Original Article

Factors associated with survival in adult people living with HIV/AIDS (PLHAs) in Mumbai, India (2004-2019): A retrospective cohort study

Shrikala Acharya[1], Amol Palkar[2], Padmaja Keskar[3], Maninder Singh Setia[4]

[1]Additional Project Director, [2]Data Specialist, [3]Project Director, Mumbai Districts AIDS Control Society, [4]Consultant Dermatologist and Epidemiologist, Department of Dermatology, Mumbai, India

Abstract

Background: Knowledge of factors that affect survival in People living with HIV/AIDS (PLHAs) on anti-retroviral therapy (ART) will help us develop and implement interventions to improve the clinical outcomes and survival in these individuals. The aim of this study was to estimate the survival in PLHAs on ART in the government ART programme in Mumbai, and the factors associated with survival in these individuals. **Methods:** It is a retrospective survival analysis of 28,345 adult PLHAs from 18 government ART centres in Mumbai (registration period 2004–2019). We estimated the mortality rates and their 95% confidence intervals [CIs], plotted the Kaplan Meier Survival curves, estimated incidence rate ratios (IRR) and hazard ratios (HR). There were done for the whole cohort and according to various demographic and clinical characteristics. **Results:** The mortality in PLHAs on ART was 9.04 per 1000 person years. The HR was significantly for those aged 50 years and more at the time of registration (HR: 3.01, 95% CI: 2.37, 3.83; $P < 0.001$), in those with baseline CD4 count of less than 200 higher hazard (HR: 1.83, 95% CI: 1.47, 2.27; $P < 0.001$), those with an adherence of 80–95% (HR; 5.58, 95% CI: 4.61, 6.75; $P < 0.001$) and adherence of <80% (HR: 9.37, 95% CI: 7.74, 11.33; $P < 0.001$). Furthermore, the hazard was significantly higher in those with TB compared those without TB (HR: 3.28, 95% CI: 2.87, 3.75; $P < 0.001$). Time from diagnosis (per month increase) to initiation of ART was not significantly associated with mortality. **Conclusions:** Increasing awareness about HIV testing and early detection of HIV in those who have high-risk behaviours, prompt diagnosis and management of TB among those infected, and developing and implementing strategies (such as enhanced counselling, telephone-based applications, messages, or reminders) to ensure ART adherence of more than 95% in those on ART will potentially help improve survival in PLHAs in India.

Keywords: Adult PLHAs, antiretroviral therapy, hazard ratios, survival curves

Introduction

Globally, there are about 38 million people living with HIV/AIDS (PLHAs) as of 2019; of these 1.7 were new infections and 690,000 HIV-related deaths were reported in 2019.[1] India has reported a total of 2.1 million cases according to 2017 estimates. Even though estimated adult HIV prevalence reduced from a high of 0.38% in 2001–2003 to 0.22% in 2017, a total of 87,580 (36,450 to 172,900) new infections were detected in 2017.[2] Among the states of India, Maharashtra has the highest number of HIV cases (330,000 [253,000 to 435,000]) with an estimated prevalence of 0.33%.[2] The introduction of anti-retroviral therapy (ART) has helped reduce HIV related mortality; however, it is estimated that only about 67% of those infected globally were on ART at the end of 2019.[3] Thus, there is a need to improve access to ART to improve survival in PLHAs. Furthermore, it

Address for correspondence: Dr. Maninder Singh Setia, Consultant Dermatologist and Epidemiologist, Mumbai, Maharashtra, India.
E-mail: maninder.setia@karanamconsultancy.in

Received: 20-08-2020 **Revised:** 27-09-2020
Accepted: 28-10-2020 **Published:** 27-02-2021

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/jfmpc.jfmpc_1703_20

How to cite this article: Acharya S, Palkar A, Keskar P, Setia MS. Factors associated with survival in adult people living with HIV/AIDS (PLHAs) in Mumbai, India (2004-2019): A retrospective cohort study. J Family Med Prim Care 2021;10:758-64.

has also been reported that 19% of those infected need access to testing services.[3]

