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Original Article

To Study the Correlation of Viral Load and CD4 Count of Patients on Antiretroviral Treatment in A Tertiary Care Hospital

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ABSTRACT

Introduction: HIV infection was global pandemic with widespread uses of Anti-Retroviral Therapy. HIV RNA (viral load) and CD4 T lymphocyte (CD4) cell count are the two key surrogate markers utilized to evaluate antiretroviral therapy (ART) response and HIV disease progression. Our objective is, to study correlation between CD4 count and viral load in seropositive adult age group patients on Antiretroviral treatment (ART).

Material and Method: A prospective observational study was carried out among HIV-seropositive adult patients who were receiving antiretroviral therapy (ART) at a tertiary care hospital from May 2024 to April 2025.

Result: Out of 3089 seropositive patients, who were receiving Anti-retroviral therapy (ART), of which 1403 were male (45.43%) and 1683 were female patients (54.48%) and 3(0.09%) patients were trigender. Individuals aged 31-45 years comprised (52.97%), representing the most commonly affected age group. Out of 3089 patients, 1735(56.16%) patients having >500 CD4 cell count and <1000 viral load copies and 132 patients having <200 CD4 cell count range and 40(1.29%) patients have >1000 viral load copies.

Conclusion: Viral load and CD4 monitoring along with clinical presentation of patients on ART serves as a key predictor of HIV/AIDS progression by providing a clear assessment of disease status, enabling effective treatment monitoring and control, and promoting adherence to therapy.

Keywords*: HIV patients on Antiretroviral therapy, CD4 cell count and Viral load correlation*

INTRODUCTION

Human Immunodeficiency Virus (HIV) is a member of the Retroviridae family and the Lentivirus subfamily. It is a single-stranded RNA virus that contains the enzyme reverse transcriptase, which facilitates the conversion of viral RNA into DNA within the host cell. Two genetically and immunologically distinct types of HIV have been identified: HIV-1 and HIV-2.

The virus particle (virion) is structurally composed of an envelope, a capsid, and a core. The outer surface of the virus possesses the glycoprotein gp120, which specifically binds to CD4 receptors on host cells, beneath the viral envelope lies the capsid, a protein shell composed of p18, enclosing the viral core.

The core is an elongated, dense inner structure that contains two identical single-stranded RNA molecules, structural proteins, and the enzyme reverse transcriptase. The major core protein is p24.The HIV-1 genome comprises genes that code for the virus structural proteins — GAG and ENV.[1]

The primary objective of ART is to achieve and maintain durable viral suppression. Consequently, viral load monitoring, most essential tool for assessing therapeutic effectiveness after ART initiation.

HIV RNA (viral load) and CD4 T lymphocyte (CD4) cell count are the two key surrogate markers utilized to evaluate Anti-retroviral therapy (ART) response and HIV disease progression. [2]

In India, Human Immunodeficiency Virus (HIV) testing is carried out either on a voluntary basis or as a diagnostic evaluation for individuals exhibiting clinical symptoms. The aim of these interventions is the early diagnosis of HIV infection, which enables better clinical care, improves patient outcomes, and enhances healthcare delivery strategies.[3]

CD4 count and viral load, Health-Related Quality of Life (HRQOL) judge disease progression of people living with HIV (PLWH) integrated with clinical assessments.[4]

World Health Organization (WHO) advises using HIV RNA to monitor ART, it still emphasizes the critical role of CD4 cell count in evaluating baseline disease status and managing care for patients with advanced HIV. [5]

World Health Organization (WHO) recommend, CD4 count testing every 6 months to monitor immunological response.[6]

The influence of ART on population-level morbidity and mortality is determined by the CD4 count, making the average CD4 count a vital indicator of overall public health.[7]

India is dedicated to achieving the UNAIDS 90-90-90 goals, which seek to ensure that 90% of people living with HIV (PLHIV) are aware of their status, 90% of those diagnosed receive antiretroviral therapy (ART), and 90% of individuals on ART attain viral suppression.[8]

The RNA-PCR assay offers high sensitivity, detecting as few as 40 copies of HIV RNA per milliliter, yields positive results in over 98% of cases.

