

**"SURVIVAL TRENDS AND PREDICTORS AMONG HIV PATIENTS ON ART IN HAMIRPUR, NORTHERN INDIA (2016–2023)"**

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ABSTRACT **Background:** Antiretroviral treatment (ART) consistently improved survival of people living with HIV and contributes to prevent new infections. Present study is designed to assess the trends and predictors of Survival time among HIV patients after initiation of Anti Retro Viral therapy from ART centre Hamirpur Himachal Pradesh **Methods:** It is retrospective cohort study. Data collection spans was from January 1, 2016, to December 31, 2023. There were total 711 PLWHIV who were enrolled in ART centre within the specified period. The Kaplan-Meier method was used to estimate the survival. **Results:** The study population consisted of 711 HIV-positive patients, of whom 57.0% were male and 43% were female. The majority (59.9%) fell within Age Group of 41-60 years. 72.2% of patients were alive on ART, with higher mortality observed among male patients (18.5%) compared to females (9.5%). Female patients had a notably higher mean survival time (84.72 months, 95% CI: 80.41–89.03) compared to male patients (70.43 months, 95% CI: 65.98–74.88). **Conclusions:** The scale-up of ART has resulted in substantial reductions in mortality and increased survival. Such information is useful for institution of intervention measures to reduce risk of death.

KEYWORDS : HIV/AIDS, ART, Survival, Kaplan-Meier, Himachal Pradesh

INTRODUCTION:

HIV (Human Immunodeficiency Virus) continues to be a significant global health challenge, affecting millions of individuals worldwide. As per the recent India HIV Estimations 2023 report, over 2.5 million people are living with HIV in India. The impact of HIV not only the physical well-being of patients but also their psychological and social aspects of life. New annual HIV infections have decreased by 44% since 2010, outperforming the global reduction rate of 39%¹ The survival time of HIV infected individuals or patients with acquired immunodeficiency syndrome (AIDS) is influenced by multiple factors. Antiretroviral therapy (ART) has revolutionized the management of HIV, allowing individuals to achieve viral suppression and leading to improved quality of life and longevity. The disparities in access to care, adherence to treatment, and co-morbid conditions and factors such as socio-economic status, mental health play vital roles in shaping these outcomes among HIV patients.

Understanding health outcomes in HIV patients is crucial for developing effective interventions and policies aimed at improving care. Moreover, the emergence of co-infections and non-communicable diseases poses additional challenges that can complicate management and treatment strategies. Finally, there was the 'Treat All' approach from 2017, which ensures that ART is initiated, irrespective of CD4 count.² ART is not merely about starting a person living with HIV on treatment. It is equally important to keep the viral load down and suppressed to ensure that the transmission of diseases is also halted. Improved access to antiretroviral treatment (ART) has significantly increased the survival rate of people living with HIV (PLWH) In developed countries, PLWH are living almost as long as the general population, however, in most less-developed countries, the survival rate of PLWH is lower than that of the general population³

The finding of this study could supplement achieving the Sustainable Development Goal (SDG) to "end AIDS epidemic" by 2030⁴ and is designed to assess the trends and predictors of Survival time among HIV patients after initiation of Anti Retro Viral therapy from ART centre Hamirpur Himachal Pradesh.

Methodology:**Objectives****Primary Objective:**

To determine the survival rate of HIV-positive patients on antiretroviral therapy (ART) from 2016 to 2023, with death as the

primary endpoint.

Secondary Objective:

To examine whether survival rates differ according to age groups and gender.

2. Study Design

Type of Study: Retrospective cohort study.

Study Period: Data collection spans from January 1, 2016, to December 31, 2023.

3. Study Population:

Individuals with HIV enrolled in ART centre within the specified period.

Inclusion Criteria:

- HIV-positive individuals who commenced ART between 2016 and 2023.
- Patients with documented baseline demographics, including age and gender.

Exclusion Criteria:

- Individuals lacking complete baseline or follow-up information
- Individuals lost to follow-up without documented outcomes (i.e., mortality or survival)

Data Collection

Data Source: Secondary data of patients with HIV registered in ART centre Hamirpur (Himachal Pradesh)

Demographic Variables: Age at ART initiation, gender, and geographic location.

Clinical Variables:

- Baseline and follow-up CD4 cell counts.
- ART initiation status, including any interruptions.
- Mortality status, with date if deceased.
- Follow-up Information: Date of last known status (either deceased, alive, or lost to follow-up) and total follow-up time.

5. Data Preparation:**Variable Transformation:**

Age Categories: Categorize patients by age at ART initiation into

clinically relevant age groups (Eg : 0-18 ,19-40,41-60 and more than 61).