Though ART services were available to those who could afford it in the initial years, the National AIDS Control Organisation introduced ART services in government centres free of cost in 2004.[4,5] The guidelines for initiating ART therapy have changed from 2004 onwards, in accordance with the guidelines from the World Health Organization (bases on CD4 counts, presence of co-infections, and stage of the disease).[5] Since 2017, however, India has initiated 'test and treat' policy; thus, all individuals who are detected HIV positive are initiated on ART; the treatment options include first line, second line, and third line ART.[4,6] In addition, viral loads have also been made available to monitor patients of ART. There has been gradual decline of about 71% in HIV-related deaths from 2005 through 2017; an estimated 69,110 deaths were ascribed to HIV-related illness.[7] Over the period of 2005 through 2017, the cost of providing first line ART has also reduced; it has also been postulated that further scaling up ART services may help reduce the cost of ART.[8]

Though, these are positive developments in HIV management, stigma related to HIV/AIDS still in an impediment in access to care.[9] Thus, individuals may not get tested early; consequently, they may not be initiated on ART. Individuals who are detected later in the course of infection or with low CD4 counts may have a higher mortality.[10-12] Besides this, place of residence and presence of opportunistic infections are associated with increased mortality.[13,14] It has been more than 15 years since free ART was introduced in the government systems. Maharashtra has the highest number of HIV infected individuals in India.[2] Mumbai, the capital of Maharashtra has been important in implementing the national HIV programme from the beginning. Thus, at this point it will be important to understand the factors that affect the survival in PLHAs who have been on the government ART programme. Knowledge of these factors will help us develop and implement interventions to improve the clinical outcomes and survival in these individuals.

With this background, we conducted the present study to estimate the survival in PLHAs on ART in the government ART programme in Mumbai, and the factors associated with survival in these individuals.

Methods

The present study is a retrospective survival analysis of 28,345 adult PLHAs.

Data sources

Administrative and clinical data of PLHAs from 18 ART centres (registered from 2004 onwards) in Mumbai were included for the present study. All these data are electronically recorded in a datasheet in Mumbai. The following variables were extracted from the electronic records: (1) name of the ART centre; (2) date of HIV test; (3) date of ART registration; (4) date of ART initiation; (5) age at the time of registration in the ART centre; (6) gender; (7) marital status; (8) potential route of infection; (9) baseline CD4 counts; (10) treatment regimen (according to the NACO guidelines) (11) adherence to the ART medications; (12) presence of tuberculosis (TB) co-infection; (13) Date of last visit; (14) date of death (if person had died). The main outcome for the present analysis was death of the individual. The last data point was till October 2019. We only included individuals who were more than 18 years of age at the time of registration. We did not include individuals who were transferred to other ART centres (considered as transferred out) in the present analysis.

Statistical analysis

(a) Descriptive statistics: We estimated the means and standard deviations (SDs) and median and interquartile range (IQR) for continuous variables. The means across groups was compared using the analysis of variance (ANOVA). We compared the proportions using the Chi square test or Fisher's exact test for low expected cell counts.

(b) Mortality and Survival statistics: We then estimated the mortality rates (per 1000 person-years) and their 95% confidence intervals [CIs] for the whole population and according to various demographic and clinical characteristics. We then plotted the Kaplan Meier Survival curves to estimate the survival. The equality of the survivor function was assessed using the log-rank test. We also estimated the survival (and their 95% CIs) at one, five, and 10 years. The time factor in our survival analysis was 'years after initiation of ART' and the main outcome event was death.

(c) Models: The next step in analysis was building of hazard models. We initially estimated the incidence rate ratios (IRR) for mortality and compared the mortality rates across various categories of clinical and demographic characteristics. Finally, we estimated the hazard ratios (HR) for mortality in this cohort. Initially, we used the Cox Proportional hazard models; however, the proportional assumptions were not met. Hence, we used other models for estimating the hazard ratio. The model that fit the best was chosen based on the Akaike Information Criteria, Bayesian Information Criteria, and Cox-Snellen Residuals. Based on these criteria, we chose the Weibull model for the present analysis.[15] The following variables were included in the models: age at the time of registration, gender, baseline CD4 count, adherence, TB co-infection, treatment regime, and time from ART diagnosis to initiation of ART. Data were entered in Ms Excel (© Microsoft, USA) and analysed using Stata Version 15.1 (© StataCorp, College Station, USA).

The study was approved by the Insitutional Ethics Committee of the Mumbai Districts AIDS Control Society for secondary data analysis (Reference Number: 006/2019).

