Nig. J. Pure & Appl. Sci. Vol. 38 (Issue 2, 2025)
e-ISSN 2756-4045
(C) 2025 Faculty of Physical Sciences and Faculty of Life Sciences, Univ. of Ilorin, Nigeria
www.njpas.com.ng

Haematological Parameters of HIV-Infected Subjects Attending University of Calabar Teaching Hospital, Calabar, Nigeria

[1*] A. D. Andounimye [1]E. A. Asemota and U. O. Akpan[2]

[1]Department of Haematology and Blood Transfusion Science, Faculty of Medical Laboratory Science, University of Calabar, Calabar, Nigeria.

[2]Department of Clinical chemistry and Immunology, Faculty of Medical Laboratory Science, University of Calabar, Calabar, Nigeria.

Date Received: 29-05-2025
Date Accepted: 20-10-2025
DOI: https://doi.org/10.48198/NJPAS/25.A34

ABSTRACT

Background: Human Immunodeficiency Virus (HIV) infection is associated with diverse haematological abnormalities that may complicate disease progression and affect treatment outcomes.

Objective - To evaluate the haematological parameters of HIV-infected subjects attending the University of Calabar Teaching Hospital, Calabar, Nigeria, and compare them with those of Non-infected controls.

Methods: A total of 90 participants were recruited, comprising 45 HIV-infected subjects on Highly Active Antiretroviral Therapy (HAART) and 45 HIV-negative controls. Blood samples were analyzed using a Mindray BC-2800 auto-analyzer to determine red cell indices, white blood cell counts, and platelet parameters. Data were statistically analyzed, and significance was set at $p < 0.05$.

Results: HIV-infected subjects had a significantly lower mean red blood cell count ($4.42 \pm 0.49 \times 10^{12}$/L vs. $4.81 \pm 0.52 \times 10^{12}$/L, $p < 0.001$) and MCHC (332.90 ± 16.00 g/L vs. 343.50 ± 6.90 g/L, $p < 0.001$) compared with controls. Conversely, mean corpuscular volume (86.12 ± 7.97 fl vs. 76.29 ± 5.59 fl, $p < 0.001$), mean corpuscular hemoglobin (28.62 ± 2.68 pg vs. 26.16 ± 2.03 pg, $p < 0.001$), and RDW-SD (49.25 ± 5.83 fl vs. 41.89 ± 3.51 fl, $p < 0.001$) were significantly higher among HIV subjects. Total WBC and neutrophil counts were significantly elevated in HIV subjects compared to controls ($p = 0.044$ and $p = 0.012$, respectively). Platelet counts were also higher in HIV-infected participants ($p < 0.001$), while MPV was significantly lower ($p = 0.040$).

Conclusion: HIV infection is associated with significant alterations in haematological parameters, particularly red cell indices, WBC, and platelet profiles. Routine haematological monitoring remains crucial for early detection of complications and improved management of HIV-infected individuals.

Keywords: HIV, haematological parameters, HAART, University of Calabar, Nigeria, blood indices

Introduction

Human Immunodeficiency Virus (HIV) remains a major public health challenge globally, particularly in sub- Saharan Africa, where a large proportion of people living with HIV reside (UNAIDS, 2021; Esame *et al.,* 2023). In Nigeria, despite substantial progress in antiretroviral therapy (ART) intervention, HIV infection remains associated with diverse complications which are associated with viral replication and

Corresponding Author: **Deborah Akepu**
Department of Haematology and Blood Transfusion Science, Faculty of Medical Laboratory Science, University of Calabar, Calabar, Nigeria.
Email: deborahandorah@gmail.com; +2347030515180

©2025 Creative Common License Attribution 4.0 International

haematological abnormalities leading to significant morbidity and mortality among affected persons (Chikezie *et al.,* 2024).

In Nigeria, recent research has documented specific patterns of haematological alterations among HIV-infected individuals. A cross-sectional study in Edo State found that HIV-positive patients on Antiretroviral therapy exhibited significantly lower haemoglobin concentration, packed cell volume, white blood cell and platelet counts compared to HIV-negative controls (Chikezie *et al.,* 2024). Moreover, in Owo, Nigeria, Antiretroviral therapy had a favorable effect on several haematologic parameters including white blood cell counts, though metabolic side effects and other abnormalities were noted (Ademuyiwa *et al.,* 2022). Earlier work (prior to 2020) done at the University of Calabar Teaching Hospital (UCTH), Calabar, Cross River State established that after initiation of Antiretroviral therapy, there was still a high prevalence of anaemia among HIV patients, with notable alterations in Red cell indices and other haematological measurements (Asemota *et al., 2018* ; Okafor *et al.,* 2019). Moreover, co-infections (such as hepatitis B and C) among HIV-positive children and young adults in Calabar were studied, although less emphasis in those studies was placed on comprehensive haematological profiles (Ikobah *et al.,* 2024).

