

Prevalence and associated factors of cytopenia among people living with human immunodeficiency virus at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia

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ABSTRACT

Background: Hematological abnormalities are associated with increased risk of disease progression and death in people infected with human immunodeficiency virus (HIV). However, distribution and risk factors of cytopenia in people living with HIV (PLHIV) who are on anti-retrovirus treatment (ART) are not well investigated. Thus, this study aimed to estimate the prevalence and associated factors of cytopenia among PLHIV and on ART at Saint Paul's Hospital Millennium Medical College (SPHMMC), Addis Ababa, Ethiopia.

Methods: A hospital-based cross-sectional study was conducted from June to August 2021 among 387 PLHIV. The associated factors of cytopenia at baseline and at six months were analyzed using an ordinal regression model, and cross tabulation after at least 6 months of ART in SPHMMC.

Results: The prevalence of cytopenia was 42.8% among PLHIV. There was a significant increase in the mean values of CD4 count, white blood cell (WBC) count, hemoglobin (HGB), mean cell hemoglobin concentration (MCHC) and platelets (PLT) while there was a decrease in red blood cell distribution width (RDW) after at least six months on ART compared with the baseline. There was also significant decrease in the prevalence of anemia and thrombocytopenia after at least on ART for six months compared to the baseline. CD4 cell count < 200 cells/ μ L (AOR = 4.8, 95% CI (1.2–18.8), $p = 0.023$), being female (AOR = 6.7, 95% CI (1.3–34.4), $p = 0.022$, co-infection with hepatitis B virus (HBV) (AOR = 4.8, 95% CI (1.5–15.9) $p = 0.010$), BMI < 18.5 kg/m² (AOR = 5.9 95% CI (3.0–11.5), $p < 0.001$) and absence of opportunistic infections (AOR = 0.65 (0.45–0.93), $p = 0.019$) were significantly associated with cytopenia after six months on antiretroviral.

Conclusion: The prevalence of cytopenia is significantly high at the baseline of the study. Early detection could decrease the prevalence of cytopenia among PLHIV. Monitoring of hematological parameters among PLHIV and on ART is vital to reduce cytopenia.

Keywords: Cytopenia, Human immunodeficiency virus, Hematological diseases, Anti-retroviral therapy

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This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International license. Address correspondence to Shiferaw G et al. getachewshiferaw24@gmail.com. The authors declare that they have no competing interests. The views expressed in this article do not necessarily reflect the views of HAJHBS. Submitted: September 08, 2025 | Revised: December 28, 2025 | Accepted: December 30, 2025 | Published: August 25, 2026

BACKGROUND

Approximately 38 million individuals are living with HIV worldwide, and 70% of those infected are living in sub-Saharan Africa (1). East and Southern Africa is the region most significantly affected by HIV. Though the region is home to 6.2% of the population of the world, it has 19.4 million people living with HIV, which is greater than 50% of the global burden (1).

Thrombocytopenia is a frequent hematologic disorder in PLHIV (1,2). It is defined as platelet counts less than 150,000 cells per microliter with further classification into mild (100,000-150,000 cells per microliter), moderate (50,000-100,000 cells per microliter) and severe (platelet counts less than 50,000 cells per microliter) (1).

The prevalence of thrombocytopenia ranges from 4.5% to 26.2% across the world in PLHIV (1,2). Moreover, a prevalence of thrombocytopenia is 26% in Canada and 5.5% in Denmark although patients studied have undetectable viral load, which may have contributed to the low prevalence of thrombocytopenia (1). HIV ribonucleic acid (RNA) more than 400 copies/ml, hepatitis c virus (HCV) infection and cirrhosis are significantly associated with thrombocytopenia (1,3) among PLHIV.

Studies demonstrated that thrombocytopenia has been associated with demographic,

clinical, medication related factors and other secondary causes (1,2,3). It was independently associated with older age groups, male gender, Zidovudine (ZDV) based regimen, CD4 count less than 200 cells/mm³, HBV and HCV co-infection and viremia (1,3). It is also associated with duration on ART, clinical stages (1,4). However, the effect of helicobacter pylori, connective tissue diseases (CTD) (like idiopathic thrombocytopenic purpura and systemic lupus erythematosus) and hypersplenism on the thrombocytopenia are not well studied.

A study carried out in Brazil with 55 PLHIV revealed that 63.6% of patients had idiopathic thrombocytopenic purpura while 25.5% had a platelet production deficiency, both secondary to HIV infection (1,3 ,4). The presence of thrombocytopenia may change according to the CD4+ T lymphocyte count, the presence of opportunistic infections and the ART treatment (1,5,6).

Leucopenia is one of the hematological abnormalities encountered commonly in PLHIV (7). The most common form of leucopenia usually encountered is neutropenia, occurring in 10-30% of the HIV infected individuals (2,7). Neutropenia is caused by decreased production of cells because HIV suppresses the bone marrow by changing the marrow microenvironment and altering the cytokine expression (2).

Anemia is the most common hematological abnormality in HIV seropositive patients and its incidence is strongly associated with the progression of the disease (2,6,7). Up to 90% of adults can develop anemia during an HIV infection and especially in individuals with advanced disease and CD4+ T- cell count (2).

