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Temporal trends from HIV diagnosis to ART initiation among adults living with HIV in the Asia–Pacific (2013–2023)

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Abstract

Introduction Data on the impact of World Health Organization (WHO)'s guideline changes and COVID-19 on ART initiation in the Asia–Pacific remain scarce. This study described temporal trends from HIV diagnosis to ART initiation from 2013 to 2023 and its associated factors.

Methods Adults (≥ 18 years) diagnosed with HIV after 2013 in a regional observational cohort were included. Fine and Gray competing risk regression examined predictors of ART initiation (≥ 3 antiretroviral medications), accounting for those lost to follow-up or deceased before treatment considered as competing risks.

Results Among 14,968 participants, most were male (70.1%), with a median age of 36 years (interquartile range [IQR]: 28–44). At HIV diagnosis, median CD4 count was 208 cells/μL (IQR: 69–395), and median viral load was 86,296 copies/mL (IQR: 13,186–392,000). Over 85% of participants had initiated ART during the study period. Median time from HIV diagnosis to ART initiation differed across years of HIV diagnosis: 51 days (2013–2015), 28 days (2016–2019), and 26 days (≥ 2020). Factors associated with shorter time to ART initiation were higher country income-level (upper-middle: sub-distribution hazard ratio [SHR] = 1.34, 95% CI: 1.28, 1.40; high: SHR = 1.35, 95% CI: 1.28, 1.43; vs. lower-middle); HIV transmission via male-to-male contact (SHR = 1.06, 95% CI: 1.02, 1.11) or injection drug use (SHR = 1.23, 95% CI: 1.09, 1.38; vs. heterosexual contact); and later years of HIV diagnosis (2016–2019: SHR = 1.33, 95% CI: 1.28, 1.38; ≥ 2020: SHR = 1.40, 95% CI: 1.33, 1.48; vs. 2013–2015). Those with higher CD4 counts had longer time to ART start (350–499 cells/μL: SHR = 0.76, 95% CI: 0.67, 0.86; > 500 cells/μL: SHR = 0.55, 95% CI: 0.49, 0.61; vs. CD4 < 200 cells/μL).

Conclusion Time to ART initiation from HIV diagnosis decreased after 2016, aligning with evolving WHO guidelines, and did not appear to be impacted by COVID-19. Optimizing treatment initiation during the treat-all era is crucial, especially among those with higher CD4 counts.

Keywords ART initiation, Competing risks, WHO guidelines, COVID-19, Asia–Pacific

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Introduction

Globally, HIV remains as a public health issue, with approximately 39.9 million people living with HIV (PLHIV) in 2023. Among these, the Southeast Asian region contributed the second highest number of PLHIV, following Africa [1]. Early initiation of ART demonstrably improves individual, community, programmatic, social, and economic outcomes [2]. These benefits include the prevention of onward HIV transmission [3, 4], facilitation of rapid viral suppression [5], reduction in both serious AIDS-related and non-AIDS-related clinical events [6, 7], and improvement in survival rates [8]. Despite global ART coverage reaching 76% in 2022, it is noteworthy that the Southeast Asia region lags behind with only 65% coverage [1]. This gap could be attributed to several factors, including persistent stigma, concerns about confidentiality, reluctance to start lifelong medication, inadequate counseling services, complex diagnostic procedures, and disparities in income and healthcare infrastructures, all of which hinder the optical care for PLHIV [9]. Delays in ART initiation lead to early death, higher healthcare-related costs, poorer retention in care programs, as well as lower rates of ART uptake and viral suppression [5, 10]. Therefore, further investigation is needed to explore the temporal dynamics of ART initiation to strengthen the HIV care cascade [5], especially in Asia, as it could guide the development of more effective and broad-scale strategies for addressing HIV.