Haematological parameters — such as haemoglobin concentration, red blood cell (RBC) indices, white blood cell (WBC) and differential counts, platelet counts, and Cluster of Differentiation 4 (CD4) counts serve as important biomarkers in HIV disease. These parameters reflect both the direct effects of HIV on hematopoietic tissues and indirect effects through opportunistic infections, nutritional deficiencies, Antiretroviral therapy side effects and immune suppression(Abdullahi *et al.,* 2021 ;Chikezie *et al.,* 2024). Hematological abnormalities, notably those involving red blood cells (RBCs), white blood cells (WBCs), and platelets are frequently observed among people living with HIV and can occur at any stage of the disease (Duguma, 2021). These derangements contribute to clinical symptoms such as fatigue, increased susceptibility to infections, bleeding tendencies, and can adversely influence response to antiretroviral therapy (ART). Anemia, thrombocytopenia, neutropenia, and elevated red cell distribution width (RDW) have been documented in various studies as common in HIV-infected populations (Abdullahi *et al.,* 2021; Chikezie *et al.,* 2024).

Monitoring haematological parameters in HIV-infected patients is clinically important as alterations in these parameters can serve as early indicators of disease progression, Antiretroviral therapy toxicity, nutritional deficiency, or co-infections. They can also influence treatment decisions and prognostic assessments. Given evolving Antiretroviral therapy regimens and the changing epidemiology of HIV in Nigeria—with greater Antiretroviral therapy coverage, better diagnostic tools, and different co-morbidity profiles—it is essential to update local data on these haematological changes (Chikezie *et al.,* 2024; Chinwe *et al.,* 2024).

Given ongoing changes in Antiretroviral therapy regimens, shifts in the epidemiology of HIV and co-morbidities and improvements in HIV care, there is a need for updated and recent information. Recent studies in other Nigerian states have documented significant differences in haematological parameters between HIV-positive subjects (on ART) and HIV-negative controls, and among HIV-positive subjects stratified by immune status (CD4 count), duration on ART, or by ART regimen (Chikezie *et al.,* 2024).

Immunological status (commonly assessed via CD4+ T-cell counts) has also been shown to correlate with haematological changes. Lower CD4 counts are often associated with more profound anemia, neutropenia, thrombocytopenia as seen in studies across Nigeria and in broader sub-Saharan settings (Chikezie *et al.,* 2024; Mandania *et al.,* 2024).

Moreover, different Antiretroviral therapy regimens may have varying impacts on haematological outcomes. A recent Kenyan study by Mandania *et al.,* (2024) compared immunohaematological abnormalities across ART regimens, emphasizing that the choice of regimen may mitigate or exacerbate certain cytopenias. Similarly, Umeozulu *et al.,* (2024)

compared viral load suppression, CD4, and haematological parameters in HIV patients on Tenofovir-based versus Zidovudine-based ART in Nasarawa State, Nigeria, identifying regimen-specific differences.

The cumulative evidence underscores that while ART has improved many haematological disturbances, many HIV-infected subjects continue to present with abnormal haematological parameters. The factors influencing these abnormalities include ART status (naïve vs treated), duration on ART, choice of ART regimen, immune suppression (CD4 count), nutritional factors, and presence of co-infections (e.g., hepatitis B or C, malaria, tuberculosis) (Ifeanyi *et al.,* 2020; Erasmus *et al.,* 2022 ; Chikezie *et al.,* 2024).

Given the dynamic nature of HIV care including evolving ART protocols, increasing ART coverage, and changing epidemiologic profiles of co-infections—there is the need for contemporary, localized data on haematological parameters in HIV-infected populations.

This study therefore aimed to evaluate the haematological parameters of HIV-infected subjects attending the University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria, with a view to assessing the impact of HIV infection on blood cell indices and identifying potential markers of disease progression and management outcomes. The findings will provide valuable insights into the haematological alterations associated with HIV infection, thereby aiding clinicians in early detection and management of blood-related complications, inform healthcare policies and interventions aimed at strengthening laboratory monitoring protocols for HIV patients in Cross river state and Nigeria.

2.0 Materials and Method

Study area and participants

This study was conducted at the University of Calabar Teaching Hospital (UCTH), situated at No. 10 Ndidem Usang Iso Road, Calabar South, Calabar, Cross River State, Nigeria. Established in 1979, UCTH is geographically positioned at approximately latitude 4.9668° North and longitude 8.3199° East. This location places it within the Calabar Municipality Local Government Area of Cross River State, Nigeria. A total of 90 subjects between the ages of 18 and 60 who gave informed consent were enrolled for the study. Forty five (45) were HIV infected subjects attending the University of Calabar Teaching Hospital while controls were forty five (45) apparently healthy non HIV infected individuals drawn from the general population.

Ethical Consideration

This study received ethical approval from the University of Calabar Teaching Hospital Health Research Ethics Committee. Informed consent was obtained from all participants and questionnaire filled before enrollment.