Although cytopenias have been widely reported in HIV infection, there is little data regarding the prevalence and associated factors of thrombocytopenia among PLHIV and on ART in Ethiopia. This study provided further information and it can serve as a reference material for further researches with regards to thrombocytopenia in PLHIV. Therefore, this study aimed to determine prevalence and associated factors of thrombocytopenia among PLHIV who are on ART in SPHMMC, Addis Ababa, Ethiopia.

METHODS

Study area and design

A hospital based cross-sectional study design was conducted among adult PLHIV and on ART at least for six months at SPHMMC ART clinic. SPHMMC is the second largest specialized referral hospital in Addis Ababa Ethiopia. Currently, there are a total of 5077 PLHIV who are attending ART clinic. Around 1750 PLHIV are getting services monthly. The average appointment period for follow up is 4 months. The study was conducted from June to August, 2021.

Inclusion and exclusion criteria

All PLHIV who were older than 18 years and on ART at least for six months at SPHMMC ART clinic were included to this study. However, pregnant women, individuals with incomplete records, missing blood test results and those who have received chemotherapeutic agents (for any malignancy) within six months prior to the study were excluded from the study.

Sample size determination and sampling technique

The required sample size was calculated using the single population proportion formula, considering a 35.3% prevalence of cytopenia from a previous similar study (2), 95% confidence level, 5% marginal of error, and 20% of data missing. Accordingly, a total sample size of 387 was determined. The sample size was also calculated for the factors associated with cytopenia, however, the larger sample size which determined by single population proportion was taken for this study.

The total number of charts of PLHIV and on ART during the study period (from June 01 to August 30, 2021) were selected using systematic random sampling. Charts were ordered by serial number in the ART registration and identified by their medical record numbers. After randomly selecting the first chart, every 12th

chart was included in the study. The sampling process continued until the required sample

size was achieved.

Data collection tools

Data was collected using structured data extraction checklists which was adopted from previous studies (2,5,8,9,10,11,12). Data was collected on socio-demographic, clinical, laboratory, immunological and ART (cytopenia and Thrombocytopenia) related characteristics (2).

Data processing and analysis

Data was coded, entered and cleaned using SPSS version 25 statistical software for further analysis. Frequencies and cross tabulations were used to summarize descriptive statistics. Ordinal logistic regression model was used to assess the association between the dependent and independent variables. The degree of association between dependent and independent variables was expressed by using odds ratio with 95% confidence interval. Tables and graphs were used with text description for data presentation.

RESULTS

Sociodemographic characteristics

A total of 387 charts of PLHIV and on ART at SPHMMC were included into the study. The age ranged from 18 to 76 years with a mean age of 42.2 ($\pm$ 10.3 standard deviation (SD)) years. One hundred forty-four (37%) of the participants were between 40 to 49 years,

whereas only 28 (7.2%) younger than 29 years and 15 (3.9) % older than 65 years. Out of the total study participants, 244(63 %) were females, 354(91.5%) were urban dwellers, and 171 (44.2%) were married. Of the total participants, 155 (40.1%) attended secondary school while 131 (34%) attended primary schools (Table 1).

Table 1: Sociodemographic characteristics of HIV positive adult individuals taking ART at SPHMMC ART clinic, Addis Ababa, Ethiopia, 2021 (n = 387).

Variable		n	%
Age (in years)	18-29	28	7.2
	30-39	131	33.9
	40-49	144	37.2
	50-64	69	17.8
	≥ 65	15	3.9
Sex	Male	143	37.0
	Female	244	63.0
Residence	Urban	354	91.5
	Rural	33	8.5
Marital status	Never married	97	25.1
	Married	171	44.2
	Divorced	67	17.3
	Widowed	45	11.6
Educational status	No education	40	10.3
	Primary	131	33.9
	Secondary	155	40.1
	Tertiary	48	12.4

Clinical characteristics of the study subjects

One hundred seventeen (30.2%) of the participants were in Stage I (38.8%) and 150 (38.8%) in Stage III at baseline. Of the total

participants, 172(44.4%) started the ART based on both clinical and CD4+ T cell count, while 49 (12.7%) started based on clinical symptoms/signs (Table 2). Tenofovir Disoproxil Fumarate – Lamivudine – Efavirenz regimen was the most (54.8%) widely used ART regimen and followed by Stavudine– Lamivudine – Nevirapine

(12.9%) regimen. Majority (83.7%) of the participants took the treatment for more than 35 months (Table 2). A total of 291 (79.3%) participants were receiving either on cotrimoxazole prophylaxis or ART, while 213 (58%) were taking both cotrimoxazole and isoniazid preventive therapy (Table 2).

