BMJ Open

Incidence of attrition and predictors among HIV-infected adolescents receiving antiretroviral therapy in public hospitals, South Ethiopia: a multicentre retrospective follow-up study

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To cite: Guyo TG, Sapo AA, Merid F, *et al*. Incidence of attrition and predictors among HIV-infected adolescents receiving antiretroviral therapy in public hospitals, South Ethiopia: a multicentre retrospective follow-up study. *BMJ Open* 2025;**15**:e093129. doi:10.1136/bmjopen-2024-093129

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2024-093129).

Received 02 September 2024
Accepted 28 March 2025

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ABSTRACT

Objective This study aimed to determine the incidence of attrition and its predictors among HIV-infected adolescents receiving antiretroviral therapy in public hospitals, South Ethiopia.

Study design A multicentre retrospective follow-up study was conducted, and Cox proportional hazards model was used to identify predictors of the study outcome variable (attrition).

Settings The study was conducted in eight public hospitals (two general and six primary hospitals) in South Ethiopia.

Participants Adolescents (10–19 years) on antiretroviral therapy from 1 January 2014 to 30 December 2023 (n=409). The data were collected from patients' charts and electronic data records.

Outcome variable The primary outcome was time to attrition, and the secondary outcome was predictors of attrition.

Results The overall incidence density of attrition was 3.33 (95% CI: 2.65 to 4.18) per 100 person-year of observation. Age 15–19 years (adjusted HR (AHR): 1.88; 95% CI: 1.12 to 3.18), death of both the parents (AHR: 2.19; 95% CI: 1.04 to 4.61), no formal education (AHR: 3.16; 95% CI: 1.48 to 6.77), Co-trimoxazole Prophylactic Therapy (CPT) non-utilisation (AHR: 1.73; 95% CI: 1.03 to 2.91), not changed regimen (AHR: 6.16; 95% CI: 3.56 to 10.66) and poor treatment adherence (AHR: 5.16; 95% CI: 2.35 to 11.32) were predictors of attrition.

Conclusion Attrition was identified to be a significant public health problem in study settings. Moreover, old age, parental death, not attending formal education, not using CPT, unchanged baseline regimen and suboptimal treatment adherence predict attrition. Hence, special attention should be given to older adolescents, those with no formal education, orphaned and with poor baseline clinical characteristics. Likewise, early tracing of missed follow-up schedules, improving adherence support and increasing contacting frequency to reduce attrition are highly encouraged.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ As attrition is a warning indicator for drug resistance, determining attrition is very important to monitor antiretroviral therapy drug resistance, and the current study used a long follow-up period to do so.
⇒ Evidence on the important predictors that can be used for intervention targeted at improving adolescents' HIV-related care and services was generated.
⇒ The effect of some important predictor variables like viral load and CD4 count was not assessed because of incomplete records.
⇒ Adolescents whose charts were lost and those with incomplete records were excluded from the analysis which may underestimate or overestimate the attrition.

INTRODUCTION

HIV continues to be a critical global public health problem. In 2022, about 1.65 million adolescents aged 10–19 were living with HIV, and 34 000 AIDS-related deaths occurred among them, globally.[1 2] About 1.40 million, or 85%, of adolescents living with HIV (ALHIV) were from sub-Saharan Africa (SSA).[2] Ethiopia is one of the SSA countries with a total of 610 000 people living with HIV (PLHIV) and about 11 000 AIDS-related mortalities.[3]

Attrition refers to the disruption in antiretroviral therapy (ART) care, including lost patients, deaths and those who stopped treatment, indicating progress towards achieving the 95-95-95 targets.[4] It continues to be a great public health problem among adolescents. Adolescents have significantly higher attrition rates from ART than adults without being privileged and getting access to HIV

care and treatment services; these result in relatively poorer outcomes.[5]

Evidence from the global cohort collaboration reported that 30% and 3.9% of HIV-positive adolescents were lost to follow-up and died worldwide, respectively.[6] Based on the studies conducted in different countries, the incidence of attrition from ART care among adolescents was anticipated to be high. Studies done in Myanmar[7] and Thailand[8] revealed that attrition rates among ALHIV were determined to be 6.4 per 100 person-year of observation (PYO) and 29.5%, respectively. Evidence from a systematic review conducted in SSA reported that 15.07% of ALHIV experienced attrition due to lost follow-up from ART after the initiation of treatment.[9] In Ethiopia, about 28.1%[10] of adolescents aged 10–19 years experienced attrition from HIV care and 11.1% experienced attrition from care due to death.[11] Attrition of patients from HIV care and treatment after ART initiation is resulting in an increase in poor treatment outcomes, including drug resistance, increased healthcare costs, preventable onward HIV transmission and avoidable morbidity and death.[12] It can weaken the continuing provision of opportunistic infection prophylaxis, timely identification of treatment failure and adverse events assessment.[13] In addition, attrition from HIV care also affected the 95-95-95 ambitious targets of Joint United Nations Programme on HIV and AIDS which aimed at 95% viral suppression. Due to the impact of attrition, only 68% of PLHIV were virally suppressed and adolescents were highly in need of lifelong treatment, care and social support to have better treatment and health outcomes as they pass through youth to adulthood.[14] Even though there is a paucity of information on adolescent viral suppression, 46% of children and adolescents were virally suppressed.[15] Attrition from the ART programme can significantly impact households, often requiring orphaned children to assume responsibility for the household after the death of their young parents.[16 17] Predictors of adolescent attrition from HIV care and treatment include advanced HIV disease, low haemoglobin level, absence of social support, financial constraints, lower age and year of ART initiation. Attrition is also predicted by infection with tuberculosis (TB), non-disclosure, malnutrition and Co-trimoxazole Prophylactic Therapy (CPT) utilisation.[7 12 18 19]