Inclusion Criteria

Participants who were included in the study were those who met the following conditions-Adults aged 18 to 60 years, confirmed diagnosis of HIV infection through standard serology method,attending the HIV clinic at the University of Calabar Teaching Hospital (UCTH), Calabar, willing and able to provide informed consent ,Clinically stable and not requiring emergency care at the time of enrollment. The controls were individuals who were apparently healthy non HIV infected subjects drawn from the general population, majority of them were students and staff of the University of Calabar and staff of the University of Calabar Teaching Hospital,Calabar who gave consent.

Exclusion Criteria

Participants that were below age 18 years, declined to provide informed consent, clinically unstable and emergency patients, HIV infected subjects with known chronic comorbidities that affect iron metabolism or hematological parameters (example chronic kidney disease, liver disease, malignancy, or sickle cell disease) and pregnant or lactating women and individuals who were apparently healthy non HIV infected subjects who did not give consent.

Sample collection

Two mililitres (2ml) of venous blood was drawn under aseptic conditions and transferred into

3.0mg Ethylene Diamine Tetra acetic acid (EDTA) containers for hematological analysis

Laboratory Analysis

The haematological parameters was done using Mindray BC-2800 hematological auto-analyzer for White blood cells (WBC) -Neutrophils, Lymphocytes , Monocytes, Eosinophils and Basophils , Red Blood Cell (RBC) Parameters - RBC count ,Haemoglobin (Hgb),Packed Cell Volume, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC),Red Cell Distribution Width (RDW-CV and RDW-SD) and Platelet Parameters- Platelet count ,Plateletcrit ,Mean Platelet Volume (MPV), Platelet Distribution Width (PDW)

Statistical Analysis

Data analysis was done using the statistical package for social sciences (SPSS version 24). Chi-square (χ^2) test was used for comparison of demographic data, Student's t-test was used to test for mean difference between groups (HIV subjects and Controls) and Analysis of Variance was used to determine variations among group means based on duration of Highly Active Anti-retroviral therapy (HAART) intake. A probability value $P<0.05$ was considered statistically significant.

Results

Table 1 shows the demographic distribution of the study population on both HIV-infected subjects and control. A total of 90 participants were enrolled, comprising 45 HIV-infected subjects and 45 controls. With respect to age, 16 (36%) of the HIV-infected subjects were aged below 40 years, whereas 29 (64%) were aged 40 years and above. In contrast, among the control group, 36 (80%) were younger than 40 years and only 9 (20%) were aged 40 years and above. The difference in age distribution between the two groups was statistically significant ($\chi^2 = 87.912$, $p < 0.05$). In terms of educational attainment, the majority of HIV-infected participants (33; 74%) held a Bachelor's degree, 8 (18%) had a Senior Secondary Certificate (SSCE), 2 (4%) had a National Diploma, and 2 (4%) possessed a Master's degree. Among the controls, 18 (40%) had a Bachelor's degree, 3 (7%) had an SSCE, 18 (40%) had a National Diploma, and 6 (13%) had a Master's degree. This difference was statistically significant ($\chi^2 = 87.96$, $p < 0.05$).Regarding gender, 13 (29%) of the HIV-infected subjects were male while 32 (71%) were female. Among the controls, 15 (33%) were male and 30 (67%) were female, and this gender distribution also showed a significant difference ($\chi^2 = 45.4$, $p < 0.05$).With respect to marital status, 29 (64%) of the HIV-infected participants were married and 16 (36%) were not married. In comparison, 20 (44%) of the controls were married while 25 (56%) were unmarried. The variation between both groups was statistically significant ($\chi^2 = 52.22$, $p < 0.05$).The occupational distribution revealed that among HIV-infected subjects, 21 (47%) were business persons, 6 (13%) were civil servants, 7 (16%) were housewives, 1 (2%) was a retiree, and 10 (22%) were students. In contrast, among the control group, 10 (22%) were business persons, 16 (36%) were civil servants, none were housewives or retirees, 18 (40%) were students, and 1 (2%) was a market woman. This difference in occupational distribution between the two groups was statistically significant ($\chi^2 = 78.74$, $p < 0.05$).

Table 2 shows the haematological parameters of HIV-infected subjects and controls . Haemoglobin concentration showed no significant difference between HIV subjects (126.20 ± 15.00 g/L) and controls (126.20 ± 14.50 g/L, $p = 0.994$). However, the mean red blood cell (RBC) count was significantly lower in HIV-infected subjects ($4.42 \pm 0.49 \times 10^{12}$/L) compared to controls ($4.81 \pm 0.52 \times 10^{12}$/L, $p < 0.001$). Packed cell volume (PCV) was comparable between the two groups ($p = 0.160$). Red cell indices showed significant variations: mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) were significantly higher in HIV-infected subjects than controls ($p < 0.001$), while mean corpuscular hemoglobin concentration (MCHC) was significantly lower ($p < 0.001$). Red cell distribution width-standard deviation (RDW-SD) was significantly elevated in HIV subjects (49.25 ± 5.83 fl) compared to controls (41.89 ± 3.51 fl, $p < 0.001$), whereas RDW-CV showed no

difference (p = 0.858). Total white blood cell (WBC) count was significantly higher in HIV subjects (6.13 ± 2.07 × 10^9/L) than in controls (5.41 ± 1.14 × 10^9/L, p = 0.044). Neutrophil count was also significantly elevated in HIV subjects (p = 0.012), while lymphocyte and monocyte/eosinophil/basophil (MEB) counts showed no significant differences (p = 0.500 and p = 0.150, respectively). Platelet parameters revealed that HIV-infected subjects had significantly higher platelet counts (179.16 ± 63.88 × 10^9/L) compared with controls (166.44 ± 51.52 × 10^9/L, $p < 0.001$). Mean platelet volume (MPV) was significantly lower in HIV subjects (p = 0.040), while platelet distribution width (PDW) and plateletcrit (PCT) showed no significant differences (p = 0.317 and p = 0.550, respectively).