Table 2: Clinical characteristics of HIV positive adult individuals taking ART at SPHMMC ART

Variable		n	%
Duration on ART (in months)	6-11	13	3.4
	12-17	5	1.3
	18-23	17	4.4
	24-29	14	3.6
	24-29	13	3.4
	>36	324	83.9
Types of drugs taken	CPT	78	21.3
	Fluconazole	2	0.5
	Isoniazid	68	18.5
	Anti-TB	5	1.4
	CPT and INH	213	58
	Others	1	0.3
WHO clinical Stages	Stage 1	117	30.2
	Stage 2	63	16.3
	Stage 3	150	38.8
	Stage 4	57	14.7
ART regimens	1c	50	12.9
	2d	44	11
	1e	212	54.8
	1j	27	7.0
	1f	42	10.9
	2h	9	2.3
	1g	3	0.8

1c= AZT-3TC-NVP, 1d= AZT-3TC-EFV, 1e=TDF-3TC-EFV, 1f=TDF-3TC-NVP, 2d=TDF-ddI-NFV, 1j=TDF-3TC-DTG, 2h =TDF-3TC-ATV/r, 1g=ABC-3TC-EFV, CPT= Cotrimoxazole prophylactic therapy, INH=isoniazid, TB=Tuberculosis, AZT for zidovudine, 3TC for lamivudine for nevirapine, EFV for Efavirenz, ddI for didanosine, NFV for nelfinavir, DTG for dolutegravir, ATV/r for atazanavir/ritonavir, ABC for abacavir. WHO= World Health Organization, ART= Antiretroviral therapy, CD4= Cluster of differentiation

Immunohematological parameters

Immunological parameters

The study participants had a baseline CD4

count ranging from 4-1763 cells/μl with the mean of 267.99 (± SD 225.83) cells /μl. After a minimum of 6 months on ART, the CD4 count

increased and the mean CD4 count at six months was almost double that at baseline (546.72 (SD of ± 268.74) cells / μ l).

Hematological Values before and after initiation of ART

Table 3 depicts the mean $\pm$ standard deviation distribution of immunohematological tests results. The mean WBC count increased significantly increased from baseline (6.38 (SD $\pm 2.63 \times 10^3$ / μ l)) to 6.40 (SD ± 2.43) after at least six months of receiving ART ($p < 0.001$). The mean RBC count was (23.43 ± 180.05 / μ l) at baseline and (4.49 $\pm$ SD ± 64 / μ l) after at least

six months of receiving ART ($p = 0.001$). The mean HGB concentration increased from (14.10 ± 2.28 g/dl) at baseline to (14.48 ± 2.15 g/dl) after six months of ART ($p < 0.001$). RBC, HGB and MCHC values were higher after 6 months of ART initiation compared to baseline, while MCV, MCH and RDW values decreased. The mean RBC and HGB increased significantly ($p = 0.001$ and $p < 0.001$ respectively). The mean platelet count increased significantly from baseline (274.18 ($\pm 94.81 \times 10^3$ / μ l SD)) to 282.64 ($\pm 99.49 \times 10^3$ / μ l) after six months of ART initiation (p value < 0.001 (Table 3)).

Table 3: Immunohematological values (Mean $\pm$ SD) of HIV positive adult individuals at baseline and after 6 months of HAART SPHMMC ART clinic, Addis Ababa, Ethiopia, 2021 (n=387).

Parameters	Before initiation of HAART (Mean $\pm$ SD)	After 6 months of HAART (Mean $\pm$ SD)	P- value
CD4 (Cells/ μ l)	267.99 ± 225.83	546.72 ± 268.74	<0.001
PLT ($\times 10^3$ / μ l)	274.18 ± 94.81	282.64 ± 99.49	<0.001
WBC ($\times 10^3$ / μ l)	6.38 ± 2.63	6.40 ± 2.43	<0.001
RDW (%)	23.43 ± 180.05	14.79 ± 5.74	0.360
RBC ($\times 10^6$ / μ l)	4.35 ± 70	4.49 ± 64	0.001
Hgb (g/dl)	14.10 ± 2.28	14.48 ± 2.15	<0.001
MCV (fl)	97.86 ± 11.59	96.05 ± 10.30	0.105
MCH (pg)	32.67 ± 4.69	32.46 ± 3.91	0.726
MCHC (g/dl)	33.43 ± 1.88	33.75 ± 1.85	0.006

Prevalence of immunohematological abnormalities

Hematological abnormalities were observed both before and after ART initiation. Of the total participants, 12.9% developed leukopenia at

baseline, while 15.2% developed leukopenia after on ART at least for six months. Nearly 6% of the participants developed thrombocytopenia at both baseline and after at least on ART for six months (Figure 2. A, B, C and D).