To minimise adolescents' attrition from HIV care and treatment services, different measures have been taken in Ethiopia: decentralisation of services, provision of ART drugs without charge, health education and counselling through community partners and delivering phone text messages.[12] Attrition from care among ALHIV remains a significant challenge to ART programme effectiveness, necessitating assessment of incidence and predictors for effective retention strategies.[20]

According to the WHO 2021 consolidated HIV guideline, total attrition is one of the early warning indicators, and attrition≥25% during the reporting period is a warning sign of drug resistance.[21] Despite the country's growing adolescent population and high prevalence of adolescent HIV infections, Ethiopia's HIV/AIDS policies currently do not provide adequate regard to the unique needs of adolescents.[5 22 23] Ethiopia's current HIV care and treatment guidelines primarily target children and adults, lacking a national focus on HIV care and treatment for ALHIV.[12] But this adolescent population is with rapid physical, cognitive and psychological development that significantly impacts their emotions, thoughts, decisions and interactions with their environment and even affects their engagement in the ART programme.[24] Moreover, there is little indication of attrition from care among ALHIV on ART in Ethiopia, and none in the research settings. As a result, the purpose of this study is to determine the incidence of attrition and its predictors among HIV-infected adolescents receiving ART in public hospitals, South Ethiopia.

METHODS

Study design, period and setting

A multicentre retrospective follow-up study was conducted in Gamo Zone and Ari Zones public hospitals in South Ethiopia from 5 March 2024 to 5 April 2024. Arba Minch town is the administrative centre of the Gamo Zone. It is 505 km southwest far from the capital city, Addis Ababa. Jinka town is the administrative centre of Ari Zones in southwest Ethiopia. It is about 563 km far from Addis Ababa. In these two zones, there are two general and six primary public hospitals providing ART services, with about 5480 individuals currently on HIV care and treatment, among which are 1041 adolescents. These health facilities provide different services (outpatient department service, inpatient department services, emergency services, maternal and child health services, dental treatment, ophthalmic service and follow-up services) to the community in their catchment area and nearby woredas and zones. The estimated total population in the two zones was 2 127 970, among which are 410 059 adolescents.

Population

All HIV-positive adolescents (10–19 years) who were on ART in public hospitals of Gamo and Ari Zones were the source population. All randomly selected HIV-positive adolescents (10–19 years) who were on ART in the public hospitals of Gamo and Ari Zones from 1 January 2014 to 30 December 2023 were the study population. All HIV-positive adolescents (10–19 years) who were on ART and had at least one follow-up visit from 1 January 2014 to 30 December 2023 were included in the study. HIV-positive adolescents whose charts had incomplete records (indicators of the outcome were not registered) were excluded from the study.

Sample size determination and sampling procedures

The sample size was determined using STATA software V.14.0 for major predictor variables using Cox model comparing one slope to the reference value based on the following assumptions: significance level (α)

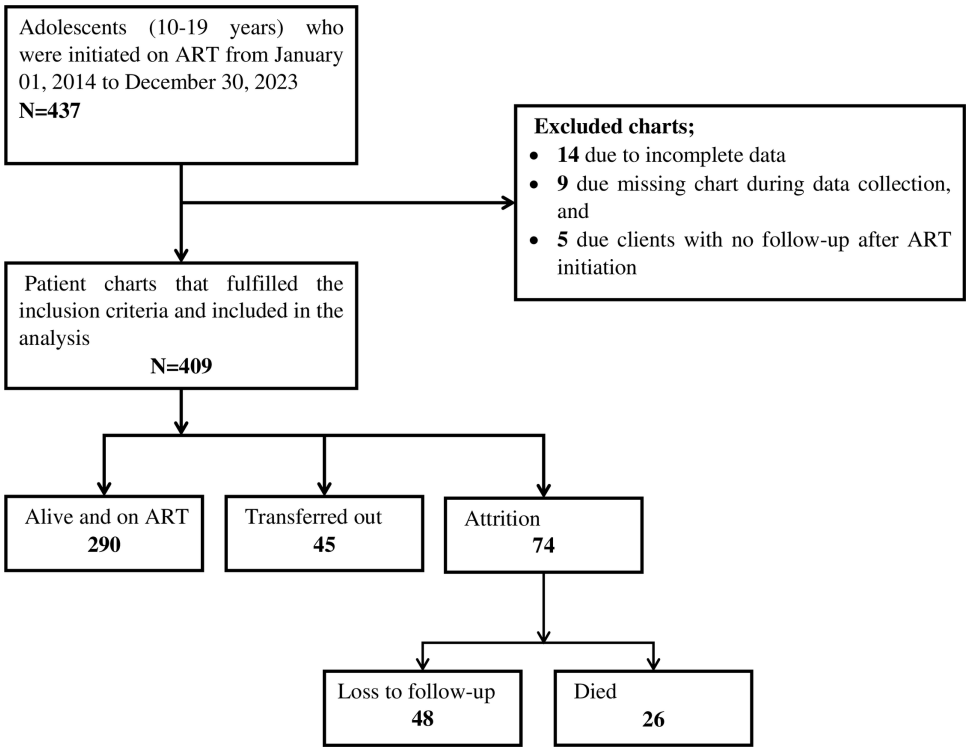

Figure 1 Flow chart of study participant recruitment to assess the incidence of attrition and its predictors among HIV-infected adolescents receiving antiretroviral therapy (ART) in public hospitals, South Ethiopia, 2024.