Serial measurement of HIV RNA levels helps in understanding the association between viral load and disease progression, dynamics of viral replication and turnover, immune system activation, and the development of resistance to antiretroviral drugs.[9]

AIM AND OBJECTIVES

To study correlation between CD4 count and viral load in seropositive adult age group patients on Antiretroviral treatment (ART).

MATERIAL AND METHOD

Prospective Observational study was carried out on HIV seropositive patients on Antiretroviral treatment at microbiology department of tertiary care hospital from May 2024 to April 2025.

Inclusion criteria – Confirmed seropositive adult age group cases of HIV infection on Antiretroviral Treatment.

Exclusion criteria- Paediatric and ANC patients of HIV infection on Antiretroviral Treatment.

Sample collection and Processing:

Ethical clearance from institutional ethics committee and permission of sample collection from respective Head of Department will be obtained. Confidentiality of the study subjects will be assured and maintained throughout the study. Approximately 4-6ml of venous blood from patients collected after counselling in two EDTA vacutainer, one used for CD4 cell count and another used for viral load estimation.

Viral load testing was performed using the Real Time HIV-1 Polymerase Chain Reaction (PCR) assay (Abbott 2000 SP Molecular). The absolute $CD4^+$ T-lymphocyte count was determined by flow cytometry by Sysmex CyFlow^{TM} Counter cytometer.

Virological failure was defined as a plasma HIV-1 RNA level of ≥1000 copies/mL, in accordance with the national viral load testing guidelines.

RESULT

Present study was carried out among 3089 HIV-seropositive adult patients who were receiving antiretroviral therapy (ART) at a tertiary care hospital from May 2024 to April 2025.

In the present study, table no 1 show, individuals aged 31-45 years comprised the majority of participants (52.97%), representing the most commonly affected age group. **3(0.09%) patients were tri-gender. (Table no 1)**

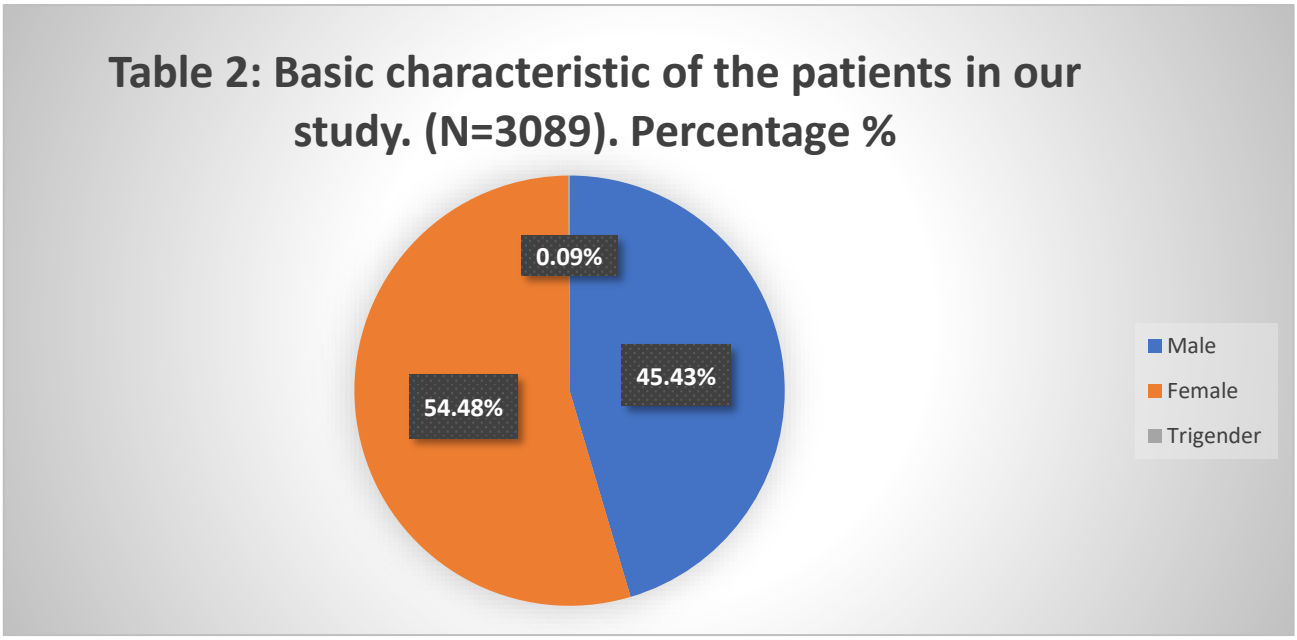
Table 1: Age wise distribution of HIV infection.