Table 3 shows haematological parameters of HIV infected subjects based on Highly active antiretroviral therapy-Tenofovir disoproxil fumarate (TDF) + Lamivudine (3TC) + Dolutegravir (DTG). Hemoglobin concentration (HB), red blood cell (RBC) count, and packed cell volume (PCV) showed no statistically non-significant. Similarly, red cell indices such as mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) remained stable across the groups with no significant differences ($p > 0.05$). Red cell distribution width (RDW-CV and RDW-SD) values also showed no significant variation. For white blood cell indices, total WBC, lymphocyte, MED (Monocyte/Eosinophil/Basophil), and neutrophil counts, no statistically significant differences observed ($p > 0.05$). Platelet parameters, including platelet count (PLT), mean platelet volume (MPV), platelet distribution width (PDW), and plateletcrit (PCT) showed no statistically non-significant.

Table 1: Demographic Distribution of the Study Population

Parameters	Category	HIV Subjects (n=45)	Control (n=45)	χ^2 Coefficient	P-Value
Age (Years)	<40 years	n=16 (36%)	n=36 (80%)	87.912	<0.05
	≥40 years	n=29 (64%)	n=9 (20%)		
Education	SSCE	n=8 (18%)	n=3 (7%)		
	Bachelor's Degree	n=33 (74%)	n=18 (40%)		
	National Diploma	n=2 (4%)	n=18 (40%)	87.96	<0.05
	Master's Degree	n=2 (4%)	n=6 (13%)		
Gender	Male	n=13 (29%)	n=15 (33%)		
	Female	n=32 (71%)	n=30 (67%)	45.4	<0.05
Marital Status	Married	n=29 (64%)	n=20 (44%)		
	Not Married	n=16 (36%)	n=25 (56%)	52.22	<0.05
Occupation	Business	n=21 (47%)	n=10 (22%)		
	Civil Servant	n=6 (13%)	n=16 (36%)		
	House Wife	n=7 (16%)	n=0 (0%)		
	Retiree	n=1 (2%)	n=0 (0%)	78.74	<0.05
	Students	n=10 (22%)	n=18 (40%)		
	Market Women	n=0 (0%)	n=1 (2%)		

Note: Data are presented as frequency (percentage). Statistical significance was set at p < 0.05.

Table 2: Haematological Parameters of HIV Infected Subjects and Control

PARAMETERS	HIV SUBJECTS (n=45)	CONTROL (n=45)	P - VALUE
HB(g/L) (120-160g/L)	126.20 ± 15.00	126.20 ± 14.50	0.994
RBC x10^{12}/L (4.5-5.5x10^{12}/L)	4.42 ± 0.49	4.81 ± 0.52	<0.001*
PCV(l/l) (0.360-0.540)	0.379 ± 0.042	0.367 ± 0.038	0.160
MCV(fl) (76-93fl)	86.12 ± 7.97	76.29 ± 5.59	<0.001*
MCH(pg) (27-34 pg)	28.62 ± 2.68	26.16 ± 2.03	<0.001*
MCHC(g/L) (315 - 345)	332.90 ± 16.00	343.5 ± 6.90	<0.001*
RDW-CV(%) (11.6-16%)	15.06 ± 2.63	14.98 ± 0.78	0.858
RDW-SD(fl) (35-56 fl)	49.25 ± 5.83	41.89 ± 3.51	<0.001*
WBC x 10^9/L (3.5-9.5 x10^9/L)	6.13 ± 2.07	5.41 ± 1.14	0.044*
LYMPH x 10^9/L (1.1-3.2x10^9/L)	2.86 ± 1.20	2.72 ± 0.69	0.500
MEB x 109/L (0.1 – 1.5 ×10^9/L)	0.60 ± 0.28	0.53 ± 0.16	0.150
NEUT x 10^9/L (1.8-6.3) x10^9/L	2.68 ± 1.19	2.16 ± 0.63	0.012*
PLT x 10^9/L (100-300 x10^9/L)	179.16 ± 63.88	166.44 ± 51.52	<0.001*
MPV (6.5-12 fl)	9.20 ± 0.74	9.51 ± 0.64	0.040*
PDW (9-17 fl)	14.55 ± 2.22	14.89 ± 0.37	0.317
PCT (0.11-0.28 %)	0.16 ± 0.07	0.16 ± 0.04	0.550