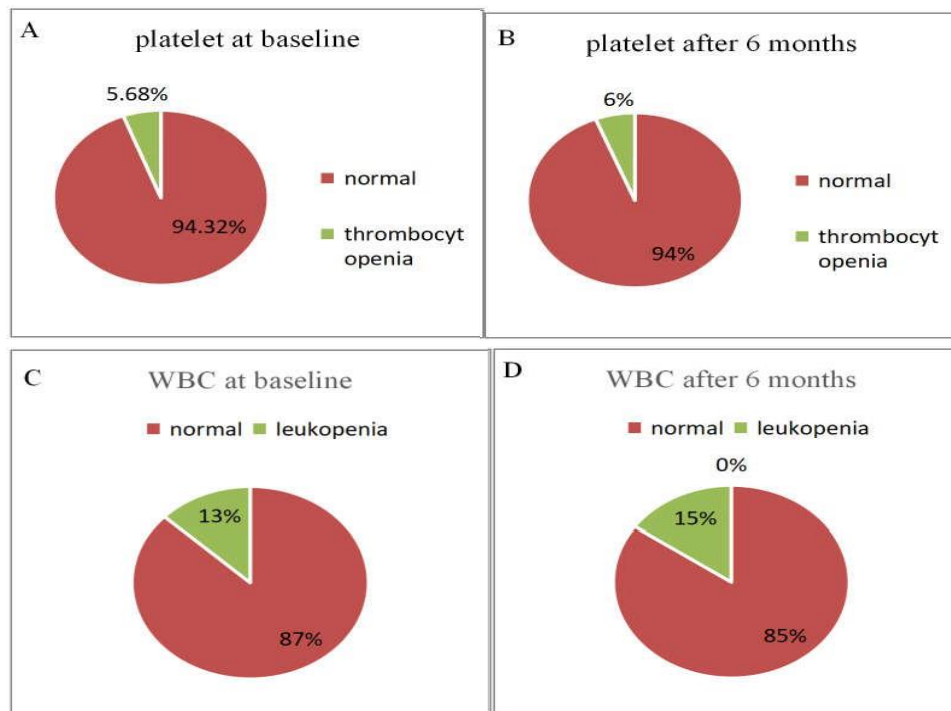


Figure 1: Comparison of the severity of thrombocytopenia (A and B) and leucopenia (C and D) at baseline and 6 months after initiation of ART SPHMMC ART clinic, Addis Ababa, Ethiopia, 2021 (n = 387)

Anemia was found in 22.5% of the participants at baseline and in 21.7% among those at least on ART for six months. Of the total of anemia cases, the majorities (69%) had mild anemia at baseline and 68 (81%) at least on ART for six months. Moderate anemia was

also found in 21 (24.1%) participants at baseline and in 14 (16.7%) on ART at least for six months. From the total anemic participants, 188 (48.6%) had macrocytic- normochromic anemia, 167 (43.2%) normocytic- normochromic and 15 (3.88%) microcytic- normochromic anemia at baseline (Fig 2).

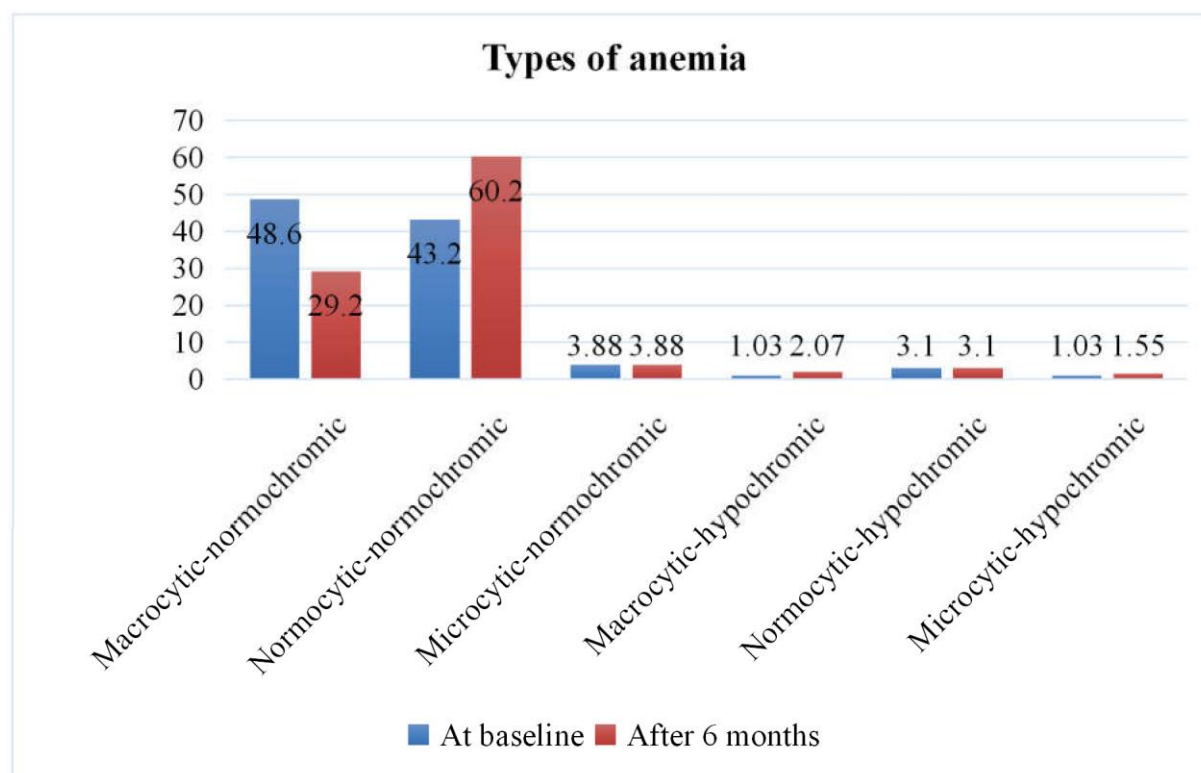


Figure 2: Summary of the types of anemia and its percentage of HIV positive adult individuals at baseline and after 6 months of ART at SPHMMC ART clinic, Addis Ababa, Ethiopia, 2021 (n = 387).