Results

The mean (SD) age at the time of registration 39.2 (9.9) years; it was significantly higher in the males compared with females or male-to-female transgendered people (TGH) (40.5 [9.9] vs

37.5 [9.7] vs 35.2 [9.6]; $P < 0.001$). The proportion of males in the cohort was 56%, females was 43% and 0.65% were TGH. The potential routes of transmission were: heterosexual (91%), homosexual (2%), infected blood/unsafe injection (1%), and unknown (3%). Majority of them were married (64%) and 20% were widowed. The median (IQR) time of initiation of ART after HIV test was 1.4 (0.5, 22.1) months. The median (IQR) CD4 values at baseline was 264 (150, 436). About 4.5% of PLHAs had died and 7.9% were recorded as lost-to-follow-up. The total follow-up time (years after initiation of ART) in our study was 1,40,260 years. The mean survival of PLHAs after initiation of ART was 14.73 (95% CI: 14.67, 14.79) years. The maximum follow-up time was 15.67 years and the total follow-up time 1,40,260 years. In our study cohort, about 14% had TB.

The overall mortality in PLHAs on ART was 9.04 per 1000 PY. It was significantly higher in those above the age of 50 years (18.10/1000 PY). The mortality was highest in PLHAs with a reported adherence of <80% (67.60/1000 PY). We have presented all the mortality rates and IRRs in Table 1. This finding was also seen in the Kaplan Meier Survival curves [Figure 1a-e]. As seen in Figure 1b, there was no significant difference in the survival according to gender. However, those above the age of 50 had a significantly lower survival ($p < 0.001$) [Figure 1a]. Presence of tuberculosis and poor adherence was associated with lower survival [Figure 1d and e].

Based on our cohort, the estimated mean survival in PLHAs on ART was 14.73 (95% CI: 14.67, 14.79) years. However, it was 12.43 (95% CI: 11.90, 12.97) in PLHAs who reported an adherence of 80-95%, and 10.40 (95% CI: 9.60, 11.19) years in PLHAs with an adherence of <80%. Similarly, in PLHAs with a history of tuberculosis the survival was lower (13.15, 95% CI: 12.91, 13.39 years) compared with those who did not have tuberculosis (14.91, 95% CI: 14.85, 14.97 years). In those reporting poor adherence (<80%), the survival was low at one year (0.86, 95% CI: 0.83, 0.88), it reduced further at five years (0.78, 95% CI: 0.74, 0.82), and it reduced to 0.59 (95% 0.50, 0.67) at 10 years. We also found that survival at one year, five years, and 10 years was lower in those with TB compared with those who did not have TB. We have presented the mean survival and survival probabilities according to demographic and clinical characteristics in Table 2.

In the multivariate models, we found that HR was significantly high for those aged 50 years and more at the time of registration (HR: 3.01, 95% CI: 2.37, 3.83; $P < 0.001$) compared with those who were less than 30 years old. PLHAs with a baseline CD4 count of less than 200 had a significantly higher hazard (HR: 1.83, 95% CI: 1.47, 2.27; $P < 0.001$) compared with those who had a baseline CD4 count of greater than 500. However, there were no significant differences in other groups of CD4. The HR was significantly higher in those who reported an adherence of 80-95% (HR; 5.58, 95% CI: 4.61, 6.75; $P < 0.001$) and adherence of <80% (HR: 9.37, 95% CI: 7.74, 11.33; $P < 0.001$). The hazard was significantly higher in those with TB compared those without TB (HR: 3.28, 95% CI: 2.87, 3.75; $P < 0.001$).Time from diagnosis (per month increase) to initiation of ART was not significantly associated with an increased hazard of mortality. Details of HRs and their 95% confidence intervals are presented in [Table 3].

Table 1: Table showing the mortality rates (per 1000 person-years) and incidence rate ratios in 28,345 PLHAs, Mumbai, India