The World Health Organization (WHO)'s ART initiation guidelines have steadily shifted towards earlier treatment [11, 12]. Before 2006, ART initiation was recommended at CD4 counts below 200 cells/mm^3, shifting to clinical stage consideration in 2006 with a CD4 count of 201–350 cells/mm^3. By 2010, initiation was advised for CD4 < 350 cells/mm^3, and in 2013, at ≤ 500 cells/mm^3 [13]. In 2016, WHO introduced the "treat-all" approach, initiating ART as soon as possible following HIV diagnosis and irrespective of CD4 count [14]. The few studies evaluating time to ART initiation were predominantly conducted in African countries [5, 12], with only one investigating the impact of WHO guideline changes on ART initiation rates [12]. They found that individuals diagnosed during later WHO treatment guideline eras, with more advanced WHO clinical stage, and older age at diagnosis generally started ART sooner. Conversely, those with a higher nadir CD4 (the lowest CD4 count ever recorded) tended to delay ART initiation. However, this study did not account for competing risks and excluded CD4 counts at HIV diagnosis. Hence, there is a need for more research to examine these factors which will allow for a more accurate evaluation of timing to ART initiation and guide the development of optimized strategies.

The COVID-19 pandemic has significantly disrupted the cascade of HIV care across Asia. A multi-national cross-sectional study across 10 countries/territories in the region revealed declines in hospitals or clinic attendance, reduced rates of HIV testing, and diminished utilization of ART medications [15]. However, previous studies did not assess the impacts of COVID-19 on ART initiation timing [5, 12]. Understanding ART initiation trends within the context of WHO treatment guidelines changes and COVID-19 impacts can offer insights into the resilience of the healthcare system, patient behaviors, and adherence to evolving guidelines. Our study aims to investigate temporal trends in the timing of ART initiation from the date of HIV diagnosis among PLHIV in the Asia–Pacific region and associated factors in the context of WHO guideline changes and COVID-19 impacts.

Methodology

Study population

This study utilized data from The TREAT Asia Adult HIV Observational Database Continuum of Care study (TAHOD-CC), an observational study encompassing more than 60,000 adult PLHIV (aged 18 and older) in 20 clinical sites from 12 countries/territories across the Asia–Pacific (Cambodia, Hong Kong SAR, India, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand, and Vietnam) [16, 17]. Briefly, TAHOD-CC collects routine demographic, hepatitis serology, HIV immunology and virology, ART, physical findings and laboratory test data, and allows for the evaluation of HIV treatment outcomes, co-morbidities, and co-infections.

Our analyses included nine out of 12 countries/territories (Hong Kong SAR, India, Indonesia, Japan, Malaysia, Philippines, South Korea, Taiwan, Thailand) after excluding 3712 PLHIV with HIV diagnosis date after ART initiation. These exclusions were necessary because they would have introduced irrelevant data points with a negative time from HIV diagnosis to ART initiation. This study specifically focused on adult PLHIV enrolled in the TAHOD-CC cohort who were diagnosed with HIV from January 1, 2013, onwards, reflecting the constraints of retrospective data availability.

Data analysis

Time to ART initiation from HIV diagnosis, stratified by year of HIV diagnosis categorized according to WHO treatment guideline era and the onset of the COVID-19 pandemic (2013–2015, 2016–2019, ≥ 2020) [11, 12], was visualized using Kaplan–Meier curves. Viral load (log-transformed) and medium CD4 counts over the year of HIV diagnosis were plotted using box plots with median

and interquartile range (IQR), to provide further insights into the trends.

Fine and Gray competing risk regression with stepwise backward selection was used to estimate sub-distribution hazard ratios (SHRs) and 95% confidence intervals (CIs) for factors associated with time to ART initiation [18]. ART initiation encompassed individuals who received three or more ARV medications. Risk time began from the date of the HIV diagnosis and ended on the date of ART initiation. Those in active follow-up or transferred out without evidence of ART initiation were censored on the date of last follow-up. PLHIV were lost to follow-up (LTFU) or died prior to ART initiation were analyzed as competing risks. LTFU was defined as not seen at the clinic for more than 12 months excluding deaths or transfers.

Demographic covariates included were years of HIV diagnosis, CD4 at diagnosis, viral load at diagnosis, mode of HIV transmission, World Bank country income levels, age at diagnosis, and sex. Clinical and laboratory factors included a history of HBV or HCV surface antigen test, CD4 cell counts, and viral load levels measured within 6 months prior to HIV diagnosis.