Of the total participants, 26 (3.69%) presented with both anemia and leukopenia, 8 (2.1%) with anemia and thrombocytopenia, and 8 (2.07%) with both leukopenia and thrombocytopenia. In addition, 4 (1.1%) had pancytopenia (Table 1). The most common abnormality observed in this study was immunosuppression (CD4 count < 500 cells/mm³) which is found in 336 (86.8) of the participants at baseline and 220 (56.8%) after six months of ART initiation. The majority of individuals at baseline were immune-suppressed in 178 (46%) and 23 (5.9%) of the individuals had immunosuppression after 6

months on ART. After at least 6 months from baseline, the degree of immunosuppression decreased and the observed difference was statistically significant (p value < 0.01).

Factors associated with cytopenia after 6 months

We found that CD4 cell count < 200cells/μL (AOR = 4.8, 95% CI (1.2–18.8), p = 0.023), being female (AOR = 6.7, 95% CI (1.3–34.4), p = 0.0220, co-infection with hepatitis B virus (HBV) (AOR = 4.84, 95% CI (1.5–15.9) p = 0.010), BMI < 18.5 kg/m² (AOR = 5.9 95% CI (3.0–11.5), p < 0.001) and absence of opportunistic infections (AOR = 0.65 (0.45–

0.93), $p = 0.019$) were significantly associated with cytopenia after six months on ART (Table 4).

Table 4; Ordinal logistic regression model outputs indicating associated factors of cytopenia among HAART-infected patients on ART SPHMMC, Addis Ababa, Ethiopia, 2021

Variables		n (%t)	AOR (95% CI)	P-value
Sex	Female	143(37)	6.7 (1.3–34.4)	0.022
	Male (1)	244(63)	1.00	
WHO stage	Stage IV	57(14.7)	1.1 (0.55–2.1)	0.852
	Stage III	150(38.8)	1.0(0.43–1.8)	0.640
	Stage II	63(16.3)	1.1(0.63–1.9)	0.543
	Stage I (1)	117(30.2)		
Type of ART	1e	212(54.8)	1.2 (0.55–2.1)	0.535
	Other (1)	121(44.2)		
Type of drug	CPT	78(21.3)	0.87 (0.65–1.2)	0.356
	CPT & INH	213(58)		
	Other	76(20.7)	0.79(0.57–1.24)	0.472
BMI (Kg/m ²)			5.9 (3.0–11.5)	<0.001
OIs	Absent	245(63.3)	0.65 (0.45–0.93)	0.019
	Present	142(36.7)	1.00	
CD4	Total		4.8 (1.2–18.8)	0.023
Duration of disease			0.92 (0.59–1.7)	0.976
Age (years)			0.65 (0.35–1.2)	0.193
Viral load			1.0 (0.94–1.1)	0.873
Hepatitis B virus	Present	216(55.6)	4.8 (1.5–15.9)	0.01
	Absent	171(44.4)		

OIs-opportunistic infections; BMI-Body mass index; WHO-World Health Organization; ART-Antiretroviral therapy; CPT- Cotrimoxazole preventive therapy; CD-Custer differentiation; INH-Isoniazid

Discussion

This study investigated the hematological profiles of 387 adult PLHIV and on ART for more than six months at ART clinic of SPHMMC. Determination of hematological profiles among HIV positive patients on ART could contribute to understand the effect of the drugs on different hematological parameters. All study participants were under first line ART. The prevalence of cytopenia is in PLHIV and on

ART was 41.2%. Female gender, having low BMI and CD4+ T-cell count, presence of opportunistic infections and coinfection with HBV were significantly associated with cytopenia in the present study.

The study has found that six months of treatment with ART resulted in a significant and favorable change in hematological profiles of PLHIV. The hematological abnormalities observed before and after ART are the

categories of Cytopenia which includes anemia, leucopenia, and thrombocytopenia.

In the present study, low hematological parameters were associated with stage of HIV disease. In the advanced stage of the disease, the blood cell counts were lower than the early stage of the disease. This finding is similar to a previous study which reported lower blood cell counts in the advanced HIV/AIDS stage (1). The study reported from Ethiopia showed that the prevalence of any cytopenia (at least one form of cytopenia) was significantly associated with male patients, older age groups, rural dwellers, being unmarried marital status, WHO clinical stage II, ZDV based regimen, taking ART regimen below 60 months, presence of opportunistic infection, and CD4 count less than 200 cells/mm³ and 200–499 cells/mm³ on the bivariate analysis (6). This might be due to increase in the frequency of bone marrow abnormalities as the disease progresses. In contrast, the current study found no significant association between age, marital status, male sex and cytopenia. Instead, female sex was strongly associated with the condition, which contradicts the findings of the previous study (6).

The present study did not show that patients on AZT based ART regimen had a lower blood cell counts compared to non-AZT based ART regimen due to the reason that only 12.9% of the individuals were taking the regimen. To

substantiate this, study done in Beijing Ditan Hospital, found that persistent cytopenia was associated with the effects of AZT (2).

This study showed that the mean WBC at baseline was almost similar after 6 months initiation of ART. However, a retrospective study done in Addis Ababa indicates that the mean WBC of PLHIV has increased after 6 months from the initiation of ART (12). The study conducted in Nigeria also showed that there was an increment of mean WBC after ART initiation (2). Increase in WBC count after ART initiation might be due to increase in hematopoietic progenitor cell growth, decreasing the HIV viral burden and decreasing marrow suppression by opportunistic infections (11). In contrast to aforementioned findings, a decreased WBC among PLHIV and on ART compared to PLHIV who were not on ART was reported by different studies (2,6,9). This difference might be due to a short duration of ART intake as in the initial stage of ART initiations, concomitant opportunistic malignancies and infect others cells, which leads to low WBC (12).