Characteristics	Estimate (95% CI)		*P*
	Mortality rate (per 1000 PY)	Incidence Rate Ratios	
Total	9.04 (8.56, 9.55)		
Age groups			
19-29	6.69 (5.59, 7.99)	Reference	
30-39	6.47 (5.82, 7.18)	0.97 (0.79, 1.19)	0.75
40-49	9.25 (8.44, 10.13)	1.38 (1.13, 1.69)	0.002
>=50	18.10 (16.28, 20.13)	2.71 (2.20, 3.33)	<0.001
Gender			
Male	9.13 (8.49, 9.82)	Reference	
Female	8.91 (8.19, 9.70)	0.98 (0.87, 1.09)	0.67
TGH	9.73 (4.64, 20.41)	1.07 (0.51, 2.24)	0.87
Baseline CD4 counts			
0-200	11.95 (11.10, 12.86)	Reference	
201-350	5.87 (5.19, 6.64)	0.49 (0.43, 0.57)	<0.001
351-500	7.17 (6.05, 8.49)	0.60 (0.50, 0.72)	<0.001
>=500	6.44 (5.39, 7.69)	0.54 (0.44, 0.65)	<0.001
Adherence			
Good >95%	5.75 (5.36, 6.17)	Reference	
Average 80-95%	36.74 (30.89, 43.69)	6.39 (5.30, 7.71)	<0.001
Poor <80%	67.60 (57.04, 80.12)	11.76 (9.79, 14.14)	<0.001
TB			
No	7.02 (6.57, 7.51)	Reference	
Yes	24.44 (22.15, 26.97)	3.48 (3.09, 3.92)	<0.001

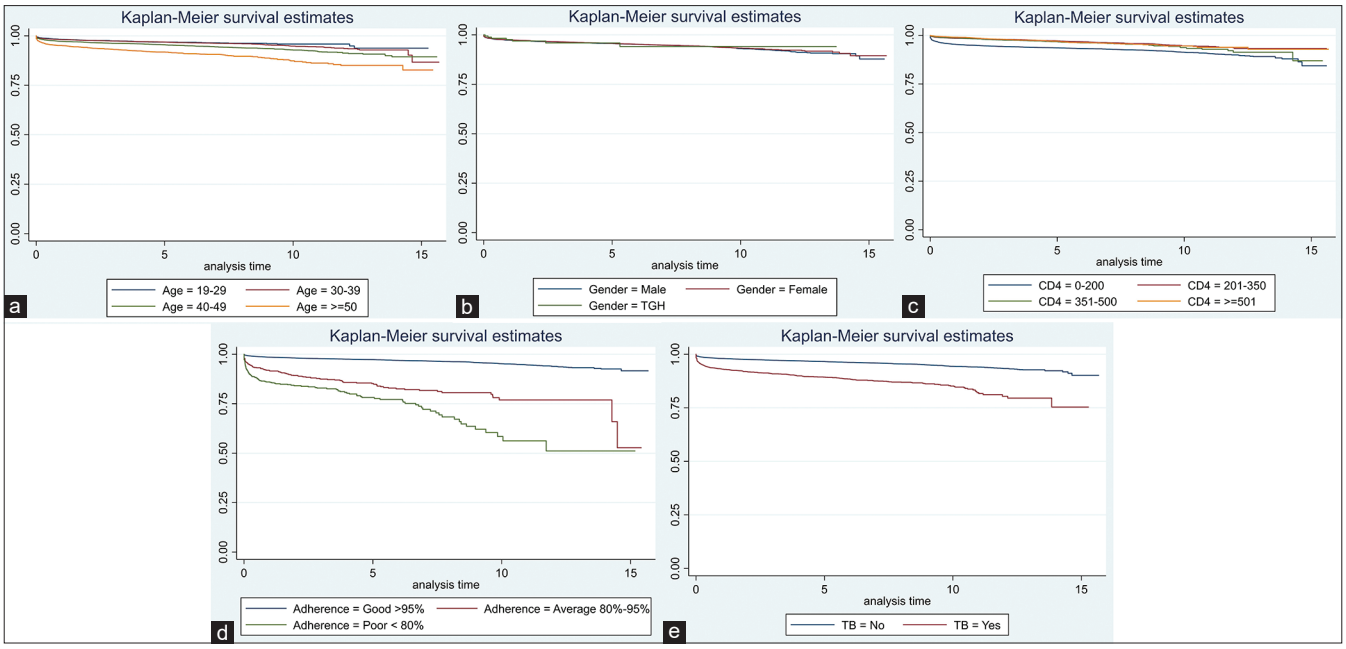

Figure 1: a to 1e: Figure showing Kalpan Meier Survival Estimates in Adult PLHAs according to demographic and clinical characteristics. (a) Age groups (b) Gender (c) Baseline CD4 counts (d) Adherence to ART (e) Presence of TB co-infection

Table 2: Table showing the mean survival and survival probability in 28,345 PLHAs, Mumbai, India