All covariates in the bivariate analysis with $p < 0.10$ were fitted in the multivariable model. Covariates with $p < 0.05$ in the multivariable model were considered significant. Data management and statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, NC) and STATA software version 18 (STATA Corp., College station, TX).

Results

Demographic characteristics, baseline clinical and laboratory factors

A total of 14,968 PLHIV were included in the analysis. The majority were male (70.1%), with a median age of 36.0 years (IQR: 28–44), and primarily from lower-middle and upper-middle income countries (42.5% and 42.8%, respectively). Heterosexual contact was the most common route of HIV transmission (62.7%). The proportions of HBV and HCV co-infection were 5.2% and 3.1%, respectively. Nearly half of participants (48.3%) were diagnosed with HIV between 2016 and 2019, followed by 32.1% during 2013–2015, and 19.6% after 2020 (Table 1). The median CD4 counts at diagnosis was 208 cells/μL (IQR: 69–395), and the median viral load at diagnosis was 86,296 copies/mL (IQR: 13,186–392,000) (Table 1).

Eighty-five percent (12,749/14,968) of the total study population initiated ART treatment. Of the 12,749 who started ART, the majority were male (71.4%) with a median age of 35 years (IQR: 28–44). Precisely 49.4% received their HIV diagnosis between 2016 and 2019, with 31.6% diagnosed during 2013–2015, and 19% diagnosed after 2020. These participants had a median CD4 cell count of 198.0 cells/μL (IQR: 66.0–372.0), and a median viral load of 99,150 copies/mL (IQR: 17,510–421,683.5) at diagnosis. More participants who initiated ART were from upper-middle countries/territories (45.6%) (Table 1).

When stratified by year of HIV diagnosis, median CD4 cell count at diagnosis varied from 226 cells/μL (IQR: 83–430) among participants diagnosed between 2013 and 2015 to 170 cells/μL (IQR: 49–365) after 2020 (Fig. 1a). The median viral load at HIV diagnosis, by year of HIV diagnosis ranged from 10.9 log copies/mL (IQR: 3.66, 15.16) between 2013 and 2015 to 11.4 log copies/mL (IQR: 2.94, 16.02) after 2020 (Fig. 1b).

Time to ART initiation from HIV diagnosis

Figure 2 shows Kaplan–Meier curves for time to ART initiation from HIV diagnosis. The probability of not having initiated ART at two years from HIV diagnosis was 16.30% (95% CI: 15.17, 17.47) for those diagnosed in 2013–2015, 8.95% (95% CI: 8.23, 9.69) for 2016–2019, and 10.11% (95% CI: 8.77, 11.55) after 2020. Median time to ART initiation varied across years of HIV diagnosis: 51 days (2013–2015), 28 days (2016–2019), and 26 days ($\geq$ 2020). There were differences in time to ART initiation across the three-year groups (log-rank p value < 0.001).

Factors associated with time to ART initiation from HIV diagnosis

In the univariate analysis (Table 2), all demographics (e.g., age at HIV diagnosis, sex, country income levels, HIV transmission route, years of HIV diagnosis) and clinical and laboratory factors (e.g., HBV co-infection, CD4 and viral load at diagnosis) were significantly associated with time to ART initiation from HIV diagnosis (all global p values < 0.1). No significant association was observed between HCV co-infection and time to ART initiation (p value = 0.587).

After being adjusted (Table 2), participants from upper-middle (SHR = 1.34, 95% CI: 1.28, 1.43) and high-income countries (SHR = 1.35, 95% CI: 1.28, 1.43) were more likely to initiate ART faster than those from lower-middle income countries. Other factors associated with shorter time to ART initiation were male-to-male contact as mode of HIV transmission (SHR = 1.06, 95% CI: 1.02, 1.11) and injection drug use (SHR = 1.23, 95% CI: 1.09, 1.38) compared to heterosexual mode of exposure; and later year of HIV diagnosis (2016–2019: SHR = 1.33, 95% CI: 1.28, 1.38; after 2020: SHR = 1.40, 95% CI: 1.33, 1.48) compared to 2013–2015. Compared to CD4 cell

Table 1 Demographic and clinical characteristics at HIV diagnosis among people living with HIV enrolled in TAHOD-CC