(two-sided)=0.05, 95% CI, power of 80%, AHR: 1.58 for adolescents with HIV/TB coinfection who experienced attrition,[25] SD (variability) of covariates of interest=0.5, the overall probability of event (attrition) (d) at the end of the study 0.428[25] and a 10% withdrawal probability was added for incomplete records, yielding a total sample size of 434 to conduct the study.

First, in the two zones (Gamo and Ari) there are eight public hospitals: two general hospitals (Jinka and Arba Minch General Hospitals) and six primary hospitals (Chencha, Selamber, Kamba, Gerese, Dilfana and Gazer Primary Hospitals). In these public hospitals, 437 adolescents were on ART between 1 January 2014 and 30 December 2023. The adolescents (10–19 years) were identified in each hospital using medical record numbers (MRNs) obtained from electronic databases, and patient charts were drawn using the MRNs. The total number of adolescents identified in the hospitals is very close to the calculated sample size; all their charts were screened for eligibility by considering the inclusion criteria, and 409 eligible charts were included in the analysis (figure 1).

Data collection tool, procedure and personnel

Data were collected using a data extraction checklist developed in English from the standardised ART intake and follow-up forms from national HIV guideline[12] and reviewing related literature.[6–11 19 25–30] The data were collected from the charts of the adolescents who were initiated on ART care between 1 January 2014 and 30 December 2023. Adolescents who were categorised as loss to follow-up (LTFU) during the study but came back to the care before the follow-up (since this type of study looks back at the existing records, the follow-up period is defined by the time frame in which the researcher can ascertain the outcome from the historical data) ends were counted as active because their coming back was the result of defaulter-tracing intervention. The checklist contains the socio-demographic, clinical and treatment-related characteristics of participants. The lists of study participants were taken from the ART data clerk using children's MRN or unique ART numbers. Charts of the adolescents were taken from card rooms. Then data were collected by reviewing the registration books and patient follow-up charts by 10 data collectors and 8 supervisors.

Study variables

The dependent variable was time to attrition, and the predictor variables included socio-demographic variables: age, sex, residence, educational status and marital status of the adolescents; clinical-related variables: entry point of care, WHO clinical staging, nutritional status, haemoglobin level, CD4 count, presence of opportunistic infections, functional status and disclosure status; and treatment-related variables: type of baseline regimen, regimen change, treatment adherence and CPT prophylaxis.

Operational definitions

Attrition (Event) is if adolescents on ART were lost to follow-up or died within the follow-up period.[31] Whereas censored is if adolescents on ART who were transferred

out or alive and active on ART at the end of the study or turning 19 years of age.[19 31] Loss to follow-up is if an adolescent has not come to care for ≥3 consecutive months (≥90 days) after the last missed appointment and is not registered as died or transferred out to other health facilities.[32] However, adolescents were counted as died if he/she documented or registered as 'died' on the exit form of the patient. Adherence is the extent to which an adolescent's behaviour of taking ART medication with agreed-upon recommendations from a healthcare provider. It was classified as good if >95% of the recommended doses were taken or <3 doses missed monthly; fair if 85–94% of the recommended doses were taken or 4–9 doses missed monthly; and poor if <85% of the recommended doses were taken or ≥10 doses missed monthly.[12] Regimen change is if the ART regimen given to the adolescent at the time of treatment initiation was changed to another regimen type different from the baseline one. An adolescent is a study participant whose age was precisely between 10 and 19 years.[24]

Data quality assurance

Data were collected by health professionals who were trained in HIV comprehensive care and working on the clients' follow-up services. One-day orientation was given to the data collectors (BSc in Public Health or Nursing) and supervisors (BSc in Public Health) on the way of reviewing charts and extracting the needed data, study objectives and keeping confidentiality. To check the consistency, completeness and accuracy of the checklist, a pre-test was conducted in Jinka General Hospital on 5% of the sample before the actual data collection. Necessary modifications (adding the % option for viral load and removing the 'presence of comorbidity other than opportunistic infection' because it was absent for all the pre-test charts) were made accordingly before the starting of the actual data collection. The checklists were properly coded and numbered. The investigators and supervisors carried out daily data collection monitoring. Then appropriate feedback was given to the data collectors. After completing the data collection process, all the checklists were collected together and cross-checked for relevance.

Statistical analysis

The data were checked, coded, cleaned and then entered into Epi-Data V.3.1 before being exported to STATA V.14.0 for further management and analysis. Exploratory data analysis was performed to determine the presence of probable outliers, normality (by the skewness and kurtosis tests) and the level of missing values. Viral load and CD4 count showed missing values of more than 30% and were excluded from the analysis. Median, IQR, frequencies and percentages were used for descriptive statistics. PYO was used to compute the incidence density (Incidence of Attrition = [number of attrition/total number of person-years of observation]*100). The Kaplan-Meier curve was used to estimate survival time and compare survival experience among categories of predictor variables, and the significance of survival experience was checked using the log-rank test. A life table was used to estimate the cumulative probability of survival at different time intervals. The Cox proportional hazards model was fitted after checking for proportional hazards assumption using the Schoenfeld residual test (global test) (p value=0.5585) (online supplemental file 1). To analyse the association between each independent variable and the outcome variable, a binary Cox proportional hazards model was fitted, and variables with a p value<0.25 in bivariable Cox regression were candidates for multivariable analysis. To find independent predictors of attrition, a multivariable Cox regression model with a backward stepwise likelihood ratio technique was built. The variance inflation factor (VIF) and tolerance were used to test for multicollinearity, the mean VIF=1.23, showing no threat of multicollinearity. The Cox-Snell residuals plot was used to assess the model's goodness of fit. The hazard function followed the 45° line very closely over time except for large values and fulfilled the assumption of goodness of fit of the model (figure 2). To identify statistically significant variables, AHR with a 95% CI and matching p value was used. The statistical significance was declared at the p value<0.05.