The present study also found that CD4+ T cell count was continued to increase with increasing in the duration of use of ART without evidence of a significant decline. This result is consistent with the finding of the study reported from Maryland in which CD4+ T cell count continued to be increase through 4 years

of ART without evidence of a significant decline in the slope (13). However, it did not undergo a further significant increase through year 6 after it reached a plateau at 4 year (13). A lower CD4+ T cell count at baseline were associated with a lower increase in the CD4+ cell count after ART in the present study. However, in the present study a plateau was not reached and this might be due to lower CD4+ T count at baseline compared with that of other previous studies (14).

In the current study, the mean value of RBC count was higher after 6 months on ART than at baseline. This result is in contrast with a study conducted at Ethiopia (15) and Iran (16). The depletion of RBC in ART experienced PLHIV is usually attributed to the adverse effect of Zidovudine, which could also explain the current findings (17). It is claimed that both AZT and d4T induce a metabolic defect in developing RBC precursor. In similar scenario, lower RBC was observed in our study among PLHIV and taking AZT based regimen.

The present study also showed that hemoglobin value has increased after ART initiation. This finding is consistent with other studies, in which proves the positive effect of ART on hemoglobin (18).

The mean value MCV and MCH were lower among HIV patients after 6 months of ART than at baseline. In contrast with the present study finding, higher mean values of MCV and MCH

among PLHIV and on ART were reported in several studies (19). However, circulating RBC, hemoglobin level and MCHC increased significantly after the initiation of effective antiretroviral therapy. This effect may be attributed to the effect that few patients were taking zidovudine.

This study showed that after 6 months of ART initiation, the mean value of RDW was significantly lower than baseline values which agrees with other studies (9,11,14,17). Lower value of RDW after ART initiation could be as a result of improved nutritional status of the individuals and decreases in the underlying inflammatory state that leads to impaired erythrocyte maturation and anisocytosis.

The present study revealed that the prevalence of anemia has decreased from baseline which is agrees with previous study (8). Moreover, the study reported from Arba Minch (19) showed that the prevalence of anemia at baseline was higher (52.3%) than the current study findings. A study from Hawassa also indicated a prevalence of anemia 23.4% before ART and 12.0% after ART (20). Moreover, the study reported from Jimma showed 29.9% prevalence of anemia before ART and 16.2% after ART (21). The baseline prevalence of anemia reported from Hawassa and Jimma are similar to the current study finding. In contrast, studies reported from Europe and North America reported 35% prevalence of anemia at

baseline and 26% at 6 months after ART initiation (20). This differences most probably attributed to the difference in socio-economic status, geography, sample size and variability in the definition of anemia. The decreasing tendency in the prevalence of anemia after ART initiation could be attributed to the positive effect of ART. HIV infection of marrow stromal cells, decrease in serum erythropoietin levels, auto-antibodies to erythropoietin, or marrow suppression by opportunistic infections, may contribute to the anemia commonly observed in HIV-infected persons. ART may ameliorate many of these effects in an indirect manner simply by decreasing the HIV viral burden (23).

In the present study, platelet count increased significantly after 6 months of the treatment. A comparative study conducted in Ethiopia and Uganda reported that ART induces an increment in the platelet count after initiation of the treatment (11). This might be because, after initiation of ART; disorders of hematopoiesis, opportunistic infections and immune causes related to HIV leading to low platelets count (11). In addition, the incidence of opportunistic infections hampers thrombopoietin production (24). This study revealed that the prevalence of thrombocytopenia was 25.9% at baseline and 7.1% after six months of ART initiation. The study conducted at Gondar indicated that the prevalence of thrombocytopenia was 4.1% in patients on ART and 9% in ART naive patients

(9). These previous studies findings are contradicted with the current study finding. The difference might be due to the difference in the definition of thrombocytopenia, study design and sample size of the study.

In the present study, ART was an effective treatment for cytopenia patients before the initiation of ART. Along with the recovery of the CD4+T-cell count, blood cells (leukocytes, platelets, and hemoglobin) were also increased. Being female, the lower CD4+ T- cell count at baseline, a low BMI, presence of opportunistic infections, coinfection with HBV were associated factors for persistent cytopenia after ART, which suggested the importance of starting ART early in cytopenia patients with HIV infection.

In this study being female was independently associated with persistent cytopenia after ART initiation. This finding may be explained by the multifactorial burden of anemia and other cytopenias among women, particularly in resource-limited settings. Chronic menstrual blood loss, higher prevalence of iron deficiency, nutritional vulnerabilities, and pregnancy-related hematologic stress may contribute to lower hematologic reserves. In addition, sociocultural and economic disparities may predispose women to delayed care-seeking and suboptimal nutritional status, further increasing the risk of persistent cytopenia despite ART initiation. Several studies in sub-Saharan Africa have

similarly demonstrated higher rates of anemia and cytopenia among female PLHIV both before and after ART (18,23).