	Total (N = 14,968) n (%)	**PLHIV who initiated ART (N = 12,749)** n (%)
Age at diagnosis (years)		
Median (IQR)	36.0 (28.0–44.0)	35.0 (28.0–44.0)
< 30	4165 (27.8)	3741 (29.3)
30–39	4843 (32.4)	4116 (32.3)
40–49	3674 (24.5)	3024 (23.7)
≥ 50	2286 (15.3)	1868 (14.7)
Sex		
Male	10,497 (70.1)	9100 (71.4)
Female	4471 (29.9)	3649 (28.6)
Country income level		
Lower-middle	6364 (42.5)	4852 (38.1)
Upper-middle	6407 (42.8)	5814 (45.6)
High	2197 (14.7)	2083 (16.3)
Modes of HIV transmission		
Heterosexual contact	9386 (62.7)	7733 (60.6)
Male-to-male sex	4240 (28.3)	3926 (30.8)
Injection drug use	172 (1.2)	164 (1.3)
Other (e.g., blood products, bisexual/unknown)	1170 (7.8)	926 (7.3)
CD4 at diagnosis (cells/μL)		
Median (IQR)	208.0 (69.0–395.0)	198.0 (66.0–372.0)
< 200	1893 (12.6)	1589 (12.5)
200–349	824 (5.5)	693 (5.4)
350–499	526 (3.5)	418 (3.3)
≥ 500	641 (4.3)	460 (3.6)
Not reported	11,084 (74.1)	9589 (75.2)
Viral load at diagnosis (copies/mL)		
Median (IQR)	86,296.0 (13,186.0–392000.0)	99,150.0 (17,510.0–421683.5)
≤ 1000	145 (1.0)	107 (0.8)
> 1000	972 (6.5)	865 (6.8)
Not reported	13,851 (92.5)	11,777 (92.4)
Hepatitis C infection (HCV)		
Negative	9143 (61.1)	8105 (63.6)
Positive	460 (3.1)	422 (3.3)
Not reported	5365 (35.8)	4222 (33.1)
Hepatitis B infection (HBV)		
Negative	10,045 (67.1)	8782 (68.9)
Positive	772 (5.2)	696 (5.5)
Not reported	4151 (27.7)	3271 (25.6)
Year of HIV diagnosis		
2013–2015	4811 (32.1)	4027 (31.6)
2016–2019	7223 (48.3)	6305 (49.4)
≥ 2020	2934 (19.6)	2417 (19.0)

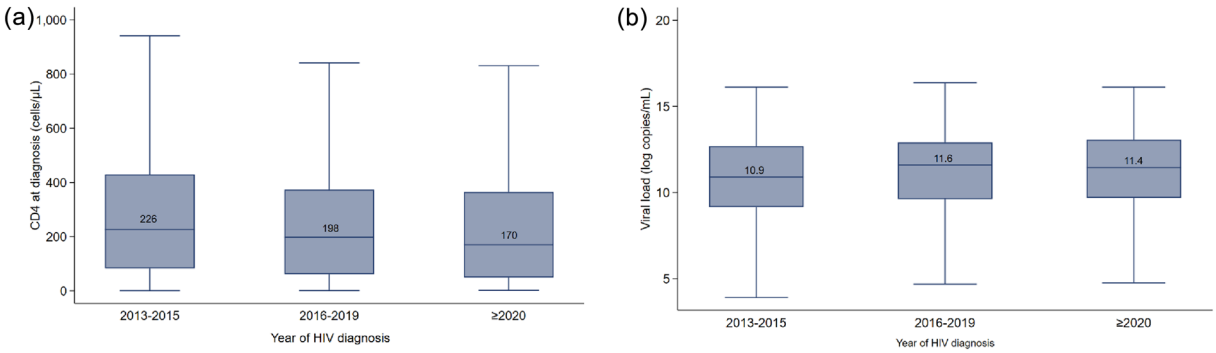

Fig. 1 **a** Median CD4 at HIV diagnosis, **b** Median viral load at HIV diagnosis