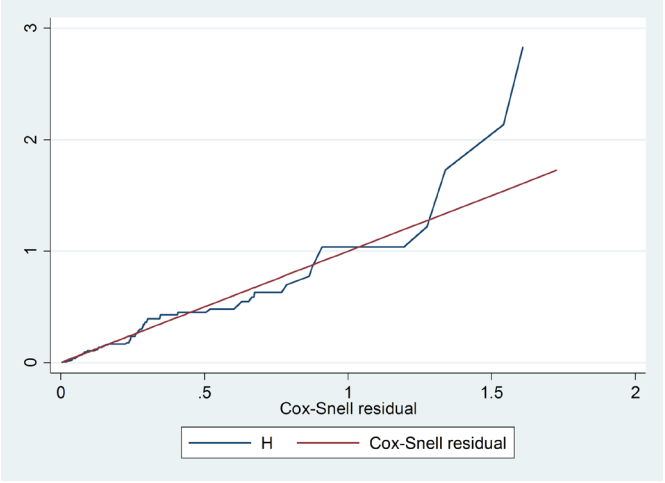

Figure 2 Cox-Snell residual plot for model fitness to assess the incidence of attrition and its predictors among HIV-infected adolescents receiving antiretroviral therapy in public hospitals, South Ethiopia, 2024.

Patient and public Involvement

None.

RESULTS

Adolescent's socio-demographic characteristics

Of 437 adolescents (10–19 years) who were initiated on ART from 1 January 2014 to 30 December 2023, in the eight public hospitals, the chart of 409 adolescents fulfilled the inclusion criteria and were reviewed.

The median age of the adolescents included in the study was 14, with an IQR of 12–18 years, and of the study participants, 213 (52.1%) were females. More than half

Table 1 Socio-demographic characteristics of HIV-infected adolescents receiving antiretroviral therapy in public hospitals, South Ethiopia, 2024

Variables	Categories	Frequency	Percentage
Age (in years)	10–14	211	51.6
	15–19	198	48.4
Sex	Male	196	47.9
	Female	213	52.1
Residence	Urban	255	62.4
	Rural	154	37.7
Parent status	Both alive	200	48.9
	Either died	160	39.1
	Both died	49	12.0
Marital status	Single	352	86.1
	Married	41	10.0
	Divorced	16	3.9
Educational status	No formal education	77	18.8
	Primary	206	50.4
	Secondary	116	28.4
	Tertiary and above	10	2.4
Occupational status	Student	282	69.0
	Daily labourer	38	9.3
	Female sex worker	12	2.9
	No work/child	49	12.0
	Other*	28	6.8

*Other: merchant, housewife and farmer.

of the adolescents were urban residents. Regarding the marital status of the adolescents, a majority (86.1%) were single and 16 (3.9%) were divorced after being married. Half, 206 (50.4%), of the adolescents who participated in the study have attained primary educational status, and only 10 (2.4%) attained tertiary and above. About 3% (2.9%) of the participants were female sex workers (table 1).

Adolescents' baseline clinical and treatment-related characteristics

Of the total adolescents enrolled in ART care during the follow-up period, 253 (61.9%), were entered into care through medical referral or linkage. The haemoglobin level of the majority, 381 (93.1%), of the adolescents who participated in the study was ≥100 g/L. Regarding the WHO clinical staging, more than half, 227 (55.5%), of the participants were in stage I at the time of ART initiation. Of the study participants, 65 (15.9%) have a history of TB infection at the start of the treatment initiation. Participants with a history of Opportunistic Infections (OIs) other than TB account for less than 20% of the total participants, and from these, pneumonia, 24 (34.8%), and diarrhoea, 23 (33.3%), are among the commonly identified opportunistic infections. Two-thirds, 265 (64.8%), of the study participants disclosed their HIV status to others, and the remaining kept their status secret from others. Regarding prophylaxis for the prevention of opportunistic infections, 227 (55.5%) and 268 (65.5%) took CPT and Isoniazid (INH), respectively. During the follow-up time, 157 (38.4%) of the adolescents were initiated on zidovudine, lamivudine and nevirapine-containing regimen (AZT+3TC+NVP) at baseline. The median duration of ART during the follow-up time was 63 months, with an IQR of 20–101 months. Regarding treatment adherence, 30 (7.3%) had fair treatment adherence. Reasons for fair or poor treatment adherence are known for only eight participants, and the reasons are far distance, forgetting the drug, stigma and others. The baseline regimen of 265 (64.8%) adolescents who participated in the study was changed during the follow-up time, and the main reason for the regimen change was the availability of a new drug, 150 (80.6%) (table 2).

Incidence of attrition

The follow-up time was from 1 January 2014 to 30 December 2023, and the adolescents were followed for 0.3 years at minimum and 9.9 years at maximum. The median follow-up time was 5.6 (IQR 1.9–9) years, which yields a total of 2222.1 PYO. The adolescents' mean survival time was 8.41 (95% CI: 8.09 to 8.73) years. At the end of the follow-up, among the total study participants, 74 (18.1%) experienced attrition (11.7% were lost and 6.4% died), and 335 (81.9%) were censored (11.0% were transferred out and 70.9% were alive and on ART at the end of follow-up). The overall incidence density of attrition was 3.33 (95% CI: 2.65 to 4.18) per 100 PYO. The incidence of attrition was 4.50 (95% CI: 3.42 to 5.93) per 100 PYO in general hospitals and 2.11 (95% CI: 1.40 to 3.18) per 100 PYO in primary hospitals, respectively. The cumulative probability of survival was 0.9368, 0.8953, 0.8576 and 0.8469 at the end of 12, 24, 48 and 60 months, respectively, as described by the life table.