	Mean survival (yrs)	Survival Probability Estimate (95% CI)		
	Mean (95% CI)	1 year	5 years	10 years
Total	14.73 (14.67, 14.79)	0.97 (0.97, 0.97)	0.96 (0.95, 0.96)	0.93 (0.93, 0.94)
Age groups				
19-29	14.68 (14.55, 14.80)	0.98 (0.98, 0.99)	0.97 (0.96, 0.97)	0.96 (0.95, 0.97)
30-39	14.92 (14.80, 15.04)	0.98 (0.98, 0.98)	0.97 (0.96, 0.97)	0.95 (0.94, 0.95)
40-49	14.62 (14.53, 14.72)	0.97 (0.97, 0.98)	0.95 (0.95, 0.96)	0.93 (0.92, 0.94)
>=50	13.81 (13.63, 13.99)	0.95 (0.94, 0.95)	0.92 (0.91, 0.93)	0.87 (0.85, 0.89)
Gender				
Male	14.64 (14.56, 14.72)	0.97 (0.97, 0.97)	0.96 (0.95, 0.96)	0.93 (0.92, 0.94)
Female	14.76 (14.67, 14.85)	0.97 (0.97, 0.98)	0.96 (0.95, 0.96)	0.93 (0.93, 0.94)
TGH	13.05 (12.55, 13.55)	0.98 (0.94, 0.99)	0.96 (0.91, 0.98)	0.94 (0.87, 0.97)
Baseline CD4 counts				
0-200	14.33 (14.23, 14.44)	0.95 (0.95, 0.96)	0.94 (0.93, 0.94)	0.91 (0.91, 0.92)
201-350	14.94 (14.86, 15.03)	0.99 (0.98, 0.99)	0.97 (0.97, 0.98)	0.95 (0.94, 0.95)
351-500	14.62 (14.44, 14.81)	0.99 (0.98, 0.99)	0.97 (0.96, 0.97)	0.94 (0.92, 0.95)
>=500	14.99 (14.85, 15.14)	0.99 (0.99, 0.99)	0.97 (0.96, 0.98)	0.95 (0.93, 0.96)
Adherence				
Good >95%	15.02 (14.97, 15.08)	0.99 (0.98, 0.99)	0.97 (0.97, 0.97)	0.95 (0.95, 0.96)
Average 80-95%	12.43 (11.90, 12.97)	0.91 (0.89, 0.93)	0.85 (0.82, 0.88)	0.77 (0.72, 0.82)
Poor <80%	10.40 (9.60, 11.19)	0.86 (0.83, 0.88)	0.78 (0.74, 0.82)	0.59 (0.50, 0.67)
Tuberculosis				
No	14.91 (14.85, 14.97)	0.98 (0.98, 0.98)	0.97 (0.96, 0.97)	0.94 (0.94, 0.95)
Yes	13.15 (12.91, 13.39)	0.93 (0.92, 0.94)	0.89 (0.88, 0.90)	0.85 (0.83, 0.87)

Discussion

Thus, we found that the overall mortality in PLHAs after initiation of ART was 9.04 per 1000 PY and the estimated mean survival time was 14.73 (95% CI: 14.67, 14.79) years. Poor adherence, presence of TB co-infection, low CD 4 counts at baseline (<200), and old age were significantly associated with low survival and increased hazard of mortality in our cohort.

Adherence to ART medications was the most important factor associated with increased hazard of mortality in these individuals. It has been shown that good adherence is associated with an increase in CD4 counts, appropriate virologic response, and

Table 3: Table showing the hazard ratio estimates (and 95% confidence intervals) from univariate and multivariate models, Mumbai, India

	Univariate Models	*P*	Multivariate models*	*P*
Age groups				
19-29	Reference		Reference	
30-39	1.17 (0.93, 1.48)	0.19	1.16 (0.91, 1.47)	0.22
40-49	1.61 (1.29, 2.03)	<0.001	1.58 (1.25, 1.99)	<0.001
>=50	3.03 (2.40, 3.83)	<0.001	3.01 (2.37, 3.83)	<0.001
Gender				
Male	Reference		Reference	
Female	0.83 (0.73, 0.94)	0.003	1.03 (0.90, 1.17)	0.66
TGH	1.09 (0.52, 2.29)	0.83	1.59 (0.75, 3.35)	0.23
Baseline CD4 counts				
>=500	Reference		Reference	
351-500	1.20 (0.95, 1.55)	0.13	1.14 (0.87, 1.48)	0.33
201-350	1.15 (0.93, 1.43)	0.20	0.95 (0.75, 1.21)	0.69
≤ 200	2.48 (2.05, 3.01)	<0.001	1.83 (1.47, 2.27)	<0.001
Adherence				
Good >95%	Reference		Reference	
Average 80-95%	5.58 (4.63, 6.73)	<0.001	5.58 (4.61, 6.75)	<0.001
Poor <80%	9.58 (7.97, 11.52)	<0.001	9.37 (7.74, 11.33)	<0.001
Tuberculosis				
No	Reference		Reference	
Yes	3.57 (3.14, 4.06)	<0.001	3.28 (2.87, 3.75)	<0.001