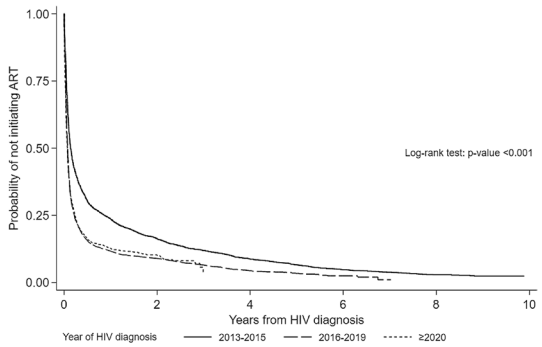

Fig. 2 Time to ART initiation from HIV diagnosis among people living with HIV enrolled in TAHOD-CC

counts < 200 cell/μL at diagnosis, those with CD4 cell counts of 350–499 cell/μL (SHR = 0.76, 95% CI: 0.67, 0.86) and > 500 cell/μL (SHR = 0.55, 95% CI: 0.49, 0.61) had longer time to ART initiation. These findings are also visualized in the Forest Plot in Fig. 3.

Discussion

Our study revealed factors associated with a shorter time to ART initiation included later years of HIV diagnosis, higher World Bank country income level, acquiring HIV through male-to-male sex and injection drug use. Compared to those diagnosed with HIV before 2016, all subsequent periods exhibited significantly faster median time to ART initiation. Interestingly, higher CD4 counts were associated with a longer time to ART initiation.

Our finding of faster time to ART initiation in later years is similar with previous studies including those from the Asia–Pacific region. A prior study conducted in four African countries indicating that the hazard ratio for ART initiation among those diagnosed after 2016 were 18.86 times higher than those diagnosed before 2006 [12]. Likewise, these findings align with previous studies in Spain, Iran, and China showing a rising trend in early ART initiation following the WHO's updated treatment guideline in 2016 [12, 19–21]. The observed decrease in rates of time to ART initiation across various eras can be attributed to factors other than changing WHO treatment guidelines, including increased HIV awareness and testing, reduced stigma, and the promotion of Treatment as Prevention (TasP) strategies (e.g., Undetectable = Untransmittable) [22]. These findings underscore the critical importance of ongoing efforts to bolster and streamline early ART initiation protocols, emphasizing the need for continued investment in strategies aimed at facilitating prompt access to treatment for individuals diagnosed with HIV.

This study also found that throughout the follow-up periods, participants typically presented with HIV at a later stage of the disease, characterized by low median CD4 count and high viral load. This finding may imply that PLHIV may have delayed seeking medical care or testing, leading to a diagnosis occurring at a point where the disease has progressed further. In Asia, a significant proportion—ranging from 34 to 72%—of individuals diagnosed with HIV presented late, characterized by a CD4 count below 350 cells/mm3 upon diagnosis [23]. This trend might be influenced by persistent stigmatization and discrimination associated with HIV testing and treatment, insufficient awareness of personal HIV risk, and limited access to HIV services or referrals [23]. We observed that the median CD4 count at HIV diagnosis was lowest during the COVID-19 (≥ 2020) period, likely due to disruptions in the HIV prevention-to-care continuum [15]. HIV late presentation not only strains healthcare systems and increases costs but also elevates the risk of opportunistic infections and community transmission of HIV, ART drug resistance, and mortality [23, 24]. The delayed presentation of HIV cases, especially during periods of societal stress like the COVID-19 pandemic, highlights the importance of preparing healthcare systems to maintain continuity of HIV services.

Table 2 Factors associated with time to ART initiation from HIV diagnosis among people living with HIV enrolled in TAHOD-CC