Age group (yrs)	Male (n=1403)	Female (n=1683)	Total (n=3086)	Percentage %
18-30	428	452	880	28.48
31-45	773	863	1636	52.97
46 -59	181	320	501	16.23
>60	21	48	69	2.23

In this study, table no 2 shows, out of 3089 seropositive patients, 1403 were male (45.43%) and 1683 were female patients (54.48%) and 3(0.09%) patients are trigender. (Table no 2)

Table 2: Basic characteristic of the patients in our study. (N=3089)

Gender	**Frequency**	**Percentage %**
Male	1403	45.43
Female	1683	54.48
Trigender	03	00.09



In the present study, table no 3 shows, 1564(50.63%) patients got the infection by sexual route, 584(18.90%) patients had infection through unprotected sex with spouse, about 580(18.77%) patients did not reveal their route of infection, there were 224(7.25%) got infection through parental injections, 111 (3.59%) infected through blood transfusion and perinatal transfusion infected patients are only 26(0.84%). The predominant mode of HIV transmission in the present study was heterosexual contact, continues to be the leading route. (Table no 3)

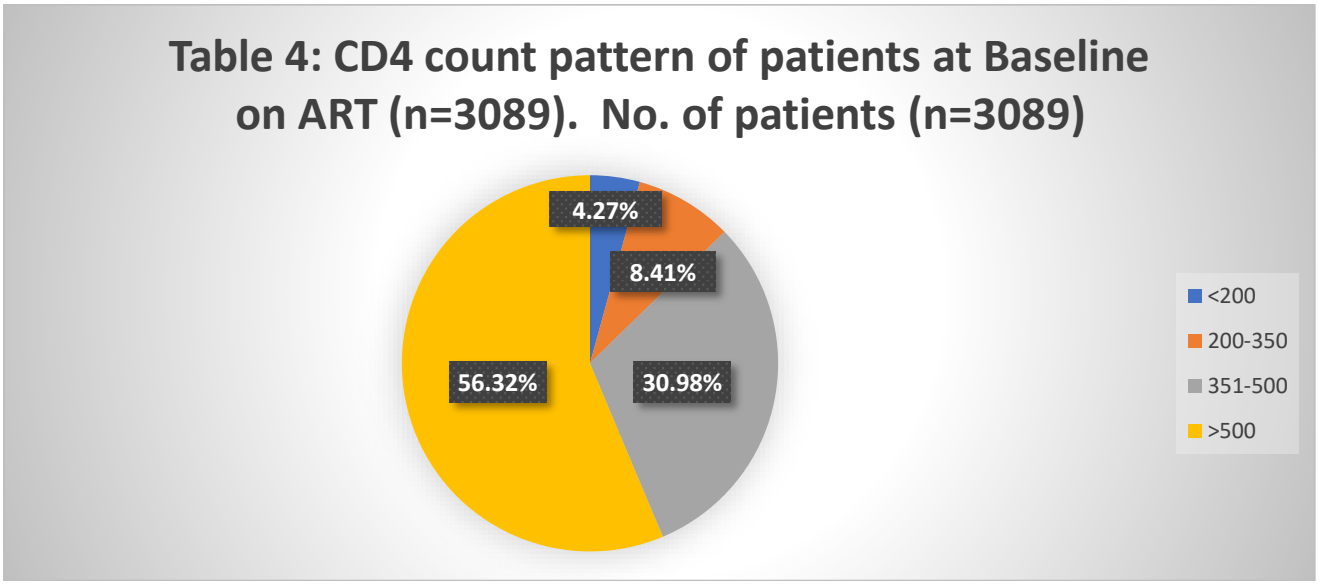
Table 3: Showing mode of transmission of HIV and no of cases. (N=3089)