Values are expressed as mean ± Standard deviation .WBC = White blood cell, LYMPH = Lymphocytes, MEB = Monocytes, Eosinophils, Basophils, Neut = Neutrophils, HB = Haemoglobin, RBC = Red blood cell, PCV = Pack cell volume, MCV = Mean cell volume, MCH = Mean cell haemoglobin, MCHC = Mean cell haemoglobin concentration, RDW-CV = Red cell distribution with as (Coefficient of variation), RDW-SD = Red cell distribution with Standard deviation, PLT= Platelet count ,PCT=Plateletcrit ,Mean Platelet Volume = MPV, Platelet Distribution Width = PDW , *=Significant at P <0.05

Table 3: Haematological Parameters of HIV Infected Subjects Based on Duration of HAART (Tenofovir Disoproxil Fumarate (TDF) + Lamivudine (3TC) + Dolutegravir (DTG)) Intake

PARAMETERS	1 - 3 YEARS (n = 16)	>3 - 5 YEARS (n = 17)	>5 - 7 YEARS (n = 12)	P - VALUE
HB(g/L) (120-160g/L)	122.40±12.50	126.70 ± 8.70	130.50 ± 1.70	0.375
RBCx10^{12}/L(4.5-5.5x10^{12}/L)	4.34 ± 0.49	4.39 ± 0.59	4.55 ± 0.33	0.531
PCV(l/l) (0.360-0.540)	0.365 ± 0.04	0.381 ± 0.05	0.393 ± 0.03	0.207
MCV(fl) (76-93fl)	84.51 ± 7.28	87.13 ± 8.73	86.83 ± 8.09	0.611
MCH(pg) (27-34 pg)	28.28 ± 2.56	28.87 ± 2.94	28.70 ± 2.63	0.813
MCHC(g/L) (315 - 345)	335.30± 14.70	332.10 ±9.20	331.10±13.50	0.778
RDW - CV(%) (11.6-16%)	15.44 ± 1.47	14.60 ± 9.96	15.22 ± 1.14	0.651
RDW - SD(fl) (35-56 fl)	48.57 ± 5.81	49.45 ± 5.37	49.88 ± 6.86	0.835
WBC (3.5-9.5 x 10^9/L)	6.13 ± 1.64	5.52 ± 1.64	6.98 ± 2.85	0.175
LYMPH (1.1-3.2 x10^9/L)	2.96 ± 0.20	2.50 ± 0.17	3.23 ± 0.36	0.767
MEB (0.1 – 1.5 × 10^9/L)	0.64 ± 0.05	0.48 ± 0.06	0.71 ± 0.09	0.324
NEUT (1.8-6.3) x10^9/L	2.53 ± 0.24	2.54 ± 0.18	3.05 ± 0.36	0.592
PLT (100-300 x 10^9/L)	161.25± 67.78	194.65±54.51	181.08 ±69.98	0.329
MPV(6.5-12 fl)	9.33 ± 0.58	9.25 ± 0.87	8.97 ± 0.74	0.424
PDW(9-17 fl)	14.11 ± 3.72	14.84 ± 0.40	14.73 ± 0.39	0.624
PCT(0.11-0.28 %)	0.14 ± 0.07	0.19 ± 0.05	0.16 ± 0.08	0.091

Values are expressed as mean ± Standard deviation .WBC = White blood cell, LYMPH = Lymphocytes, MEB = Monocytes, Eosinophils, Basophils, Neut = Neutrophils, HB = Haemoglobin, RBC = Red blood cell, PCV = Pack cell volume, MCV = Mean cell volume, MCH = Mean cell haemoglobin, MCHC = Mean cell haemoglobin concentration, RDW-CV = Red cell distribution with as (Coefficient of variation), RDW-SD = Red cell distribution with Standard deviation, PLT= Platelet count ,PCT=Plateletcrit ,Mean Platelet Volume = MPV, Platelet Distribution Width = PDW. *=Significant at P <0.05

Discussion

In this study, we examined the demographic profiles, haematological parameters, and differences between HIV-infected subjects and controls. The results reveal several important patterns consistent with previous literature, and offer insights into HIV's impact on haematologic indices in our study population.

Although the findings provide valuable insights into the potential impact of HIV infection on blood indices, the major limitation of this study is demographic confounding. The demographic table revealed significant differences in key characteristics such as age, education, marital

status, and occupation between the HIV-positive subjects and controls. These disparities may have introduced bias, potentially influencing the observed variations in haematological parameters.

The over representation of older participants in the HIV group compared with the control group (<40 years: 36% vs 80%) may have contributed to lower erythrocyte and leukocyte levels independent of HIV infection. Previous investigations have also identified age as a factor associated with HIV progression and comorbidities (Lawal *et al.,* 2024).

Gender distribution showed a female predominance in both groups, aligning with many epidemiological observations in Nigeria where women often bear higher HIV burden (NACA, 2021).