	No of patients	No of treatment	Follow up (years)	Incidence rate (/100pys)	Univariate model			Multivariable model		
					SHR	95% CI	p value	SHR	95% CI	p value
Total	**14,968**	**12,749**	**6,737.82**	**189.22**						
Age at diagnosis (years)							**0.0293**			
< 30	4,165	3,789	1,954.37	193.87	1					
30–39	4,843	4,072	2,212.25	184.07	0.97	0.93, 1.01	0.179			
40–49	3,674	3,038	1,710.62	177.60	0.96	0.92, 1.01	0,125			
≥ 50	2,286	1,850	860.59	214.97	1.05	0.99, 1.11	0.121			
Sex							**< 0.001**			
Male	10,497	9,100	4,454.93	204.27	1					
Female	4,471	3,649	2,282.89	159.84	0.89	0.86, 0.93	**< 0.001**			
Country income level							**< 0.001**			**< 0.001**
Lower-middle	6,364	4,852	3,297.98	147.12	1			1		
Upper-middle	6,407	5,814	2,467.39	235.63	1.40	1.34, 1.46	**< 0.001**	1.34	1.28, 1.40	**< 0.001**
High	2,197	2,083	972.45	214.20	1.42	1.35, 1.48	**< 0.001**	1.35	1.28, 1.43	**< 0.001**
Modes of HIV transmission							**< 0.001**			**< 0.001**
Heterosexual contact	9,386	7,733	4,379.66	176.57	1			1		
Male-to-male sex	4,240	3,926	1,841.47	213.20	1.28	1.24, 1.33	**< 0.001**	1.06	1.02, 1.11	**0.005**
Injection drug use	172	164	45.65	359.27	1.39	1.23, 1.57	**< 0.001**	1.23	1.09, 1.38	**0.001**
Other (e.g., Blood products, Bisexual/ Unknown)	1,170	926	471.04	196.58	1.04	0.96, 1.12	0.306	0.99	0.91, 1.06	0.724
CD4 at diagnosis (cells/μL)							**< 0.001**			**< 0.001**
< 200	1,893	1,589	421.74	376.78	1			1		
200–349	824	693	261.74	264.77	0.98	0.88, 1.10	0.751	1.02	0.92, 1.14	0.687
350–499	526	418	239.50	174.53	0.71	0.63, 0.81	**< 0.001**	0.76	0.67, 0.86	**< 0.001**
> 500	641	460	577.91	79.60	0.48	0.43, 0.53	**< 0.001**	0.55	0.49, 0.61	**< 0.001**
Not reported	11,084	9,589	5,236.93	183.10						

Table 2 (continued)

	No of patients	No of treatment	Follow up (years)	Incidence rate (/100pys)	Univariate model			Multivariable model		
					SHR	95% CI	p value	SHR	95% CI	p value
Viral load at diagnosis (copies/mL)							**< 0.001**			
≤ 1000	145	107	89.85	119.09	1					
> 1000	972	865	394.11	219.48	1.44	1.16, 1.78	**< 0.001**			
Not reported	13,851	11,777	6,253.86	188.32						
Hepatitis C infection							0.587			
Negative	9,143	8,782	4,511.26	194.67	1					
Positive	460	696	311.81	223.22	1.02	0.94, 1.12	0.587			
Not reported	5,365	3,271	1,914.75	170.83						
Hepatitis B infection							**0.003**			
Negative	10,045	8,105	3,700.64	219.02	1					
Positive	772	422	217.58	193.95	1.12	1.04, 1.20	**0.002**			
Not reported	4,151	4,222	2,819.61	149.74						
Year of HIV diagnosis							**< 0.001**			**< 0.001**
2013–2015	4,811	4,027.00	3,549.89	113.44	1					
2016–2019	7,223	6,305.00	2,492.01	253.01	1.37	1.32, 1.42	**< 0.001**	1.33	1.28, 1.38	**< 0.001**
≥ 2020	2,934	2,417.00	695.93	347.31	1.44	1.36, 1.51	**< 0.001**	1.40	1.33, 1.48	**< 0.001**

