidovudine) followed by 7-9years (24% for Tenofovir and 38% for Zidovudine) with the least being 10years and above. Most of the subjects had just commenced ART therapy within 1-3years (50% for Tenofovir and 26% for Zidovudine) with the least being 10years and above (12% and 4% respectively for Tenofovir and Zidovudine). Most of the participants were doing business (24% and 38% respectively for Tenofovir and

Zidovudine).

Table 4 compares the viral load of the subjects on respective ART regime, it shows that most of the subjects have their viral load <20 (66% and 64% respectively for Tenofovir and for Zidovudine) with others falling within the other ranges. However, there was no significant difference between the viral load of subjects on any of the regimen (P=0.666) while Table 5 compares the immunological and haematological parameters of subjects on any of the two ART regimen and it shows that only Red Blood cell count and Platelets count has significant difference (P<0.0001) amongst the seven parameters analysed.

The impact of the age of subjects taking the ART regimen on immunological and haematological changes was also analysed and it was revealed that there was a significant difference in the granulocyte count and PCV of subjects within the ages of 36-45years, red blood cell count of subjects between the ages of 26-35years and 46-55years while the platelets was only significant for the group of 56-65years (Table 6). The impact of sex on the immunological and haematological changes in the two ART regimen reveals that there was a significant difference in the granulocyte count (P=0.0399) and PCV (P=0.0069) as seen in Table 7.

The impact of ART commencement and ART regimen on the immunological and haematological regimen (Table 8), length of time between HIV diagnosis and ART commencement (Table 9), and occupation (Table 10) on the immunological and haematological changes in the subjects taking the two ART regimen was accessed and it showed no significant difference.

Table 2. *Demographic data of Study participants.*

N (%)		
Age of participants	≤15years	13 (13)
	16-25years	4 (4)
	26-35years	30 (30)
	36-45years	28 (28)
	46-55years	15 (15)
	56-65years	8 (8)
	>65years	2 (2)
Sex of participants	Female	72 (72)
	Male	28 (28)
Duration of ART commencement by participants	1-3YEARS	38 (38)
	4-6YEARS	29 (29)
	7-9YEARS	25 (25)
	10YEARS AND ABOVE	8 (8)
Duration of HIV diagnosis of participants	1-3YEARS	33 (33)
	4-6YEARS	35 (35)
	7-9YEARS	31 (31)
	10YEARS AND ABOVE	11 (11)
Occupation of participants	Business	31 (31)
	Child	2 (2)
	Civil Servant	0 (0)
	Farmer	22 (22)
	Housewife	12 (12)
	Student	19 (19)

Table 3. *Demographic data of Study participants According to ART Regimen.*

		Subjects on Tenofovir (TDF) Based Regimen N (%)	Subjects on Ziduvudine (Azt) Based Regimen N (%)
Age of participants	≤15years	0 (0)	13 (26)
	16-25years	4 (8)	0 (0)
	26-35years	17 (34)	13 (26)
	36-45years	16 (32)	12 (24)
	46-55years	8 (16)	7 (14)
	56-65years	3 (6)	5 (10)
	>65years	2 (4)	0 (0)
Sex of participants	Female	32 (64)	40 (80)
	Male	18 (36)	10 (20)
Duration of ART commencement by participants	1-3YEARS	25 (50)	13 (26)
	4-6YEARS	12 (24)	17 (34)
	7-9YEARS	7 (14)	18 (36)
	10YEARS AND ABOVE	6 (12)	2 (4)
Duration of HIV diagnosis of participants	1-3YEARS	11 (22)	12 (24)
	4-6YEARS	18 (36)	17 (34)
	7-9YEARS	12 (24)	19 (38)
	10YEARS AND ABOVE	9 (18)	2 (4)
Occupation of participants	Business	12 (24)	19 (38)
	Child	0 (0)	2 (4)
	Civil Servant	0 (0)	0 (0)
	Farmer	15 (30)	7 (14)
	Housewife	9 (18)	3 (6)
	Student	6 (12)	13 (26)

Table 4. *Comparison of the Viral Load of Subjects with the ART regimen taken.*

Viral Load of participants	Subjects on Tenofovir (TDF) Based Regimen N (%)	Subjects on Ziduvudine (AZT) Based Regimen N (%)
<20	33 (66.0)	32 (64.0)
20-50	10 (20.0)	8 (16.0)
51-200	3 (6.0)	4 (8.0)
201-1000	1 (2.0)	0 (0.0)
Above 1000	3 (6.0)	6 (12.0)

P-Value =0.6663

Table 5. *Comparison of some Immunological and Haematological parameters of Subjects with the ART regimen taken.*