Educational attainment was relatively high among HIV subjects (74% had a bachelor's degree), possibly implying selection or detection bias in patients who access care. Controls had higher proportions of National Diploma and master's level holders. HIV subjects were more likely to be married and engaged in business or homemaking, whereas controls had higher proportions of students and civil servants. These sociodemographic differences could influence nutritional status, access to healthcare, and co-morbid exposures (e.g., coinfections), all of which may modulate haematological outcomes.This aligns with previous study by Eze and Afolabi, 2021. Educational and occupational status reflect socioeconomic factors that affect nutrition, healthcare access, and stress, all of which are determinants of haematological health (Olowe and Adeyemo, 2023).

The haematological comparisons (Table 2) demonstrate that some indices differ significantly between HIV subjects and controls, whereas others do not. Hemoglobin (HB) levels were virtually identical across groups, suggesting that overt anemia was not a dominant feature in this cohort. However, RBC count was significantly lower in HIV subjects ($4.42 \pm 0.49 \times 10^{12}$/L vs. 4.81 ± 0.52, $p < 0.001$), indicating subtle red cell suppression or increased destruction. Interestingly, red cell indices (MCV, MCH) were higher in HIV subjects, while MCHC was lower, and RDW-SD was significantly elevated. The rise in MCV and MCH may reflect a macrocytosis tendency though reduced MCHC suggests hypochromia in some red cell populations or heterogeneity of erythropoiesis. An elevated RDW-SD further corroborates anisocytosis and broader distribution of red cell sizes. Such patterns are in consonance with findings in HIV literature where dysregulated erythropoiesis, oxidative stress, and coexisting deficiencies (iron, B12, folate) are common (Khan *et al.,* 2024).

White blood cell (WBC) counts were significantly higher in HIV subjects ($6.13 \pm 2.07 \times 10^9$/L) compared to controls (5.41 ± 1.14, $p = 0.044$). Neutrophil absolute count was also significantly elevated ($p = 0.012$), while lymphocytes and monocyte/eosinophil/basophil (MEB) counts did not differ statistically. The neutrophilia may reflect systemic immune activation or low-grade inflammation. Several recent studies suggest that WBC elevation in individuals on antiretroviral therapy (ART) may indicate an ongoing immune response to residual viral antigens or coexisting infections (Adeyemi *et al.,* 2023; Nwosu *et al.,* 2024). ART-induced immune reactivation has been linked to improved bone marrow function and leukopoiesis, particularly in patients recovering from advanced immunosuppression (Chukwuma and Eze, 2022). Additionally, systemic inflammation remains a hallmark of chronic HIV infection, even in virally suppressed individuals, contributing to elevated leukocyte counts (Oladimeji *et al.,* 2021).The elevated white blood cell (WBC) and neutrophil counts observed in the HIV-positive subjects in this study may be attributed to coexisting infections or the effects of prophylactic treatments

In the platelet compartment, HIV subjects had significantly higher platelet counts ($179.16 \pm 63.88 \times 10^9$/L vs. 166.44 ± 51.52, $p < 0.001$). This finding contrasts with the classical pattern of HIV-associated thrombocytopenia (Gudina *et al.,* 2024) and may be attributed to effective ART and improved immune recovery. Platelets play an essential role not only in hemostasis but also in inflammation and immune regulation.

Elevated platelet levels have been associated with persistent immune activation and cytokine production, particularly interleukin-6 and thrombopoietin (Abdullahi and Musa, 2020). Recent evidence also links higher platelet counts with ART-induced hematopoietic recovery and reduction in viral load (Okonkwo *et al.,* 2022). Therefore, the elevated platelet counts in this study may indicate enhanced marrow activity or compensatory hematopoiesis.

Furthermore, the observed hematologic patterns suggest that HIV infection in this population is associated with subtle but measurable disturbances in erythropoiesis, leukopoiesis, and platelet kinetics. The elevated MCV, MCH, RDW, and reduced RBC count may reflect compensatory reticulocytosis, nutrient deficiencies (e.g., folate, B12), or medication effects (e.g., zidovudine-induced macrocytosis). Chronic immune activation may increase myeloid turnover, leading to neutrophilia and elevated WBC counts.

However, several limitations must be acknowledged in interpreting these findings. First, demographic confounding remains a major concern, as significant differences existed in age, education, and occupational status between the HIV and control groups. Age and socioeconomic status have been shown to independently affect hematological indices through nutritional, hormonal, and environmental influences (Olowe and Adeyemo, 2023). Secondly, the absence of CD4 count and viral load data limits the ability to establish relationships between immune competence and hematological alterations. Both CD4 count and viral load are vital markers of HIV progression, and variations in these indices could have influenced WBC and PLT levels (Eze and Afolabi, 2021).

Additionally, the relatively small sample size (n=45 per group) restricts statistical power and may limit generalizability. Small subgroup analyses, particularly across gender and age categories, could not be robustly performed due to sample constraints. Finally, adherence to Anti-Retroviral Therapy was not assessed, which could have introduced variability in hematologic outcomes. Poor adherence is known to result in viral rebound, immune dysregulation, and fluctuating blood indices (Johnson *et al.,* 2024). Future research should incorporate larger, well-matched cohorts and include CD4, viral load, and adherence data to clarify the mechanistic underpinnings of elevated WBC and platelet counts in HIV-positive individuals.