*Models were also adjusted for regime and time from test to initiation of ART (in months)

reduced mortality.[16-19] Indeed a randomised trial conducted by Kiwuwa-Muyingo and colleagues[20] found that about 16% to 33% of deaths could be potentially avoided by monitoring and improving adherence in PLHAs. In our study, adherence to medications was an important factor associated with mortality; the mortality increased with reducing adherence. Though, we did not assess the reasons for poor adherence in the population, previous literature has highlighted the role of access to care, mental health issues, stigma, social support, and alcohol use as potential barriers to adherence.[21-24] Indeed, the WHO has advocated an Enhanced Adherence Counselling programme; it involves education, counselling, assessment of individual requirement, and follow-up sessions.[25] Thus, one of the most important interventions for improving survival in PLHAs on ART will be to develop methods and techniques to ensure >95% adherence; this may include setting-up of telephone based applications, messages, or reminders for ART intake. However, these messages should not reveal the status of the individual; thus, these could be general messages that talk about health, prevention, and care. If individuals have disclosed their status to family members, spouses, partners, or friends, then they should be involved in improving the adherence of PLHAs. Primary care physicians and family physicians can help to monitor and improve adherence among their patients who are HIV infected and are currently on ART.

The other important factor associated with mortality was co-infection with TB, a finding that also been reported by other authors.[26,27] TB is one of the most common co-infections in PLHAs. Indeed, studies have shown that the prevalence of TB was as high as 34% and incidence was about 10% in PLHAs in India.[28] Thus, it is important to identify TB infection early and initiate prompt treatment in PLHAs. The introduction of Cartridge Based Nucleic Acid Amplification Tests (CBNAAT) has helped improve the diagnosis of TB even in extra-pulmonary cases.[29-31] It has also been shown that survival in HIV-TB co-infected can be improved by initiating ART at an appropriate time after starting of TB treatment.[27,32] Furthermore, treating physicians should use clinical judgement while starting ART to avoid mortality due Immune Reconstitution Syndrome.[33] Baseline CD4 counts at the time of diagnosis was another factor associated with mortality in our study population. Early diagnosis of HIV (> 200 CD4 cell count at baseline) will be useful to initiate ART early in the infection; this will reduce opportunistic infections and mortality in these patients.[10,34,35] Since, India already has the 'test and treat' policy, it will be important to improve testing[36] and increase awareness about early testing in those who have high-risk behaviours (such as multiple partners and unprotected sex). Family physicians can discuss high-risk behaviours and suggest testing for HIV and other sexually transmitted infections; thus, they can help in early detection of HIV.

The study was not without limitations. Since, we used clinical and demographic data from administrative records, we did not have detailed clinical information for entire duration of follow-up. Thus, we were not able to account for all the possible events in these analyses. Furthermore, though we used the baseline CD4 in the model, we did not account for later CD4 counts. Nonetheless, we have used a large database of PLHAs over a period of 15 years. Furthermore, we did account for demographic, clinical, and baseline CD4 counts in the model.

These analyses provide useful information on the factors associated with mortality in PLHAs. We found that adherence to ART, TB co-infection, and low baseline CD4 counts were significantly associated with mortality in PLHAs. Increasing awareness about HIV testing and early detection of HIV in those who have high-risk behaviours, prompt diagnosis and management of TB among those infected, and developing and implementing strategies (such as enhanced counselling, telephone based applications, messages, or reminders) to ensure ART adherence of more than 95% in those on ART will potentially help improve survival in PLHAs in India.