Follow-up Duration: Calculate the follow-up time for each participant from ART initiation to the date of death, last known status, or study endpoint (December 31, 2023).

Data Cleaning:

Address missing data through removal or imputation where appropriate, ensuring each case in the final dataset has complete information on key variables.

6. Statistical Analysis

6.1 Descriptive Analysis

Baseline Characteristics: Summarize demographic and clinical characteristics (e.g., age distribution, gender, baseline CD4 count) for the cohort.

Event Frequency: Calculate the total number of observed deaths over the study period.

6.2 Survival Analysis

Primary Outcome: Time-to-event data analysis for mortality following ART initiation.

1. Kaplan-Meier Survival Estimation:

Generate Kaplan-Meier survival curves to illustrate survival rates over time for the overall cohort.

Stratify Kaplan-Meier curves by age categories and gender, providing a visual assessment of survival patterns by demographic groups.

2. Log-Rank Test:

Conduct a log-rank test to statistically compare survival curves across different age categories and gender. A statistically significant result indicates that survival distributions differ across these subgroups.

6.3 Sensitivity Analysis

Handling Censoring: To account for potential biases due to censored data, perform a sensitivity analysis that evaluates the impact of individuals lost to follow-up.

6.4 Statistical Software

Utilize statistical software such as R, SPSS, or STATA to perform Kaplan-Meier analysis and log-rank testing.

7. Ethical Considerations

Secure ethical approval and access permissions for the use of patient data.

Ensure confidentiality by anonymizing patient identifiers and adhering to secure data handling protocols.

Observations

1. Demographic Characteristics

The study population consisted of 711 HIV-positive patients, of whom 57.0% were male and 43% were female.

Age Distribution: The majority (59.9%) fell within Age Group of 41-60 years (42.0% female, 57.7% male), while elderly Age Group [> 60 years] had the fewest patients (2.5%).

Table 1:

Age and Gender Distribution			
Age Group (years)	Female* n (%)	Male n (%)	Total n (%)
1. Less than 18	28 (50.0%)	28 (50.0%)	56 (7.9%)
2. 18-40	93 (44.1%)	118 (55.9%)	211 (29.7%)
3. 41-60	180 (42.3%)	246 (57.7%)	426 (59.9%)
4. More than 61	5 (27.8%)	13 (72.2%)	18 (2.5%)
Districts of Origin by Gender			
1. Bilaspur	25 (49.0%)	26 (51.0%)	51 (7.2%)
2. Una	10 (38.5%)	16 (61.5%)	26 (3.7%)
3. Hamirpur	193 (42.2%)	264 (57.8%)	457 (64.3%)
4. Kangra	36 (49.3%)	37 (50.7%)	73 (10.3%)
5. Mandi	29 (40.8%)	42 (59.2%)	71 (10.0%)
6. Non-Himachali	13 (39.4%)	20 (60.6%)	33 (4.6%)
Total	306 (42.9%)	405 (57.0%)	711 (100%)

*Single transgender person is included in female group for further analysis.

Table 1 demonstrates that Age Group 3 had the highest representation, with a larger proportion of male patients across all age groups. As seen in Table, Hamirpur is the primary region of residence for participants, with males representing a larger portion of the study population across regions. Place of Origin: The majority of patients (64.3%) originated from Hamirpur district, followed by Kangra (10.3%) and Mandi (10.0%). Patients from non-Himachali regions comprised 4.6%.

Table 2: Baseline and Latest CD4 Counts across Age Groups

Age Group	Baseline CD4 Count (Mean)	SD	Latest CD4 Count (Mean)	SD
1. Less than 18	575.55	120.45	476.32	110.23
2. 18-40	349.27	95.60	458.57	102.34
3. 41-60	233.97	85.34	411.94	98.12
4. More than 60	189.88	70.56	457.69	92.47
Total	293.73	95.00	431.57	100.00

If the data involves individuals with conditions like HIV, the CD4 count can decrease over time due to disease progression, particularly if treatment adherence is poor or if the infection is advanced.

Table 2 shows that Age Group 1 had the highest baseline CD4 count, while Age Group 2 demonstrated the largest improvement over time.