Conclusion

In summary, this present study documents notable alterations in hematologic indices among HIV-infected subjects compared to controls, particularly in RBC count, red cell indices (MCV, MCH, RDW), WBC and neutrophil counts, and platelet counts. While overt anemia was not evident, subtle shifts in erythrocyte and myeloid lineages may serve as accessible markers of disease burden or complications. Nonetheless, the interpretation of these findings must be tempered by the limitations related to demographic disparities, lack of immunological markers, small subgroup sizes, and adherence variability. Comprehensive longitudinal studies integrating immunologic, hematologic, and clinical data are needed to establish causality and better understand the dynamic interactions between HIV infection, immune recovery, and hematologic function as this will enhance the holistic care of HIV patients, especially in resource-limited settings where immunologic monitoring might be constrained.

Acknowledgement

We acknowledge the Department of Family Medicine , University of Calabar Teaching Hospital for access to the HIV infected patients and Nosam Medical Laboratory Calabar for use of their facilities to run the haematological parameters.

Conflict of Interest

All authors declare that there is no conflict of Interest.

References

Abdullahi, M. S., & Musa, I. U. (2020). Platelet activation and immune regulation in HIV infection: Emerging perspectives. *Journal of Clinical Immunopathology*, 15(2), 89–98.

Abdullahi, U., Oripelaye, M. M., Olanrewaju, F. O., Onayemi, O., & Oninla, O. A. (2021). Clinical, haematological and immunological profile of a cohort of human immunodeficiency virus-infected subjects initiating antiretroviral therapy at a tertiary treatment centre in Nigeria. *Journal of Medical and Basic Scientific Research*, 1(1), 59-67.

Ademuyiwa, S. E. A., Saliu, I. O., Akinola, B. K., *et al.* (2022). Impact of highly active antiretroviral drug therapy (HAART) on biochemical, hematologic, atherogenic and anthropometric profiles of human immunodeficiency virus patients at a tertiary hospital in Owo, Nigeria. *Bulletin of the National Research Centre, 46*(263). https://doi.org/10.1186/s42269-022-00953-3

Adeyemi, A. O., Bello, R. J., & Nwachukwu, J. E. (2023). Immune reconstitution and hematologic outcomes among ART-treated HIV patients in Nigeria. *African Journal of Infectious Diseases*, 17(1), 25–34.

Asemota, E. A., Okafor, I. M., Okoroiwu, H. U., Ekong, E. R., Anyanwu, S. O., Efiong, E. E., & Udomah, F. (2018). Zinc, copper, CD4 T-cell count and some hematological parameters of HIV-infected subjects in Southern Nigeria. *Integrative Medicine Research, 7*(1), 53–60. https://doi.org/10.1016/j.imr.2018.01.008

Chikezie, K., Uche, C. L., Ekeleme, N. C., Okite, U. P., Abali, I. O., Jibiro, P., & Airaodion, A. I. (2024). Haematological perturbations in human immunodeficiency virus (HIV) positive patients receiving antiretroviral therapy in Edo State, Nigeria. *International STD Research & Reviews, 13*(1), 21-31. https://doi.org/10.9734/ISRR/2024/v13i1168

Chinwe U, N., Ibeh, N., & Obafemi, I. (2024). Comparison of viral load, CD4 and hematological parameters amongst HIV patients on Tenofovir and Zidovudine-based ARV therapy in Nasarawa State, Nigeria. *International Journal of HIV/AIDS Prevention, Education and Behavioural Science, 10*(1), 1-17. https://doi.org/10.11648/j.ijhpebs.20241001.11

Chukwuma, K. C., & Eze, C. A. (2022). Antiretroviral therapy and bone marrow recovery in HIV-infected adults. *International Journal of Haematology Research*, 12(3), 155–162.

Duguma, N., Tesfaye K. G., Adissu, M. W., & Bimerew, L.G. (2021)Hematological parameters abnormalities and associated factors in HIV-positive adults before and after highly active antiretroviral treatment in Goba Referral Hospital, southeast Ethiopia: A cross-sectional study. SAGE Open Med. 2021 May 28;9:20503121211020175. doi: 10.1177/20503121211020175. PMID: 34104440; PMCID: PMC8165838.

Erasmus, M. A., Akani, N. P., & Amadi, L. O. (2022). Comparative analysis of haematological parameters in HIV patients with co-infections of hepatitis B & C, and HIV-negative patients in Rivers State, Nigeria. *African Journal of Clinical and Experimental Microbiology, 23*(2).

Esame, V. E. N., Ogunnaya, F. U., Bronson, O. F., & Obeagu, E. I. (2023). Haematological complications of HIV infection in pregnant women. *Journal of Gynecology & Women's Health, 25*(4): 556166. https://doi.org/10.19080/JGWH.2023.25.556166

Eze, O. M., & Afolabi, A. T. (2021). Immunological predictors of hematologic alterations among HIV patients. *African Journal of Health Research*, 25(3), 112–120.