The stepwise decreasing overall Kaplan-Meier survival curve did not cross the survival function at a survival probability of 0.5 (figure 3). The log-rank test showed that there is a statistically significant difference in survival experience among the categories of the predictor variable, including age, educational status, CPT prophylaxis, baseline regimen change and drug adherence.

It was identified that there is a statistically significant difference in survival time among adolescents among different categories of age groups. Hence, the mean survival time for adolescents aged 10–14 years was 8.71 (95% CI: 8.32 to 9.10) years and 8.08 (7.56 to 8.59) years, respectively. In addition, the rate of attrition among older adolescents was higher, which was 4.30 (95% CI: 3.17 to 5.85) compared with the counterparts. Adolescents on ART unchanged initial regimen have the lowest survival times, 6.36 (95% CI: 5.54 to 7.18) compared with

Table 2 Clinical and treatment-related characteristics of HIV-infected adolescents receiving antiretroviral therapy in public hospitals, South Ethiopia, 2024

Variables	Categories	Frequency	Percentage
Mode of entry	VCT	77	18.8
	Medical referral/linkage	253	61.9
	Other*	79	19.3
Body mass index for age	<–2 SD	185	45.2
	≥– 2 SD	224	54.8
Haemoglobin level	<100 g/L	28	6.9
	≥100 g/L	381	93.1
WHO clinical staging	I	227	55.5
	II	56	13.7
	III	107	26.1
	IV	19	4.7
History of tuberculosis	Yes	65	15.9
	No	344	84.1
Treated for tuberculosis (n=65)	Yes	61	93.9
	No	4	6.1
Treatment regimen for tuberculosis	2SRHZ/4RH	5	7.7
	2HRZE/4RH	55	84.6
	Unknown	5	7.7
History of opportunistic infections other than tuberculosis	Yes	74	18.1
	No	335	81.9
Functional status	Working	298	72.9
	Ambulatory	90	22.0
	Bedridden	21	5.1
Disclosure of HIV status to the adolescent	Yes	265	64.8
	No	144	35.2
Co-trimoxazole Prophylactic Therapy	Yes	227	55.5
	No	182	44.5
INH	Yes	268	65.5
	No	141	34.5
Type of initial regimen	TDF+3TC+EFV	60	14.7
	AZT+3TC+NVP	157	34.4
	TDF+3TC+DTG	69	16.9
	ABC+3TC+DTG	34	8.3
	AZT+3TC+EFV	23	5.6
	Other†	66	16.1
Month on antiretroviral therapy	<1 year	55	13.5
	1–4 years	142	34.7
	≥5 years	212	51.8
Adherence	Good	331	80.9
	Fair	30	7.3
	Poor	48	11.7
Regimen change	Yes	265	64.8
	No	144	35.2

Continued

Table 2 Continued

Variables	Categories	Frequency	Percentage
Viral load (n=205) in copies/mL	Below 1000	180	87.8
	1000 and above	25	12.2
CD4 count (n=281) in cells/mm^3	≤200	50	17.8
	200–350	47	16.7
	≥350	184	65.5

*Other: dried blood spots, index case testing and self-referral.
†Other: ABC+3TC+EFV, ABC+3TC+LPV/r, TDF+3TC+ATV/r.
ABC, abacavir ; ATV, atazanavir; AZT, zidovudine; DTG, dolutegravir; E, ethambutol; EFV, efavirenz; H, isoniazid; INH, isoniazid; LPV/r, lopinavir/ritonavir; NVP, nevirapine; R, rifampicin; S, streptomycin; 3TC, lamivudine; TDF, tenofovir; VCT, Voluntary Counseling and Testing; Z, pyrazinamide.

adolescents whose baseline regimen was changed 9.16 (8.90 to 9.43). In addition, there is a statistically significant difference in survival time among adolescents within different groups of treatment adherence levels. The mean survival time for adolescents with good treatment adherence was higher (8.96, 95% CI: 8.67 to 9.25) than for those with fair (7.48, 95% CI: 6.07 to 8.89) and poor treatment adherence (5.55, 95% CI: 4.39 to 6.72). Another categorical variable that was found to have a significant difference in attrition-free survival time between its categories is initial regimen change. Adolescents whose baseline ART regimen was not changed have lower attrition-free survival times (6.36, 95% CI: 5.54 to 7.19) compared with those whose regimen was changed (9.16, 95% CI: 8.90 to 9.43) (figure 4).