Parameters	Subjects on Tenofovir (TDF) Based Regimen	Subjects on Ziduvudine (AZT) Based Regimen	P-Value
CD4 counts	463.22 ±36.64	509.88 ±35.19	0.3893
White Blood cell count	4.70 ±0.22	4.16 ±0.23	0.3785
Lymphocytes count	1.82 ±0.11	1.88 ±0.11	0.500
Granulocyte count	2.59 ±0.16	2.03 ±0.15	0.3266
Red Blood cell count	4.31 ±0.08	3.97 ±0.25	<0.0001
Platelets count	255.46 ±9.94	275.50 ±24.00	<0.0001
Packed Cell Volume	37.56 ±0.56	34.78 ±0.64	0.1765

Mean ±SEM

Table 6. *Combined Effect of Age and ART Regimen on some Immunological and Haematological parameters of Subjects.*

Parameters	Age of participants	Subjects on Tenofovir (TDF) Based Regimen	Subjects on Ziduvudine (AZT) Based Regimen	P-Value
CD4 counts	≤15years	.-	538.08 ±75.60	NS
	16-25years	341.25 ±50.81	.-	NS
	26-35years	591.12 ±77.03	548.62 ±72.65	NS
	36-45years	351.00 ±34.30	421.67 ±73.56	NS
	46-55years	476.75 ±102.93	509.86 ±92.77	NS
	56-65years	399.33 ±68.05	547.60 ±74.91	NS
	>65years	559.50 ±290.50	-.	NS
White Blood cell count	≤15years	.-	4.95 ±0.52	NS
	16-25years	3.20 ±0.30	.-	NS
	26-35years	5.55 ±0.48	4.25 ±0.49	NS
	36-45years	4.13 ±0.26	3.28 ±0.39	NS
	46-55years	4.83 ±0.37	4.07 ±0.44	NS
	56-65years	4.42 ±0.72	4.11 ±0.57	NS
	>65years	4.80 ±0.51	-.	NS
Lymphocytes count	≤15years	-.	2.18 ±0.22	NS
	16-25years	1.40 ±0.29	.-	NS
	26-35years	2.21 ±0.23	1.98 ±0.22	NS
	36-45years	1.46 ±0.12	1.59 ±0.23	NS
	46-55years	1.85 ±0.27	1.75 ±0.26	NS
	56-65years	1.79 ±0.61	1.74 ±0.30	NS
	>65years	2.16 ±0.06	.	NS
Granulocyte count	≤15years	-.	2.47 ±0.34	NS
	16-25years	1.63 ±0.33	-.	NS
	26-35years	2.98 ±0.38	2.04 ±0.34	NS

Parameters	Age of participants	Subjects on Tenofovir (TDF) Based Regimen	Subjects on Ziduvudine (AZT) Based Regimen	P-Value
	36-45years	2.43±0.20	1.48±0.17	0.0005
	46-55years	2.70±0.22	2.13±0.23	NS
	56-65years	2.34±0.46	2.02±0.51	NS
	>65years	2.36±0.48	.-	NS
Red Blood cell count	≤15years	-.	3.61±0.18	NS
	16-25years	4.43±0.31	-.	NS
	26-35years	4.25±0.14	3.46±0.10	<0.0001
	36-45years	4.51±0.12	5.32±0.92	NS
	46-55years	4.28±0.16	3.74±0.17	0.0378
	56-65years	3.74±0.09	3.29±0.19	NS
	>65years	3.95±0.26	.-	NS
Platelets count	≤15years	.-	271.69±33.59	NS
	16-25years	253.75±16.86	-.	NS
	26-35years	248.82±19.22	246.92±14.15	NS
	36-45years	237.37±14.25	381.75±86.03	NS
	46-55years	255.75±24.08	218.43±13.13	NS
	56-65years	314.67±28.29	184.60±21.63	0.0105
	>65years	370.00±619.00	.-	NS
Packed Cell Volume	≤15years	.-	33.73±1.22	NS
	16-25years	37.63±1.99	-.	NS
	26-35years	36.21±0.69	36.00±0.85	NS
	36-45years	40.20±0.90	33.53±1.97	0.0025
	46-55years	36.38±1.88	36.78±1.01	NS
	56-65years	34.85±1.46	34.49±1.32	NS
	>65years	36.63±0.34	.-	NS

Mean±SEM

Table 7. *Combined Effect of Sex and ART Regimen on some Immunological and Haematological parameters of Subjects.*