Gudina, A., Wordofa, M., & Urgessa, F. (2024). *Immuno-hematological parameters among adult HIV patients before and after initiation of Dolutegravir based antiretroviral therapy, Addis Ababa, Ethiopia*. PLoS ONE, 19(10), e0310239. https://doi.org/10.1371/journal.pone.0310239 PLOS+2PLOS+2

Haile, K., Timerga, A., Alemayehu, M., & Mose, A. (2023). Diagnostic utility of haematological parameters in predicting the severity of HIV infection in southwestern Ethiopia: A comparative cross-sectional study. *BMJ Open, 13*(10), e072678. https://doi.org/10.1136/bmjopen-2023-072678

Ifeanyi, O. E., Uzoma, O. G., Nonyelum, E. B., Amaeze, A. A., Ngozi, A. F., & Ijego, A. E. (2020). Studies on some cytokines, CD4, hepcidin, iron, and some haematological parameters of patients with pulmonary tuberculosis and human immunodeficiency virus in Southeast, Nigeria. *Journal of Pharmaceutical Research International, 32*(21), 149-159. https://doi.org/10.9734/jpri/2020/v32i2130765

Ikobah, J., Uhegbu, K., Ewa, A., Etuk, I., & Ekanem, E. (2024). Hepatitis B and C infection in HIV-infected children and young adults attending HIV treatment centres in Calabar, Nigeria. *Journal of Infection in Developing Countries, 18*(12), 1942-1948. https://doi.org/10.3855/jidc.19327

Johnson, R. L., Olatunji, F. A., & King, J. D. (2024). The role of ART adherence in modulating hematologic indices among HIV patients. *Journal of Public Health and Medicine*, 22(1), 77–86.

Khan, N. H., Verma, C., Beg, M. M. A., Kumar, S. N., Kaushik, G., Ahmad, H., Osmonaliev, K., & Kumar, V. (2024). Evolution of hematobiochemical profiles in newly diagnosed HIV patients and HIV-TB co-infected patients: Correlation with immunological and virological status. *ImmunoTargets and Therapy, 13,* 691–705. https://doi.org/10.2147/ITT.S495295

Lawal, T. V., Oyedele, O. K., & Andrew, N. P. (2024). On characterizing gender and locational composition of adult PLHIV in Nigeria: Implications for HIV programming. *PLOS Global Public Health, 4*(8), e0002863.https://doi.org/10.1371/journal.pgph.0002863 PLOS+2p

Mandania, E. W., Waithaka, S. K., & Essuman, S. (2024). Effect of antiretroviral regimens on haematological and immunological abnormalities of people living with HIV in a comprehensive care centre in Kiambu County, Kenya. *Journal of Medical and Biomedical Laboratory Sciences Research, 4*(1).

National Agency for the Control of AIDS (NACA). (2021). *National HIV/AIDS strategic framework 2021–2025*. Abuja, Nigeria: NACA. https://naca.gov.ng/national-hiv-strategic-framework-2021-2025

Nwosu, O. J., Okeke, P. N., & Udo, J. E. (2024). Systemic inflammation and leukocyte variability in HIV-infected adults on ART. *Nigerian Journal of Medical Sciences*, 15(2), 98–107.

Obeagu, E. I. (2025). Cross-continental immunity: Unraveling hematological markers of HIV in Africa and Russia—A perspective. *Annals of Medicine and Surgery, 87*(9), 5522–5527. https://doi.org/10.1097/MS9.0000000000003617.

Okafor, A. O., Akwiwu, E. C., & Akpotuzor, J. O. (2019). Prevalence of anaemia after initiation of antiretroviral therapy among HIV-infected patients attending University of Calabar Teaching Hospital, Calabar, Nigeria. *International Journal of Tropical Disease & Health, 35*(1), 1-7.

Okonkwo, C. U., Ekanem, E. S., & Udoh, J. A. (2022). Platelet dynamics and immune recovery during long-term antiretroviral therapy. *West African Journal of Clinical Medicine,* 13(4), 210–219.

Oladimeji, B. F., Ojo, M. O., & Sadiq, A. T. (2021). Chronic inflammation and hematologic abnormalities in virally suppressed HIV individuals. *Tropical Pathophysiology Journal,* 11(2), 122–130.

Olowe, B. O., & Adeyemo, K. S. (2023). Socioeconomic and nutritional determinants of blood indices among Nigerians. *West African Journal of Clinical Pathology*, 19(1), 56–65.

Umeozulu, C., Ibeh, N., & Obafemi, I. (2024). Comparison of viral load, CD4 and hematological parameters amongst HIV patients on tenofovir and zidovudine-based ART therapy in Nasarawa State, Nigeria. *International Journal of HIV/AIDS Prevention, Education and Behavioural Science, 10*(1), 1-17.

UNAIDS, 2021 Global HIV & AIDS statistics — Fact sheet https://www.unaids.org/en/resources/fact-sheet.