Mode Of Spread	**No. Of Cases (N=3089)**	**Percentage %**
Sexual transmission	1564	50.63
Unprotected sex with spouse	584	18.90
unknown	580	18.79
Parental injection	224	7.25
Blood transfusion	111	3.59
Perinatal	26	0.84

In our study, table no 4 shows, among these CD4 count cell strata, on ART maximum 1740 (56.32%) patient had CD4 count between >500 range. 957 (30.98%) patients had CD4 count 351-500 range, between 200-350 range 260(8.43%) patients and 392 (12.69%) patients had CD4 count <350 range at the time of examination. Patients below 200 CD4 count range are only 132 (4.27%). (Table no 4)

Table 4: CD4 count pattern of patients at Baseline on ART (N=3089).

CD4 count	No. of patients (N=3089)	%
<200	132	4.27
200-350	260	8.43
351-500	957	30.98
>500	1740	56.32



In the present study, table no 5, there are 3089 HIV-seropositive adult patients were receiving Anti-retroviral Therapy (ART), out of which 3049 (98.70%) patients were showed <1000 viral load copies and 40 (1.29%) patients were showed >1000 copies of viral loads. (Table no 5)

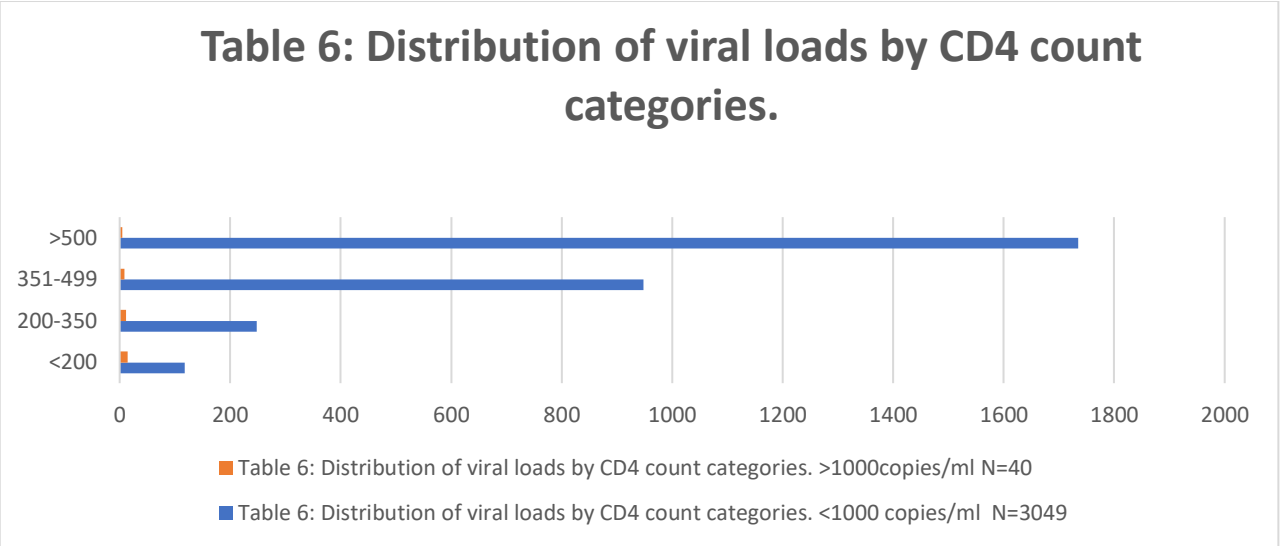
Table no 5: Distribution of viral loads with respect to number of patients:(N=3089)