Table 3: ART Status and Follow-Up Outcomes

Status	Female* (Count, %)	Male (Count, %)	Total (Count, %)
1. Alive on ART	243 (79.7%)	270 (66.7%)	513 (72.2%)
2. Died	30 (28.6%)	75 (71.4%)	105 (14.8%)
3. Lost to Follow-up	11 (33.3%)	22 (66.7%)	33 (4.6%)
4. Transferred Out	22 (7.2%)	38 (9.4%)	60 (8.4%)
Total	306 (42.9%)	405 (57.0%)	711 (100%)

As seen in Table 3, most patients remained alive on ART, with male patients having a higher mortality rate. At the study's conclusion, 72.2% of patients were alive on ART, with higher mortality observed among male patients (18.5%) compared to females (9.5%).

4. Cause Of Death Distribution

Mortality Causes: Most recorded deaths (90.3%) were classified as general or unspecified, with a smaller proportion attributed to conditions such as cardiac arrest and lung damage.

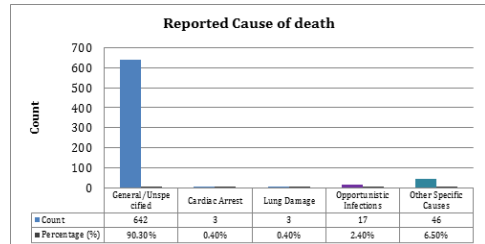
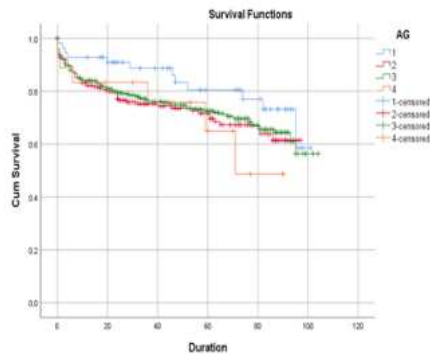


Figure 1: Causes of Death Distribution

(Figure 1: Pie chart illustrating the proportion of causes of death, with general/unspecified as the largest category) Figure 1 shows that most deaths were general or unspecified, suggesting possible gaps in cause-of-death reporting.

Kaplan-Meier Survival Analysis Interpretation

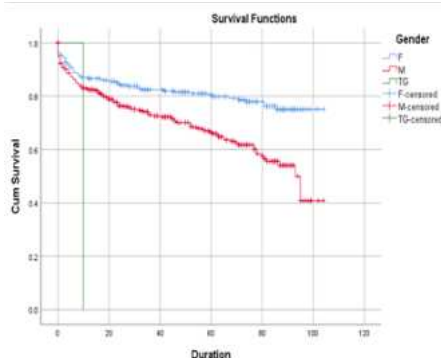
Means for Survival Time				
Age Group	Mean			
	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1. Less than 18	83.900	4.454	75.170	92.631
2. 18-40	71.266	2.789	65.799	76.732
3. 41-60	76.649	2.104	72.525	80.773
4. More than 60	64.859	8.268	48.654	81.063
Overall	76.797	1.629	73.603	79.991
		Chi-Square	df	Sig
Log Rank (Mantel-Cox)		2.990	3	.393
Test of equality of survival distributions for the different levels of Age Group.				



Kaplan-Meier Survival Analysis shows distinct trends in survival by age and gender.

For age groups Less than 18 years exhibited the highest mean survival time (83.9 months, 95% CI: 75.17–92.63), whereas Age Group more than 60 years had the lowest (64.86 months, 95% CI: 48.65–81.06). Age Groups 18–40 years and 41–60 had intermediate survival times. However, the log-rank test ($p = 0.393$) indicates no statistically significant differences among the age groups. This suggests that age alone did not strongly influence survival outcomes, as overlapping confidence intervals support a lack of substantial variance in survival based on age.

Means for Survival Time				
Gender	Mean			
	Estimate	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Female	84.718	2.198	80.410	89.027
Male	70.431	2.270	65.982	74.880
TG	10.000	.000	10.000	10.000
Overall	76.797	1.629	73.603	79.991
		Chi-Square	df	Sig.
Log Rank (Mantel-Cox)	22.606	2		.000
Test of equality of survival distributions for the different levels of Gender.				



In contrast, significant differences emerged by gender. Female patients had a notably higher mean survival time (84.72 months, 95% CI: 80.41–89.03) compared to male patients (70.43 months, 95% CI: 65.98–74.88), with the log-rank test confirming statistical significance ($p < 0.001$). This implies that gender may play a meaningful role in survival outcomes within the cohort, with females showing a survival advantage. Potential contributing factors could include biological differences, healthcare access, or adherence to treatment.

DISCUSSION:

The findings from this study provide a comprehensive overview of demographic patterns, clinical outcomes, and survival trends among HIV-positive patients, with key implications for targeted care and interventions.