Predictors of attrition among adolescents

In bivariable analysis, age, marital status, parent status, educational status, occupation, entry mode to care, CPT prophylaxis, regimen change, drug adherence, disclosure of HIV-sero status and type of baseline regimen were predictors of attrition at a p value of <0.25. In multivariable analysis, age, parent status, educational status, CPT prophylaxis, baseline regimen change and drug adherence were predictors of attrition among adolescents at p value<0.05. Hence, adolescents aged 15–19 years had nearly two times (AHR: 1.88; 95% CI: 1.12 to 3.18) increased hazard of attrition from care compared with their counterparts. The death of either or both of the parents of the adolescents increases the risk of programme attrition by twofold (AHR: 2.07; 95% CI: 1.22 to 3.52) and (AHR: 2.19; 95% CI: 1.04 to 4.61) compared with adolescents whose both parents are alive, respectively. Attaining no formal education (AHR: 3.16; 95% CI: 1.48 to 6.77) and attaining primary educational status (AHR: 2.47; 95% CI: 1.25 to 4.89) can result in more than two times higher hazard of attrition among adolescents who participated in the current study. Adolescents who did not take the CPT prophylaxis for the prevention of opportunistic infection had 1.73 times (AHR: 1.73; 95% CI: 1.03 to 2.91) increased the hazard of experiencing ART programme attrition than their counterparts. Adolescents whose baseline ART regimen was not changed are at sixfold times (AHR: 6.16; 95% CI: 3.56 to 10.66) higher risk of attrition. Poor or fair treatment adherence can increase the hazard of attrition by five (AHR: 5.16; 95% CI: 2.35 to 11.32) and six (AHR: 6.02; 95% CI: 3.52 to 10.29) times compared with adolescents with good treatment adherence, respectively (online supplemental file 2).

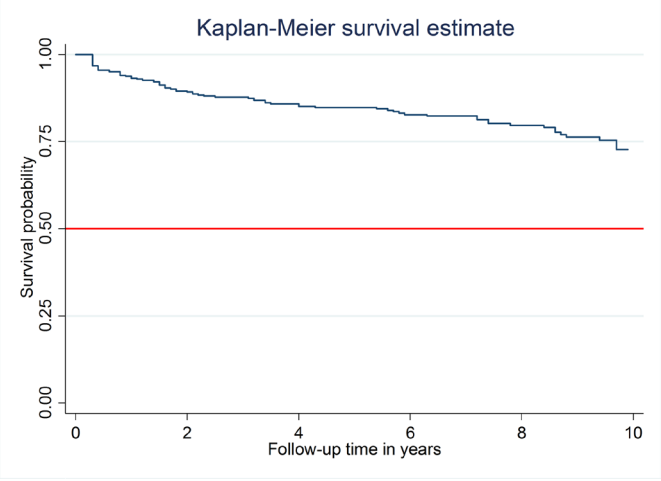

Figure 3 The overall Kaplan-Meier survival estimate showing the time until free of attrition among HIV-infected adolescents receiving antiretroviral therapy in public hospitals, South Ethiopia, 2024.

DISCUSSION

The study was conducted to determine the incidence of attrition and its predictors of attrition among HIV-infected adolescents receiving ART. At the end of the follow-up, among the total study participants, 74 (18.1%) experienced attrition. The overall incidence density of attrition was 3.33 (95% CI: 2.65 to 4.18) per 100 PYO. Moreover, older age, parental death, attaining no formal education and primary educational status, non-CPT utilisation, unchanged baseline ART regimen and suboptimal treatment adherence were predictors of attrition among adolescents receiving ART.