	VL <1000 copies/ml	VL >1000 copies/ml
No. of patients	3049 (98.70%)	40 (1.30%)

In our study, in table no 6 shows, that about 1735 (56.16 %) HIV seropositive patients had CD4 cell count >500 range having <1000 copies and 40(1.29%) patients had >1000 copies of HIV 1 viral RNA load respectively. In the present study, CD4 cell count range <200 and having < 1000 copies of viral load are 118 patients and < 200 CD4 cell count range and >1000 copies of viral load patients are only 14 in number. 248 patients present in the range of 200-350 CD4 cell range and < 1000 copies of viral load and 12 patients are lies in the range of 200-350 CD4 and > 1000 copies of viral load. 948 patients lie in the range of 351-499 CD4 range and <1000 copies and 9 patients lie in the range of 351-499 CD4 range and >1000 copies of viral load. Only 5 patients lying in category >500 CD4 cell count and >1000 copies of viral load. (Table no 6)

Table 6: Distribution of viral loads by CD4 count categories. (N=3089)

CD4 count (cells/microliter) category	<1000 copies/ml N=3049	>1000copies/ml N=40
<200	118	14
200-350	248	12
351-499	948	09
>500	1735	05



DISCUSSION

Present study shows that, regular viral load and CD4 monitoring along with integrated counselling sessions, had improved the drug adherence among PLHIV resulting in prevention of unnecessary switch to second line ART regimen.

Virological failure, was defined as a plasma HIV-1 RNA level of ≥1000 copies/mL, in accordance with the national viral load testing guidelines.[10]

Enhanced host immune responses, lower baseline viral load, fewer comorbidities, reduced concomitant medication use, and minimal drug–drug interactions improve virological outcomes among individuals with baseline CD4 counts ≥500 cells/μL.[11]

In the present study, table no 1. shows, individuals aged 31–45 years comprised the majority of participants (52.97%), representing the most commonly affected age group.

These findings are consistent with those reported by **Shilpa et al. (2018),**[12] in their study. **Chakraborty N et al. (2008),**[13] (55% were in 31-44 yrs) and and **Singh A et al. (2003),**[14] (54% were in 31-40 yrs) also reported similar finding as like our study.

In our study, table no. 2 shows, there are 45.41% are male infected with HIV and 54.48% were female infected by HIV and 3(0.09%) patients were trigender.

Similar findings are shown by **Patil et al. (2020),**[15] in their study reported as 56% were females and 34% were males are infected with HIV showing female dominance.

In contrast to our study **Nishant et al. (2022),**[16] in their study as 64% was male and 36% was females infected by HIV in their study population. Also, **Shilpa et al. (2018),**[12] in their study reported that, 77% of participants were male and 23% were female, a distribution comparable to findings from other studies, including those by **Chakravarty J et al. (2006),**[17] (80.8% male) and **Kumarasamy N et al. (2000),** [18] (68% male).

In our study table no.3 study shows that, the predominant mode of HIV transmission in the present study was heterosexual contact, continues to be the leading route. Similar findings shown by **Sharan Badiger et al. (2015),**[19]**in** their study shows that most common mode of transmission was heterosexual contact.

Similar findings were also shown by **Atul Rajkondawar et al. (2017),**[20] in their study, showing most common mode of transmission was heterosexual contact.

In our study, table no 4 shows, among these CD4 count cell strata, on ART maximum 1740 (56.32%) patient had CD4 count between >500 range. 957 (30.98%) patients had CD4 count 351-500 range, between 200-350 range 260(8.41%) and 392 (12.69%) patients had CD4 count <350 range at the time of examination. Patients below 200 CD4 count range are only 132 (4.27%).