Demographic Patterns

The cohort comprised 711 HIV-positive patients, with a male predominance (56%). The age distribution analysis revealed that the majority (59.9%) fell within the 41–60 years group, aligning with the peak HIV prevalence observed in other studies. Social, behavioural, and occupational factors likely contribute to this trend. A study by

Singh A. et al. reported a similar pattern, with 73.8% of patients in the 41–60 years group, of whom 57.75% were males and 42.25% females⁵. The notably low proportion of elderly patients (>60 years) suggests either limited survival beyond this age or delayed diagnosis.

Regionally, most patients originated from Hamirpur (64.3%), followed by Kangra (10.3%) and Mandi (10%). The higher number of cases in Hamirpur is attributable to the study being conducted at the ART center in Hamirpur, the third-oldest ART center in Himachal Pradesh.

Clinical Outcomes

The observed improvement in CD4 counts from a baseline mean of 293.73 to 431.57 indicates successful antiretroviral therapy (ART) outcomes overall. Age Group of 18–40 years demonstrated the largest increase in latest CD4 counts, likely due to effective ART adherence, higher immune resilience, and greater healthcare engagement. Similar findings were present in study done by Patel V et al.⁶ But age Group <18 years exhibited the highest baseline CD4 counts, possibly reflecting shorter HIV infection duration and earlier diagnosis. However, their latest CD4 counts were lower, likely influenced by: Higher susceptibility to infections or malnutrition.

Potential data collection errors or small sample sizes, which could skew results.

These observations underscore the need for enhanced monitoring and tailored interventions for younger patients to mitigate these vulnerabilities.

Survival Trends

Survival time was shorter among patients aged >60 years compared to younger patients, consistent with findings from other studies. Most patients (72.2%) remained alive on ART, reflecting substantial success in treatment retention and adherence. Gender differences were notable, with a higher mortality rate in males (18.5%) compared to females (9.5%)⁷. Possible contributing factors include:

Disparities in healthcare access and ART adherence.

Socio-cultural norms affecting treatment engagement.

Addressing these disparities through gender-sensitive counselling, community-based support, and tailored adherence strategies could enhance survival outcomes for males.

Mortality And Cause Of Death

The predominance of general or unspecified causes of death (90.3%) highlights gaps in mortality documentation. Improved cause-of-death reporting and post-mortem analyses are crucial for identifying and addressing preventable or manageable co-morbidities. Conditions such as cardiac disease and lung damage, though less common, warrant special attention for timely intervention and better care.

Kaplan-Meier Survival Analysis

The Kaplan-Meier survival analysis revealed that Age Group <18 years had the highest mean survival time (83.9 months, 95% CI: 75.17–92.63), while Age Group 4 >60 years had the lowest (64.86 months, 95% CI: 48.65–81.06)⁸. However, no statistically significant differences in survival among age groups were observed ($p = 0.393$), indicating that age alone may not be a primary determinant of survival outcomes. This finding highlights the effectiveness of consistent ART management and retention in care across all age groups.

In contrast, survival outcomes differed significantly by gender. Females demonstrated a higher mean survival time (84.72 months) compared to males (70.43 months), as confirmed by a statistically significant log-rank test ($p < 0.001$)⁹. Women's proactive healthcare-seeking behaviour, earlier ART initiation, and better adherence likely contribute to these outcomes. Conversely, men's higher engagement in health-compromising behaviours such as smoking, heavy drinking, and substance abuse may adversely impact ART effectiveness¹⁰.

Since new cases of HIV have been decreased since last few decades but still there is need to aware the general population about the sign and symptoms of disease so that they come to hospital for testing. Early detection of HIV and adherence to ART leads to live same life as non HIV infected general population.

CONCLUSION:

This study underscores the importance of addressing both demographic and clinical factors to enhance HIV care outcomes.

Tailored interventions focused on geographic hotspots, gender disparities, and targeted support for older populations are crucial. Moreover, efforts to improve cause-of-death reporting can refine care strategies and enhance long-term survival for all patients.

By recognizing and addressing the demographic, clinical, and social nuances observed in this cohort, healthcare providers and policymakers can further optimize ART success rates, reduce mortality, and improve overall health outcomes for HIV-positive individuals.

Recommendations:

1. Initiatives should focus on improving ART adherence and reducing barriers to care among HIV patients.
2. Strengthen diagnostic and treatment programs in underserved regions and among non-Himachali populations.
3. Expand awareness campaigns and screening programs to ensure timely initiation of ART, especially for older adults.
4. Invest in diagnostic tools and training to accurately document causes of death, enabling targeted healthcare interventions.
5. Robust public health strategies and community engagement, can contribute to improved outcomes for HIV-positive populations.

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