	Subjects on Tenofovir (TDF) Based Regimen		Subjects on Ziduvudine (AZT) Based Regimen		
	Female	Male	Female	Male	P-Value
CD4 counts	523.47±51.26	356.11±34.27	520.22±41.67	468.50±58.04	0.1011
White Blood cell count	4.93±0.30	4.27±0.28	4.08±0.27	4.49±0.46	0.1635
Lymphocytes count	1.90±0.15	1.67±0.16	1.86±0.13	1.95±0.21	0.4056
Granulocyte count	2.72±0.22	2.36±0.19	1.97±0.17	2.28±0.29	0.0399

	Subjects on Tenofovir (TDF) Based Regimen		Subjects on Ziduvudine (AZT) Based Regimen		
	Female	**Male**	**Female**	**Male**	**P-Value**
Red Blood cell count	4.20 ±0.09	4.51 ±0.12	4.02 ±0.31	3.76 ±0.15	0.4466
Platelets count	262.53 ±11.54	242.89 ±18.59	287.13 ±29.34	229.00 ±21.35	0.4863
Packed Cell Volume	36.02 ±0.49	40.29 ±1.01	34.15 ±0.74	37.27 ±0.92	0.0069

Mean ±SEM

Table 8. *Combined Effect of the Duration of ART Commencement and ART Regimen on some Immunological and Haematological parameters of Subjects.*

Parameters	**TDF Based Regimen** Duration of ART				**AZT Based Regimen** Duration of ART				**P-Value**
	1-3 yrs	**4-6 yrs**	**7-9 yrs**	**>/= 10 yrs**	**1-3 yrs**	**4-6 yrs**	**7-9 yrs**	**>/= 10 yrs**	
CD4 counts	482.32 ± 61.29	389.33 ± 58.47	498.00 ± 84.81	490.83 ± 80.35	463.23 ± 79.12	471.18 ± 43.17	584.39 ± 66.97	471.50 ± 102.50	
White Blood cell count	4.91 ±0.39	4.39 ±0.24	4.61 ±0.51	4.51 ±0.47	3.86 ±0.35	3.84 ±0.40	4.59 ±0.41	5.01 ±2.27	
Lympho-cytes count	1.95 ±0.19	1.74 ±0.17	1.66 ±0.23	1.61 ±0.28	1.66 ±0.18	1.76 ±0.17	2.07 ±0.20	2.62 ±0.85	
Granulocyte count	2.64 ±0.29	2.39 ±0.13	2.69 ±0.30	2.65 ±0.32	1.96 ±0.19	1.87 ±0.28	2.24 ±0.27	1.98 ±1.20	
Red Blood cell count	4.35 ±0.12	4.19 ±0.13	4.42 ±0.14	4.26 ±0.26	3.67 ±0.18	3.59 ±0.12	4.57 ±0.65	3.68 ±0.36	
Platelets count	240.60 ± 15.03	260.25 ± 17.47	274.43 ± 32.18	285.67 ± 17.35	225.23 ± 15.89	219.53 ± 16.54	369.78 ± 58.45	229.50 ±29.50	
Packed Cell Volume	37.61 ±0.81	36.69 ±1.08	38.97 ±1.26	37.47 ±2.07	34.59 ±1.02	34.74 ±1.56	34.99 ±0.78	34.44 ±0.45	

Mean ±SEM

Table 9. *Combined Effect of the Duration of HIV diagnosis and ART Regimen on some Immunological and Haematological parameters of Subjects.*

Parameters	**TDF BASED REGIMEN** Duration of HIV diagnosis				**AZT BASED REGIMEN** Duration of HIV diagnosis				**P-Value**
	1-3 yrs	**4-6 yrs**	**7-9 yrs**	**=/>10 yrs**	**1-3 yrs**	**4-6 yrs**	**7-9 yrs**	**=/>10 yrs**	
CD4 counts	401.91 ± 71.88	483.39 ± 77.30	475.75 ± 69.39	481.11 ± 53.03	468.75 ± 85.80	471.18 ± 43.17	574.53 ± 64.11	471.50 ± 102.50	
White Blood cell count	5.38 ±0.58	4.34 ±0.31	4.77 ±0.51	4.45 ±0.36	3.70 ±0.33	3.84 ±0.40	4.65 ±0.40	5.01 ±2.27	
Lymphocytes	1.81 ±0.29	1.86 ±0.19	1.71 ±0.21	1.87 ±0.24	1.62 ±0.20	1.76 ±0.17	2.07 ±0.19	2.62 ±0.85	