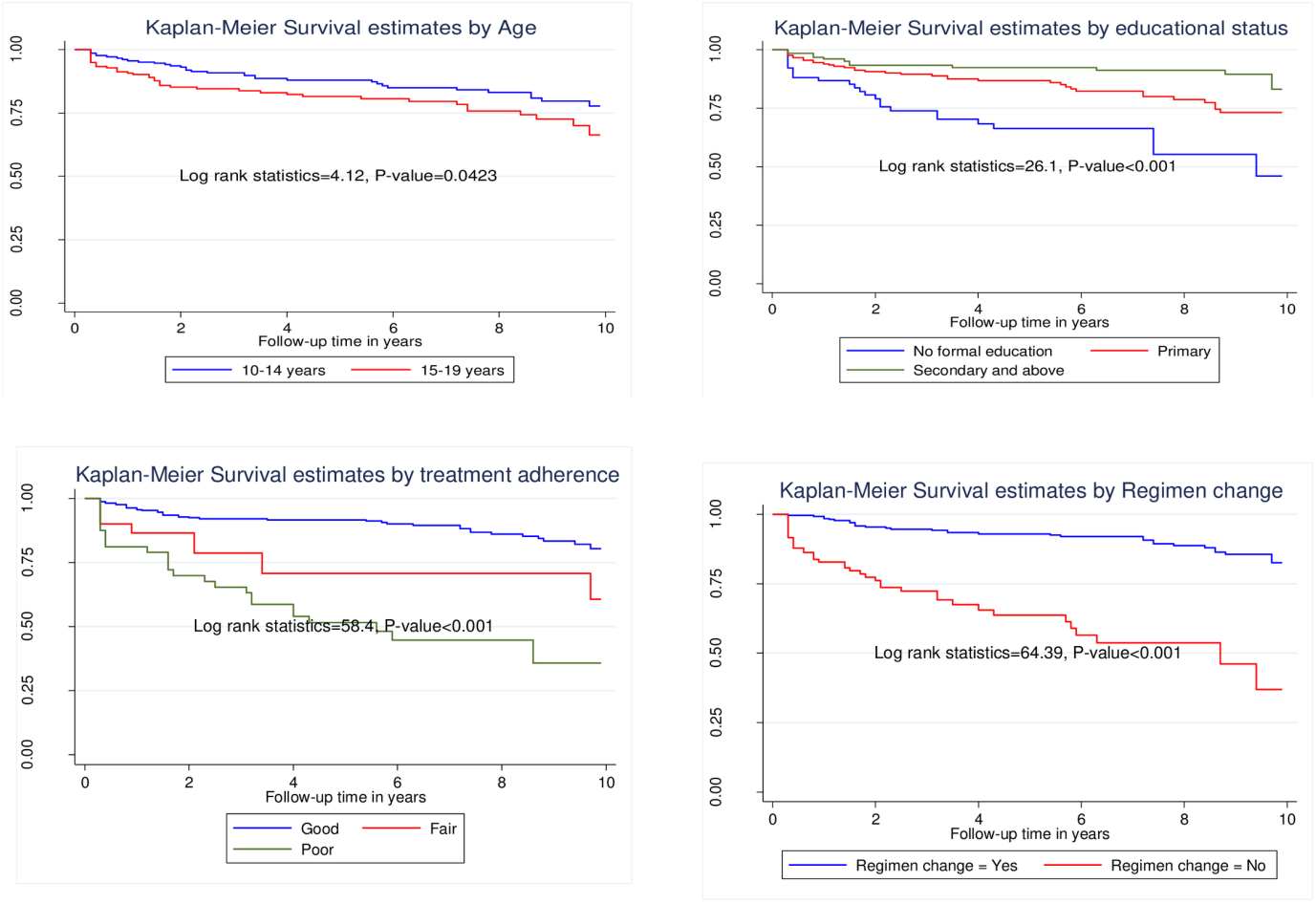

Figure 4 Kaplan-Meier survival estimates of time until attrition free of the main predictor variables among adolescents on antiretroviral therapy in public hospitals, south Ethiopia, 2024.

This study reported that the incidence density of attrition was 3.33 per 100 PYO. This finding is lower than the retrospective cohort studies conducted in Thailand[8] and Myanmar.[7] It is also lower than the findings from cohort studies done in India[29] and South Africa.[28] This finding is also lower than the result from the retrospective cohort study done in Ethiopia.[10] This discrepancy may be due to the large sample size used in the previous studies.[7 8 28 29] Also, a long follow-up time,[7] the difference in socio-demographic characteristics of the study participants and improvement in the current healthcare system than former times may contribute to the inconsistency. Another reason for the variance may be due to the difference in the operational definition of LTFU, which is defined as if the last appointment was missed for ≥12 months[8] and difference in study design.[28] Moreover, there was a difference in the study population, young adults were included in the studies done in Thailand[8] and South Africa[28] and the study done in Ethiopia[10] included children aged less than 10 years. The result of this study is in line with the studies done previously in Tanzania[26] and Ethiopia.[10] The reason behind this consistency in Ethiopia might be due to uniformity in follow-up charts and data recording formats in the ART programme prepared by the Ethiopian Federal Minister of Health.[12]

On the contrary, the overall incidence density of attrition as reported by the current study is slightly higher than the studies conducted among ALHIV in South Africa[28] and Ethiopia.[11] This may be due to differences in the study population; the study conducted in South Africa additionally included young adults aged 20–28 years.[28] It may also be because of the differences in study design[28] and large sample size.[11 28] In addition, the divergence may be explained by the differences in the socio-demographic characteristics of study participants and the longer follow-up period of the current study.

Adolescents aged 15–19 years had nearly two times increased hazard of attrition from care compared with their counterparts. This finding is consistent with results from previous studies done in India,[29] South Africa[30] and Uganda[19] which reported an increased risk of attrition with increased age (15–19 years). The reason might be because older adolescents started ART at the advanced immunodeficiency stage and also a large number of adolescents lost from ART care as they transition from paediatric care to adult care.[30 33 34]

The educational status of the adolescents was one of the identified predictors of attrition by the current study. Attaining no formal education or primary educational status can result in more than two times higher hazard

of attrition compared with those who attained secondary and above educational level as reported by this study. This is consistent with a study conducted in Amhara Region, Ethiopia.[11] This might be because adolescents who attained higher educational status were well-informed and aware of the benefit of retention in care and the effect of attrition on their health.

Death of either or both the parents of the adolescents can increase the risk programme attrition by twofold times compared with adolescents whose both parents are alive, respectively. This finding is consistent with findings from studies conducted in Ethiopia.[11 35] However, the study done in Ethiopia[35] targeted children aged 0–14 years. The reason for this could be due to the lack of caregivers' role in providing proper feeding, drug administration and supervision, collectively with the social and economic disruption resulting from the death of the caregivers.[36] In addition, adolescents living with widowed caregivers or on their own were considerably more likely to be depressed than their peers and may experience attrition from care.[37]

The other predictor of attrition among HIV-positive adolescents is the non-utilisation of CPT prophylaxis. Hence, adolescents who did not take the CPT prophylaxis for the prevention of opportunistic infection had 1.73 times increased hazard of experiencing ART programme attrition than their counterparts. A similar finding was reported by studies done in Ethiopia,[11 38] among which one was conducted among children.[38] This might be because CPT administration can prevent the occurrence of OIs among HIV-positive individuals, reduce AIDS-related mortality and improve quality of life.[39] Moreover, the provision of CPT prophylaxis is an effective and simple intervention for reducing morbidity and increasing retention rates in the ART programme.[40]

Adolescents whose baseline ART regimen was not changed are at sixfold times higher risk of attrition. This is supported by a study done in Ethiopia[11] and contrary to the study done in Namibia.[18] The study done in Namibia[18] reported that adolescents whose regimen was changed to a second-line or third-line regimen were at a higher hazard of attrition. This could be due to most of the old regimens having adverse effects that boost the progression of HIV infection to the AIDS stage and lead to succeeding complications. An AZT-based ART regimen is associated with the development of anaemia, which has an extra effect on the patient's immune system.[41] The highest attrition has occurred among adolescents on AZT-based regimens which was 43.2% as reported by the current study.