Global p values are tests for heterogeneity excluding missing values

P values in bold represent significant covariates in the final model

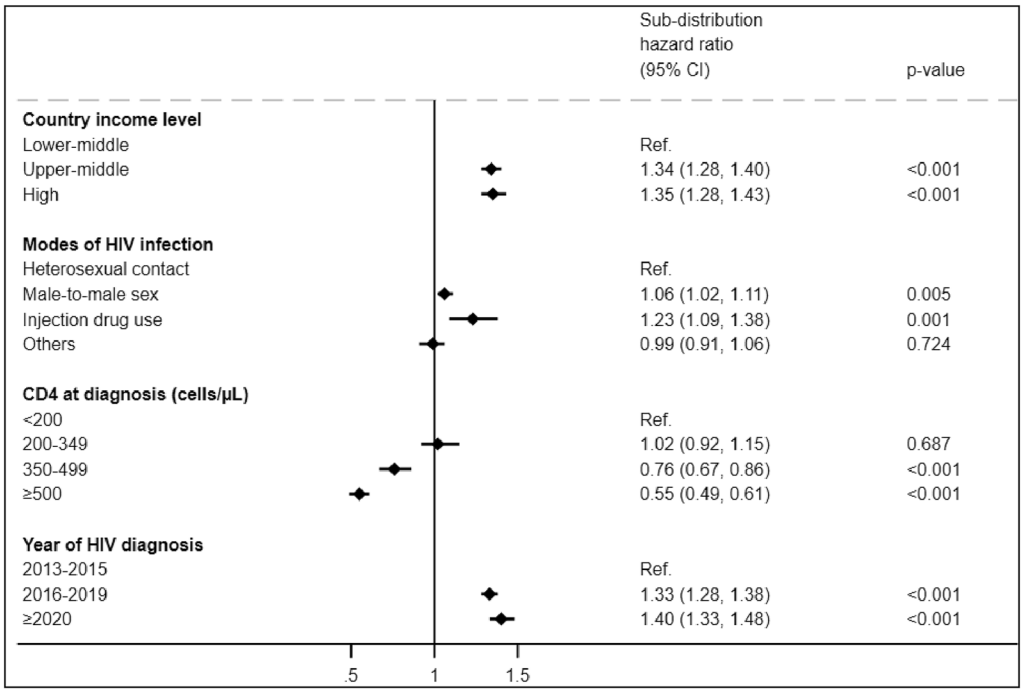

Fig. 3 Factors associated with time to ART initiation from HIV diagnosis among people living with HIV enrolled in TAHOD-CC

It was seen that individuals with higher baseline CD4 counts exhibited lower rates of ART initiation. These findings are supported by a systematic review that patients with higher CD4 counts, such as 201–500 cells/mm^3 and > 500 cell/mm^3, were more inclined to delay ART initiation compared to those with ≤ 200 cells/mm^3 (33.4%, 40.3% vs. 25.3%, respectively) [22]. Many asymptomatic PLHIV perceived themselves as healthy [22, 25, 26], particularly when they have high CD4 counts [22]. Additionally, factors such as initial denial of their HIV-positive status, doubts regarding the accuracy of HIV diagnosis, and concerns about the potential side-effects [26] can contribute to the delays in ART initiation until HIV-related symptoms become apparent. Public health efforts should focus on raising awareness about the benefits of initiating ART early, especially among those with high CD4 counts.

Upon closer inspection of the ART initiation by income countries, we found that lower-income countries have earlier up-front initiation of ART before two months after diagnosis. However, high-income and upper-income countries tended to have earlier ART initiation for PLHIV overall compared to lower-middle income countries. Limited access to antiretroviral medications and linkage to ART programs in low-income settings likely contribute to this disparity [27]. However, a previous systematic review found the opposite trend, with more delays in ART initiation for PLHIV observed in high-income countries compared to upper- and lower-middle income settings, potentially due to the expanded implementation of "treat-all" strategies in these regions [22]. Further investigation is warranted to elucidate the complex relationship between national income levels and time to ART initiation.

Regarding HIV transmission modes, individuals who reported male-to-male contact exhibited shorter time to ART initiation compared to heterosexual individuals. This observation is consistent with a previous study, which demonstrated a decrease in the mean duration to ART initiation by 123.01 days among men who have sex with men compared to those who do not [20]. However, our findings contrast with this prior study, as we found that people who self-reported injecting drugs had higher rates of initiating ART compared to the heterosexual group. This difference could be attributed to the fact that they applied multivariable linear regression model without controlling for competing risks and used non-injecting group as the reference. Additionally, according to UNAIDS 2023 report, HIV infection was seen in high proportion among people who identified as men who have sex with men and engaged in drug injection in the Asia–Pacific [28], therefore, HIV prevention and treatment program often prioritize these demographics, resulting in shorter time to ART initiation.