A lower CD4+ T-cell count at baseline was significantly associated with persistent cytopenia after ART. Advanced immunosuppression reflects prolonged viral replication and bone marrow suppression, mediated through direct HIV infection of marrow stromal cells, dysregulated cytokine production, opportunistic infections, and nutritional depletion. Patients with severe immunodeficiency often present with multiple cytopenias at baseline, and hematologic recovery may lag behind virologic suppression after ART initiation. Several longitudinal cohort studies have demonstrated that individuals initiating ART at lower CD4 counts exhibit slower hematologic recovery and higher rates of persistent anemia and leukopenia (13,24).

Low BMI was another independent predictor of persistent cytopenia. Malnutrition contributes directly to impaired hematopoiesis through deficiencies in iron, folate, vitamin B12, and protein-energy substrates essential for bone marrow proliferation. In HIV-infected individuals, low BMI often reflects advanced disease stage and chronic inflammation. Undernutrition exacerbates immune suppression and reduces marrow responsiveness even after ART initiation. Evidence from African cohorts demonstrates that underweight HIV patients have higher rates of

anemia and delayed hematologic recovery compared with patients with normal BMI (19).

The presence of opportunistic infections (OI) was significantly associated with persistent cytopenia. Opportunistic infections such as tuberculosis, chronic fungal infections, and parasitic infestations can directly suppress bone marrow function or induce anemia of chronic disease through inflammatory cytokine pathways. Moreover, certain OIs infiltrate the bone marrow, leading to pancytopenia. Even after ART initiation, persistent inflammatory responses may delay hematologic normalization. One study has reported strong associations between OIs and anemia, leukopenia, and thrombocytopenia among PLHIV (23).

HBV coinfection was also associated with persistent cytopenia after ART. Chronic hepatitis B infection may contribute to cytopenia through multiple mechanisms, including hypersplenism secondary to portal hypertension, chronic inflammation, and impaired hepatic production of thrombopoietin. Additionally, hepatic dysfunction may exacerbate drug-induced marrow toxicity and impair hematologic recovery. Studies evaluating HIV/HBV coinfecting individuals have reported higher rates of anemia and thrombocytopenia compared with HIV noninfected patients (25,26).

The main limitation of the present study is being conducted in single institution which limits its generalizability to others. The cross-sectional

nature of this study is also the limitation of this study which hinders causal assertion for the factors associated.

Conclusion

The current study shows that the prevalence of cytopenia was 41.2% in PLHIV. Cytopenia was associated with female sex, lower BMI, lower CD4+ T-cell count, opportunistic infections and coinfection with HBV. Being on ART for 6 months was associated with improvements on the number of cells. Close follow up of PLHIV for cytopenia is required, and interventions targeted female sex, low BMI, low CD4 count, coinfection with HBV and PLHIV infected with opportunistic infections are crucial to reduce the prevalence of cytopenia.

List of abbreviations and acronyms

AIDS-Acquired immuno-deficiency syndrome; ART-Antiretroviral therapy; AZT-zidovudine; cART-Combination antiretroviral therapy; CD4-Cluster of differentiation 4; CTD-Connective tissue diseases; HBV-Hepatitis B virus; HCV-Hepatitis C virus; HIV-Human immuno-deficiency virus; HMIS-Health management information system; OI-Opportunistic Infection; PLHIV-People living with HIV; WHO-World Health Organization.

Declarations

Ethical consideration

Ethical clearance was obtained from SPHMMC Institutional Review Board, and permission letter

was received from the hospital management board. This study was conducted in accordance with Declaration of Helsinki.

Availability of data and materials

The dataset is available from corresponding author on reasonable request.

Consent for publications: Not Applicable

Competing interests: The authors declare that they have no competing interests.

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References

- 1 Ababa A, Garedew BG, Tolesa T. Hematological profiles of HIV positive adults treated with highly active antiretroviral therapy at Black Lion Specialized Hospital, Addis Ababa, Ethiopia. Addis Ababa: College of Health Sciences, Department of Medical Physiology; 2016.
- 2 Fan L, Li C, Zhao H. Prevalence and risk factors of cytopenia in HIV-infected patients before and after the initiation of HAART. Biomed Res Int. 2020;2020: 1-8.
- 3 Nka AD, Sosso SM, Fokam J, Bouba Y, Teto G, Simo RR, et al. Thrombocytopenia according to antiretroviral drug combinations, viremia and CD4 lymphocytes among HIV-infected patients in Cameroon: a snapshot from the city of Yaoundé. BMC Res Notes. 2019;12(1):632.
- 4 Profiles H, Hiv OF, Adults P, Lion B, Hospital S, Ababa A. Hematological