Parameters	TDF BASED REGIMEN Duration of HIV diagnosis				AZT BASED REGIMEN Duration of HIV diagnosis				P-Value
	1-3 yrs	4-6 yrs	7-9 yrs	=/>10 yrs	1-3 yrs	4-6 yrs	7-9 yrs	=/>10 yrs	
count									
Granulocyte count	3.19 ±0.50	2.20 ±0.16	2.82 ±0.31	2.33 ±0.27	1.87 ±0.18	1.87 ±0.28	2.28 ±0.26	1.98 ±1.20	
Red Blood cell count	4.32 ±0.19	4.29 ±0.12	4.33 ±0.14	4.31 ±0.21	3.69 ±0.20	3.59 ±0.12	4.51 ±0.62	3.68 ±0.36	
Platelets count	249.64 ±27.91	246.67 ±15.10	254.42 ±20.80	281.56 ±17.38	218.33 ±15.56	219.53 ± 16.54	366.53 ± 55.38	229.50 ± 29.50	
Packed Cell Volume	37.67 ±0.97	36.54 ±0.96	38.50 ±1.17	38.21 ±1.51	35.36 ±0.73	34.74 ±1.56	34.48 ±0.90	34.44 ±0.45	

Table 10. *Combined Effect of the Occupation and ART Regimen on some Immunological and Haematological parameters of Subjects.*

ART Regime taken by participants	Parameter	Business	Child	Farmer	Housewife	Student
SUBJECTS ON TENOFOVIR (TDF) BASED REGIMEN	CD4 counts	449.75 ±48.30	.	435.20 ±59.21	497.22 ±106.26	361.00 ±90.46
	White Blood cell count	4.65 ±0.41	.	4.58 ±0.45	4.97 ±0.44	3.89 ±0.46
	Lymphocytes count	1.82 ±0.18	.	1.67 ±0.17	2.07 ±0.42	1.74 ±0.24
	Granulocyte count	2.56 ±0.28	.	2.62 ±0.37	2.48 ±0.20	2.00 ±0.36
	Red Blood cell count	4.48 ±0.12	.	4.20 ±0.14	4.33 ±0.22	4.33 ±0.30
	Platelets count	282.17 ±26.97	.	242.27 ±14.84	253.67 ±30.57	244.17 ±12.58
	Packed Cell Volume	38.84 ±1.18	.	37.76 ±1.15	36.28 ±0.82	37.64 ±1.76
SUBJECTS ON ZIDUVUDINE (AZT) BASED REGIMEN	CD4 counts	469.95 ±62.83	471.50 ±102.50	652.00 ±71.53	413.00 ±37.07	547.85 ±81.63
	White Blood cell count	3.97 ±0.46	5.01 ±2.27	4.65 ±0.47	2.75 ±0.09	4.49 ±0.40
	Lymphocytes count	1.67 ±0.21	2.62 ±0.85	2.19 ±0.20	1.30 ±0.19	2.09 ±0.19
	Granulocyte count	2.06 ±0.28	1.98 ±1.20	2.23 ±0.38	1.06 ±0.08	2.16 ±0.27
	Red Blood cell count	3.47 ±0.11	3.68 ±0.36	4.62 ±0.91	4.07 ±0.82	3.52 ±0.17
	Platelets count	235.00 ±14.45	229.50 ±29.50	330.29 ±122.51	265.67 ±71.59	269.23 ±33.24
	Packed Cell Volume	33.75 ±1.26	34.44 ±0.45	36.84 ±1.30	34.53 ±1.39	34.12 ±1.28

5. Discussion

Antiretroviral Therapy (ART) is the backbone of the treatment regimen against HIV/AIDS worldwide. The use of ART for the treatment of HIV infection has improved over the years especially since the advent of potent combination therapy in 1996 which has drastically reduced HIV-associated morbidity and mortality thereby transforming HIV disease into a chronic, manageable condition [11].

Although, Zidovudine and Tenofovir based regimen are used as preferred first line ART regimen especially in resource limited settings [62], there are limited data on the comparisons of the viral suppression efficacy alongside the immunological and haematological response of the two regimens in HIV subjects in this part of the world. This study therefore was set out to fill this gap.

Haematological parameters such as platelets counts, CD_4 cell count, packed cell volume (PCV), Haemoglobin concentration (HGB), total white count (W.C.C.), White Blood Cell differential count and Red blood Cell count of the subjects undergoing any of the two ART regimens were examined in this study. We also looked at the effects of the ART regimens on the viral load (V.L) of the subjects taking them. Comparisons of these parameters were then made among the studied groups (i.e Zidovudine-based and Tenofovir-based groups).