Acknowledgements

We would like to acknowledge the support from FHI360 LINKAGES and YRG Care Accelerate Programme, India for support for the programme.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. World Health Organization. Summary of the global HIV epidemic (2019). Available from: https://www.who.int/hiv/data/2019_summary-global-hiv-epi.png?ua=1. Published 2020. [Last accessed on 2020 Jul 15].
2. National AIDS Control Organisation. HIV Facts & Figures. Available from: http://naco.gov.in/hiv-facts-figures#:~:text=As%20per%20the%20recently%20released,0.14%2D0.25)%20among%20 Females. Published 2020. [Last accessed on 2020 Jul 15].
3. HIV.gov. Global Statistics. Available from: https://www.hiv.gov/hiv-basics/overview/data-and-trends/global-statistics. Published 2020. [Last accessed on 2020 Jul 15].
4. Department of Health & Family Welfare. Annual Report 2015-16. New Delhi, India: Ministry of Health & Family Welfare, Government of India; 2016.
5. Tanwar S, Rewari BB, Rao CD, Seguy N. India's HIV programme: Successes and challenges. J Virus Erad 2016;2(Suppl 4):15-9.
6. Bhattacharya J. HIV prevention & treatment strategies-Current challenges & future prospects. Indian J Med Res 2018;148:671-4.
7. National AIDS Control Organization & ICMR-National Institute of Medical Statistics. India HIV Estimations 2017: Technical Report. New Delhi, India: NACO, Ministry of Health and Family Welfare, Government of India; 2018.
8. Kumar GA, Dandona R, Rewari BB, Kumar SGP, Tanwar S, Gagnier MC, *et al.* Decreasing cost of public sector first-line ART services in India from 2007-2008 to 2015-2016. PLoS One 2018;13:e0206988.
9. Kandwal R, Bahl T. Link to slower access to care: What is the stigma?: An Indian perspective. Curr HIV/AIDS Rep 2011;8:235-40.
10. Buchacz K, Armon C, Palella FJ, Baker RK, Tedaldi E, Durham MD, *et al.* CD4 cell counts at HIV diagnosis among HIV outpatient study participants, 2000-2009. AIDS Res Treat 2012;2012:869841. doi: 10.1155/2012/869841.
11. Cao WJ, Yao YM, Wei W, Lin F, Lu JD, Yuan Z. [Survival time and related factors on HIV/AIDS patients in Guizhou province from 1995 to 2018]. Zhonghua Liu Xing Bing Xue Za Zhi 2020;41:557-61.
12. Kim YC, Ahn JY, Kim HY, Song JY, Park DW, Kim MJ, *et al.* Survival trend of HIV/AIDS patients starting antiretroviral therapy in South Korea between 2001 and 2015. Yonsei Med J 2020;61:705-11.
13. Javalkar P, Prakash R, Isac S, Washington R, Halli SS. An estimation of mortality risks among people living with HIV in Karnataka State, India: Learnings from an intensive HIV/AIDS care and support programme. PLoS One 2016;11:e0156611.
14. Joseph N, Sinha U, Tiwari N, Ghosh P, Sindhu P. Prognostic factors of mortality among adult patients on antiretroviral therapy in India: A hospital based retrospective cohort study. Biomed Res Int 2019;2019:1419604. doi: 10.1155/2019/1419604.
15. Cleves M, Gould W, Gutierrez R, editors. An Introduction to Survival Analysis using Stata. College Station, Texas, USA: Stata Press; 2004.
16. Abaasa AM, Todd J, Ekoru K, Kalyango JN, Levin J, Odeke E, *et al.* Good adherence to HAART and improved survival in a community HIV/AIDS treatment and care programme: The experience of The AIDS Support Organization (TASO), Kampala, Uganda. BMC Health Serv Res 2008;8:241.
17. Anoje C, Agu KA, Oladele EA, Badru T, Adedokun O, Oqua D, *et al.* Adherence to on-time ART drug pick-up and its association with CD4 changes and clinical outcomes amongst HIV infected adults on first-line antiretroviral therapy in Nigerian hospitals. AIDS Behav 2017;21:386-92.
18. Nolan S, Milloy MJ, Zhang R, Kerr T, Hogg RS, Montaner JSG, *et al.* Adherence and plasma HIV RNA response to antiretroviral therapy among HIV-seropositive injection drug users in a Canadian setting. AIDS Care 2011;23:980-7.
19. Rai S, Mahapatra B, Sircar S, Raj PY, Venkatesh S, Shaukat M, *et al.* Adherence to antiretroviral therapy and its effect on survival of HIV-infected individuals in Jharkhand, India. PLoS One 2013;8:e66860.
20. Kiwuwa-Muyingo S, Oja H, Walker A, Ilmonen P, Levin J, Mambule, *et al.* Dynamic logistic regression model and population attributable fraction to investigate the association between adherence, missed visits and mortality: A study of HIV-infected adults surviving the first year of ART. BMC Infect Dis 2013;13:395.
21. Abel E, Painter L. Factors that influence adherence to HIV medications: Perceptions of women and health care providers. J Assoc Nurses AIDS Care 2003;14:61-9.
22. Lyimo RA, Stutterheim SE, Hospers HJ, de Glee T, van der Ven A, de Bruin M. Stigma, disclosure, coping, and medication adherence among people living with HIV/AIDS in Northern Tanzania. AIDS Patient Care STDS 2014;28:98-105.
23. Mills EJ, Nachega JB, Bangsberg DR, Singh S, Rachlis B, Wu P, *et al.* Adherence to HAART: A systematic review of developed and developing nation patient-reported barriers and facilitators. PLoS Med 2006;3:e438.
24. Sweeney SM, Vanable PA. The association of HIV-related stigma to HIV medication adherence: A systematic review and synthesis of the literature. AIDS Behav 2016;20:29-50.
25. World Health Organization. Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV

Infection: Recommendations for a Public Health Approach. Geneva, Switzerland: World Health Organization; 2016.

26. Mollel EW, Todd J, Mahande MJ, Msuya SE. Effect of tuberculosis infection on mortality of HIV-infected patients in Northern Tanzania. Trop Med Health 2020;48:26. doi: 10.1186/s41182-020-00212-z.
27. Naidoo K, Rampersad S, Karim SA. Improving survival with tuberculosis & HIV treatment integration: A mini-review. Indian J Med Res 2019;150:131-8.
28. Dravid A, Natarajan K, Medisetty M, Gawali R, Mahajan U, Kilkarni M, *et al.* Incidence of tuberculosis among HIV infected individuals on long term antiretroviral therapy in private healthcare sector in Pune, Western India. BMC Infect Dis 2019;19:714. doi: 10.1186/s12879-019-4361-0.
29. Chandrappa N, Rastogi A, Bhatnagar AK. Cartridge based nucleic acid amplification test is superior in diagnosing lymphnode tuberculosis. Indian J Tuberc 2019;66:402-6.
30. Sachdeva K, Shrivastava T. CBNAAT: A boon for early diagnosis of tuberculosis-head and neck. Indian J Otolaryngol Head Neck Surg 2018;70:572-7.
31. Youngs J, Patil S, Jain Y. A prospective study evaluating the impact of cartridge-based nucleic acid amplification test (CBNAAT) on the management of tuberculosis in a low-resource high-burden Indian rural setting. J Family Med Prim Care 2018;7:982-92.
32. Maemun S, Mariana N, Rusli A, Mahkota R, Purnama TB. Early initiation of ARV therapy among TB-HIV patients in indonesia prolongs survival rates! J Epidemiol Glob Health 2020;10:164-7.
33. Chelkeba L, Fekadu G, Tesfaye G, Belayneh F, Melaku T, Mekonnen Z. Effects of time of initiation of antiretroviral therapy in the treatment of patients with HIV/TB co-infection: A systemic review and meta-analysis. Ann Med Surg (Lond) 2020;55:148-58.
34. Ghate M, Deshpande S, Tripathy S, Nene M, Gedam P, Godbole S, *et al.* Incidence of common opportunistic infections in HIV-infected individuals in Pune, India: Analysis by stages of immunosuppression represented by CD4 counts. Int J Infect Dis 2009;13:e1-8.
35. Castilla J, Sobrino P, De La Fuente L, Noguer I, Guerra L, Parras F. Late diagnosis of HIV infection in the era of highly active antiretroviral therapy: Consequences for AIDS incidence. AIDS 2002;16:1945-51.
36. Girum T, Yasin F, Wasie A, Shumbej T, Bekele F, Zeleke B. The effect of "universal test and treat" program on HIV treatment outcomes and patient survival among a cohort of adults taking antiretroviral treatment (ART) in low income settings of Gurage zone, South Ethiopia. AIDS Res Ther 2020;17:19.