Similar findings are were shown by **Kranzer et al. (2013),**[7] in their study shows that out of 219 patients ,88 (34%) patients have CD4 count >500 range and 33(13%) patients were had <200 CD4 count cell range. [7]

These findings are similar to the study done by **Nishanth et al. (2022),[16]** in their study reported that CD4 cells counts strata, 9 (10.5%) patients had CD4 cells counts between 200-300 range. Majority of patients had CD4 count less than 100 (34.1%), least number of patients are with CD4 count between 200-300 about 10.5%.[17]

Similar to our study findings, **Neelam Chauhan et al. (2023),[10]** in their study reported that, 15(5.58%) patients having CD4 count < 200, 49 patients lying in 200-350 CD4 range, 76 (28.25%) lying in 351-500 CD4 range and majority patients about 129 (47.96%) presents CD4 Cell count range >500.[18]

In our study, table no 5 showed that, 3049 (98.70%) patients had <1000 copies and 40 (1.29%) patients had >1000 copies of viral loads showing viral load suppressed patients are large in number due to better treatment response.

Chinmay Laxmeshwar et al. (2020),[8] in their study shows that 3371(87.48%) seropositive patients had <1000 copies and 440(11.43%) seropositive patients had >1000 copies of viral load copies respectively.

Neelam Chauhan et al. (2023),[10] in their study, showed that Patients had CD4 cells counts < 500 cells and suppressed viral load (VL <1000 copies/ml) were 131 (93.57%) and unsuppressed viral load (VL >1000copies/ml) were 9 (6.42%) patients.

In contrast **Pallavi shindhay et al. (2021),[21]** study showed that, proportion of virological failure was 13%.[14]

In our study, in table no 6 shows, that about 1735 (56.16 %) HIV seropositive patients had CD4 cell count >500 range having <1000 copies and 40(1.29%) patients had >1000 copies of HIV 1 viral RNA load respectively. In the present study, CD4 cell count range <200 and having < 1000 copies of viral load are 118 patients and < 200 CD4 cell count range and >1000 copies of viral load patients are only 14 in number. 248 patients present in the range of 200-350 CD4 cell range and < 1000 copies of viral load and 12 patients are lies in the range of 200-350 CD4 and > 1000 copies of viral load. 948 patients lie in the range of 351-499 CD4 range and <1000 copies and 9 patients lie in the range of 351-499 CD4 range and >1000 copies of viral load. Only 5 patients lying in category >500 CD4 cell count and >1000 copies of viral load.

Similar to our findings, **Chinmay Laxmeshwar et al. (2020),[8]** in their study shows that 1923 (96%) seropositive patients had CD4 cell count >500 range having <1000 copies and 81(4%) seropositive patients had >500 CD4 cell range having >1000 copies. 359(20%) seropositive patients had CD4 cell count <500 range and >1000 copies and 1448(80%) seropositive patients had CD4 cell count <500 range and >1000 copies of HIV 1 viral RNA load respectively. He also reported CD4 cells counts < 500 and suppressed viral unsuppressed viral load were 1448 (80%), load was 359 (20%) patients.CD4 cells count ≥ 500 and suppressed viral load were 1923 (96%), unsuppressed were 81(4%) patients after treatment.

Similar to our study, **Neelam Chauhan et al. (2023),[10]** showed that, Patients had CD4 cells counts, < 500 cells and suppressed viral load (VL 1000copies/ml) were 9 (6.42%) patients. Patients of CD4 cells counts ≥ 500 cells and suppressed viral load (VL 1000copies/ml) were 6 (4.65%) patients at 12 months.

CONCLUSION

Viral load monitoring as a predictor of HIV/AIDS progression offers clear assessment of disease status, supports treatment monitoring and control, and encourages treatment adherence, while CD4 cell counts aid in evaluating the risk of opportunistic infections and treatment failure.[5]

Early linkage to care, timely initiation of ART, and adherence counselling at every follow-up visit are essential for preventing virological failure. Patients who require regimen changes benefit from intensified counselling and close adherence monitoring to achieve virological suppression and minimize the risk of drug resistance.[14]

Routine viral load and CD4 monitoring facilitated the early detection of treatment failure, timely referral to second- and third-line regimens, and avoidance of unnecessary treatment switches.[8]

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