The subjects recruited into this study were randomly sampled, however their demographic data were evenly spread within the different category apart from the observation that none of the subjects <15years of age was on tenofovir based ART whereas all the subjects within this group were on Zidovudine based regimen. Age-disposition have been seen with many antiretrovirals [36]. however, the observation of this age related use of TDF in this study is in line with the findings in several studies [36, 44, 30], hence its common use for subjects within that age range which may be due to the established efficacy and safety in children [33].

The HIV viral load of the subjects in this study were compared and it was shown that there were no significant difference in the viral load of the subjects within the two groups (P=0.666) but, there was a marked decrease in the viral load of the subjects within the two groups when compared with their initial Viral Load before ART commencement. This finding is at variance with earlier studies like that of Tegene et al, [55] and Cheung *et al.*, [23] who did a systematic review and meta-analysis of the efficacy and tolerability of the tenofovir based regimen and the zidovudine based regimen. This observational cohort Study to compare the two regimen respectively reported better outcomes for tenofovir based regimen as opposed to the findings of Velen *et al.*, [59] who reported beagrawatter viral load outcomes for zidovudine based regimen. Though it is a known fact that HIV Viral load decreases with HAART regimen [54] hence viral load is normally affected by ART regimen not minding whether it is zidovudine based or tenofovir based as reflected in this study. We are however, not sure of the reasons behind these differences between other studies, we will be exploring that in the future to ascertain whether it has any genetic or regional undertones, though the differences in the sample sizes among the studies may be a major contributory factor.

In the same vein, comparing the CD4 count in this study also revealed that there was no significant difference between the CD4 counts of the subjects within the two groups of study (p=0.3893) though the CD4 count of subjects on tenofovir (453.22 cells/μL) was slightly lower than the CD4 count of subjects on zidovudine (509.88 cells/μL). This finding agrees with the findings of Cheung *et al.* [23] where they didn't observe any change in the CD4 count from baseline to peak within the two treatment groups with the CD4 value of the TDF based group slightly lower than that of the ZDV group. The findings in this study is opposed to the findings of other studies that revealed that TDF regimen shows more efficacy in terms of immunological outcomes compared to ZDV regimen. Their findings were from a well -structured two years cohort study which is different from the design of this study and some other previous studies. Therefore, the implied alteration in CD4 count between the two groups of subjects in this study as immunological response may be better accessed in a well-structured cohort study of not less than two years duration.

The full blood count analysis (White Blood cell count, Lymphocytes count, Granulocytes count, Red Blood cell count, Platelets count and Packed cell volume) conducted in this study reveals that only Red Blood cell count and Platelets count had significant difference within the two groups of subjects both at p<0.0001. It was also revealed that the Red blood cell count was lower in ZDV regimen (3.97 cells/μL) than TDF regimen (4.31cells/μL). The findings in this study agree with the findings of Agarwal *et al.*, 2010 were a high incidence of zidovudine induced anaemia was reported amongst Indian patients. This effect of ZDV on Red blood cells and platelets observed in this study can be attributed to its myelosuppressive ability that has been well established [2, 1, 42].

Comparing the immunological and haematological parameters of the two study groups using the demographic data, the study revealed that some of the haematological parameters (Granulocyte count and Packed cell volume at P= 0.0399 and P=0.0069 respectively) were affected only by sex. This implies that occupation, length of HIV diagnosis before ART commencement and duration of ART commencement and age group of study participants had no significant impact on the immunological and haematological response of subjects on either ZDV or TDF. However, the effect of sex on the granulocyte count and PCV of the two study group may be related to females generally having lower haematological values compared to males and to the myelosuppressive effect of ZDV on the other hand since the values of both granulocytes and PCV were lower in patients undergoing zidovudine therapy compared to their tenofovir counterparts.

6. Conclusion

In conclusion, in this study, the virologic and immunological response of HIV virus to PLHIVs on tenofovir and zidovudine-based antiretroviral therapy showed no statistical difference, the changes in Full Blood Count parameters amongst patients on the two drugs revealed that there was a difference in some haematological parameters (red blood cells and platelet counts) of subjects within the two study groups with their counts lower in subjects on zidovudine therapy. The activity of the two drugs-based therapy in terms of their virologic response (Viral load suppression) and host response (hematologic and immunologic) also showed the viral load and CD4 counts of subjects on zidovudine was statistically different from that of subjects on tenofovir. It is therefore recommended that more studies be carried out to evaluate the virological and immunological response of patients on these two therapies over a long

period of time as this study was limited by the inaccessibility to the initial parameters of the subjects both at the point of HIV diagnosis or ART commencement.

Conflicts of Interest

The authors declare no conflicts of interest.

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