A prior study indicated that older age at diagnosis was positively associated with shorter time to ART initiation

[12]. After controlling for other covariates in our study, age at diagnosis did not show a significant association with time to ART initiation and was consequently excluded from the final model. Moreover, a systematic review of 46 studies showed patients 'characteristics (e.g., education, marital status, WHO clinical stages) and healthcare access (e.g., travel time to clinic) were associated with ART initiation [29]. While our cohort did not collect data on these variables, our findings are generally consistent with previously reported associations. Future research incorporating these factors could further strengthen our understanding of the observed relationships.

This study possesses notable strengths. Firstly, we included a substantial sample size drawn from nine countries/territories in the Asia region, encompassing diverse income levels. This geographically diverse sample enhances the robustness and generalizability of our findings by reducing the potential for selection bias and increasing the external validity of our results. Additionally, we incorporated data on competing risks, such as loss to follow-up or death, which were missing in a prior research conducted in four African countries that assessed temporal trend from HIV diagnosis to ART initiation [12]. This data collection enabled us to estimate the SHRs while accounting for the presence of competing events. Importantly, by addressing these competing risks, we could reduce the likelihood of biased estimations, thereby strengthening the internal validity of our results.

However, our findings should be interpreted in the light of study limitations. Firstly, the dataset lacked information on the specific timing of the implementation of the treat-all strategies as well as the onset of the COVID-19 pandemic in each TAHOD-CC country. This gap affects the accuracy of our analysis regarding the time from HIV diagnosis to ART initiation. Further investigation into the impact of treat-all strategies on HIV management across diverse settings is needed. Additionally, while TAHOD-CC sites offer valuable insights, they may not entirely reflect the full spectrum of HIV management practices within individual countries, given potential variations in healthcare infrastructure and cultural factors. Lastly, our sample was predominantly male (70.1%), reflecting the sex distribution of PLHIV in the Asia–Pacific [30]. However, we did not capture data on the specific barriers to accessing ART, which may differ between males and females. Research focusing on females in the region is currently underway, and these analyses are expected to highlight the unique challenges women with HIV face, ensuring more inclusive and comprehensive strategies for improving ART access within this group.

Conclusion

This study demonstrates progress in timely ART initiation across this Asia–Pacific regional cohort, with the median time to treatment initiation becoming shorter, particularly after 2016, coinciding with evolving WHO guidelines. Despite these advances, there is a continued need to strengthen and refine protocols for initiating ART early, emphasizing sustained investment in strategies to enable swift access to treatment for those diagnosed with HIV. Our findings also found that participants often present with HIV at an advanced stage. This delayed diagnosis of HIV cases, especially during societal stressors like the COVID-19 pandemic, underscores the significance of healthcare systems being prepared to uphold the continuity of HIV services. Socioeconomic factors, mode of HIV transmission, and guideline updates all play a role in ART initiation practices. Further investigation is warranted to elucidate the relationship between national income levels and time to ART initiation, which could inform tailored interventions to optimize HIV care and treatment outcomes in the region. Additionally, public health efforts should focus on raising awareness about the benefits of initiating ART early, especially among those with high CD4 counts.

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Author contributions
TTV, DR, and AW contributed to the conceptualization and design of the study. TTV led data management and analysis. TTV drafted the initial versions of this manuscript. All authors provided feedback on and revised the previous versions of the manuscript. Finally, all authors reviewed and approved the final manuscript.

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Data availability
Data cannot be shared publicly because of confidentiality concerns and because it is considered as owned by contributing study sites. Anonymized data are available on reasonable request with the agreement of the study and site principal investigators (contact via Anonymized data are available on reasonable request with the agreement of the study and site principal investigators (contact via study project manager: tor.peterson@treatasia.org), for researchers who meet the criteria for access to confidential data.

Declarations

Ethics approval and consent to participate
Ethics approval for the study were obtained from the ethics committees of each participating site, the data management and biostatistical center at the Kirby Institute [The University of New South Wales (UNSW) Human Ethics committee], and the coordinating center at TREAT Asia/amfAR.

Consent for publication
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Competing interests
The authors declare no competing interests.

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