- profiles of HIV positive adults treated with HAART at Black Lion Specialized Hospital. Addis Ababa: College of Health Sciences, Department of Medical Physiology; 2016.
- 5 Wondimeneh Y, Muluye D, Ferede G. Prevalence and associated factors of thrombocytopenia among HAART naïve HIV positive patients at Gondar University Hospital, northwest Ethiopia. *BMC Res Notes*. 2014; 7:5–8.
 - 6 Gebreweld A, Fiseha T, Girma N, Haileslasie H, Gebretsadik D. Prevalence of cytopenia and its associated factors among HIV infected adults on highly active antiretroviral therapy at Mehal Meda Hospital, North Shewa Zone, Ethiopia. *PLoS One*. 2020;15(9):e0239215.
 - 7 O'Bryan TA, Okulicz JF, Bradley WP, Ganesan A, Wang X, Agan BK. Impact of the highly active antiretroviral therapy era on the epidemiology of primary HIV-associated thrombocytopenia. *BMC Res Notes*. 2015;8(1):3–7.
 - 8 Damtie S, Workineh L, Kiros T, Eyayu T, Tiruneh T. Hematological abnormalities of adult HIV-infected patients before and after initiation of highly active antiretroviral treatment at Debre Tabor Comprehensive Specialized Hospital, northcentral Ethiopia: a cross-sectional study. *HIV AIDS (Auckl)*. 2021; 13:477–484.
 - 9 Fekene TE, Juhar LH, Mengesha CH, Worku DK. Prevalence of cytopenias in both HAART and HAART naïve HIV infected adult patients in Ethiopia: a cross-sectional study. *BMC Hematol*. 2018; 18:8.
 - 10 Gunda DW, Godfrey KG, Kilonzo SB, Mpondo BC. Cytopenias among ART-naïve patients with advanced HIV disease on enrolment to care and treatment services at a tertiary hospital in Tanzania: a cross-sectional study. *Malawi Med J*. 2017;29(1):43–52.
 - 11 Kyeyune R, Saathoff E, Ezeamama AE, Löscher T, Fawzi W, Guwatudde D. Prevalence and correlates of cytopenias in HIV-infected adults initiating highly active antiretroviral therapy in Uganda. *BMC Infect Dis*. 2014; 14:496.
 - 12 Woldeamanuel GG, Wondimu DH. Prevalence of anemia before and after initiation of antiretroviral therapy among HIV infected patients at Black Lion Specialized Hospital, Addis Ababa, Ethiopia: a cross-sectional study. *BMC Hematol*. 2018; 18:7.
 - 13 Moore RD, Keruly JC. CD4+ cell count 6 years after commencement of highly active antiretroviral therapy in persons with sustained virologic suppression. *Clin Infect Dis*. 2007;44(3):441–446.
 - 14 Kaufmann GR, Furrer H, Ledergerber B, et al. Characteristics, determinants, and clinical relevance of CD4 T cell recovery to <500 cells/μL in HIV type 1-infected individuals receiving potent antiretroviral therapy. *Clin Infect Dis*. 2005;41(3):361–372.
 - 15 Tadesse S, Berhane T, Worku A. Hematological abnormalities before and after initiation of antiretroviral therapy among HIV-infected patients at Jimma University Specialized Hospital, Southwest Ethiopia. *PLoS One*. 2018;13(10):e0205799.
 - 16 Meidani M, Rezaei F, Maracy MR, Avijgan M, Tayeri K. Prevalence, severity, and related factors of anemia in HIV/AIDS patients. *J Res Med Sci*. 2012;17(2):138–142.
 - 17 Cines DB, Bussel JB. How I treat immune thrombocytopenia (ITP). *Blood*. 2005;106(7):2244–2251.
 - 18 Owiredo WKBA, Quaye L, Amidu N, Addai-Mensah O. Prevalence of anemia and immunological markers among HIV-infected patients on highly active antiretroviral therapy in Ghana. *J Med Biomed Sci*. 2011;1(1):1–7.
 - 19 Semba RD, Shah N, Klein RS, et al. Highly active antiretroviral therapy associated with increased mean corpuscular volume in HIV-infected women. *AIDS*. 2002;16(9):1267–1272.

- 20 Abebe M, Alemseged F, Hemalatha K. Prevalence of anemia among HIV infected adults before and after initiation of ART at Arba Minch General Hospital, Southern Ethiopia. *Ethiop J Health Sci.* 2012;22(1):13–20.
- 21 Mekonnen Z, Hordofa A, Belayneh M. Hematological abnormalities among HIV infected patients before and after ART initiation at Hawassa University Referral Hospital, Ethiopia. *BMC Hematol.* 2017; 17:1–7.
- 22 Tadesse S, Berhane T, Worku A. Prevalence of anemia before and after initiation of antiretroviral therapy among HIV-infected patients at Jimma University Specialized Hospital, Southwest Ethiopia. *PLoS One.* 2018;13(10):e0205799.
- 23 Sullivan PS, Hanson DL, Chu SY, Jones JL, Ward JW; Adult/Adolescent Spectrum of HIV Disease Project. Epidemiology of anemia in human immunodeficiency virus (HIV)-infected persons: results from the multistate Adult and Adolescent Spectrum of HIV Disease Surveillance Project. *Blood.* 1998;91(1):301–308.
- 24 Volberding PA, Levine AM, Dieterich D, Mildvan D, Mitsuyasu R, Saag M; Anemia in HIV Working Group. Anemia in HIV infection: clinical impact and evidence-based management strategies. *Clin Infect Dis.* 2004;38(10):1454–1463.
- 25 Thio CL, Seaberg EC, Skolasky R Jr, et al. HIV-1, hepatitis B virus, and risk of liver-related mortality in the Multicenter Cohort Study. *Lancet.* 2002;360(9349):1921–1926.
- 26 Hoffmann CJ, Thio CL. Clinical implications of HIV and hepatitis B co-infection in Asia and Africa. *Lancet Infect Dis.* 2007;7(6):402–409.