Furthermore, treatment adherence was one of the identified predictors of attrition among HIV-positive adolescents. It was identified that poor or fair treatment adherence can increase the hazard of attrition by five and six times among HIV-positive adolescents compared with adolescents with good treatment adherence, respectively. This result was supported by the findings from previous studies done in Ethiopia.[11 35] However, the source population of one of the studies done in Ethiopia[35] was children aged 0–14 years. This can be because fair or poor adherence can lead to higher viral load, drug resistance and poor treatment outcomes. This can also result in decreased CD4 levels, the progression of AIDS and an increase in OIs, all of which cause attrition.[42]

As attrition is a warning indicator for drug resistance, determining attrition is very important to monitor ART drug resistance, and the current study used a long follow-up period to do so. The current study provided evidence on predictors of attrition for adolescents that can be important and used to improve adolescents' HIV-related services. Despite the strengths, the current study has some limitations; the effect of some important predictor variables like viral load and CD4 count was not assessed because of incomplete records. In addition, adolescents whose charts were lost and those with incomplete records were excluded from the analysis, which may underestimate or overestimate the attrition. Because of this incompleteness, only 409 study participants, which is smaller than the calculated sample size, were included in the analysis, which might slightly underpower the study.

CONCLUSION

Attrition was identified to be a significant public health problem in the study setting. Moreover, old age, parental death, not attending formal education, not using CPT, unchanged baseline regimen and suboptimal treatment adherence predict attrition. Special attention should be given to the old age, no formal education, those orphaned and those with poor baseline clinical characteristics. Moreover, early tracing of missed follow-up schedules, improving adherence support and increasing contacting frequency to reduce attrition are highly encouraged. To address the effect of important clinical and sociodemographic variables, a longitudinal prospective study was needed.

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Acknowledgements We acknowledge Arba Minch College of Health Sciences for supporting the study. Our deepest gratitude and heartfelt thanks extend to the Gamo and Ari Zones Public Hospitals' administrators for the provision of all necessary information. Moreover, our thanksgiving and appreciation go to the data collectors and supervisors for their extensive help in the conduction of the study.

Contributors TGG, TMT and FM were responsible for the design of the study and contributed to the writing of the manuscript. TGG, FM, TMT and AAS conducted the research. SS and SWK supervised data collection. TGG completed the statistical analyses and drafted the manuscript, and is responsible for the overall content as the guarantor. All authors read and approved the submitted version.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Before data collection, the document was submitted to the Arba Minch College of Health Sciences' Institutional Ethical Review Board (IRB) for ethical assessment and approval. An ethical approval letter was obtained from IRB with reference number AMCHS/01/20/33/0. An official support letter was received from the Gamo and Ari Zones Health Departments. The letter of cooperation was submitted to hospital authorities, and permission was sought to have full access to the information. Individual informed consent/assent was not obtained from the participants or guardians because the study is a retrospective study that requires record review without physical contact with the participants, which was waived by the IRB.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

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REFERENCES

1 UNAIDS. Young people and HIV, 2023. Available: https://www.unaids.org/sites/default/files/media_asset/young-people-and-hiv_en.pdf
2 UNICEF. UNICEF Data: Adolescent HIV prevention, 2023. Available: https://data.unicef.org/topic/hivaids/adolescents-young-people/
3 UNAIDS. HIV and AIDS estimates country factsheet 2022 - Ethiopia, 2022. Available: https://www.unaids.org/en/regionscountries/countries/ethiopia
4 World Health Organization. Consolidated HIV strategic information guidelines: driving impact through programme monitoring and management. 2020.
5 Auld AF, Agolory SG, Shiraishi RW, *et al*. Antiretroviral therapy enrollment characteristics and outcomes among HIV-infected adolescents and young adults compared with older adults--seven African countries, 2004-2013. *MMWR Morb Mortal Wkly Rep* 2014;63:1097–103.
6 Kariminia A, Law M, Davies M-A, *et al*. Mortality and losses to follow-up among adolescents living with HIV in the IeDEA global cohort collaboration. *J Int AIDS Soc* 2018;21:e25215.
7 Htun T, Kyaw KWY, Aung TK, *et al*. Attrition during pre-ART and ART time periods among adolescents enrolled in Integrated HIV Care Programme in Myanmar, 2005–2017. *Epidemiol Infect* 2019;147.
8 Teeraananchai S, Puthanakit T, Kerr SJ, *et al*. Attrition and treatment outcomes among adolescents and youths living with HIV in the Thai National AIDS Program. *J Virus Erad* 2019;5:33–40.
9 Leshargie CT, Demant D, Burrowes S, *et al*. The proportion of loss to follow-up from antiretroviral therapy (ART) and its association with age among adolescents living with HIV in sub-Saharan Africa: A systematic review and meta-analysis. *PLoS One* 2022;17:e0272906.
10 Jerene D, Abebe W, Taye K, *et al*. Adolescents living with HIV are at higher risk of death and loss to follow up from care: Analysis of cohort data from eight health facilities in Ethiopia. *PLoS One* 2019;14:e0223655.
11 Leshargie CT, Demant D, Burrowes S, *et al*. Incidence and predictors of mortality among adolescents on antiretroviral therapy in Amhara Region, Ethiopia: a retrospective cohort analysis. *BMJ Open* 2022;12:e063879.
12 Government of Ethiopia. National consolidated guidelines for comprehensive HIV prevention, care and treatment; 2018. Addis Ababa. 2018;1–238. Available: https://www.afro.who.int/sites/default/files/2019-04/National%20Comprehensive%20HIV%20Care%20%20Guideline%202018.pdf
13 Geng EH, Nash D, Kambugu A, *et al*. Retention in care among HIV-infected patients in resource-limited settings: emerging insights and new directions. *Curr HIV/AIDS Rep* 2010;7:234–44.
14 UNAIDS. Danger: UNAIDS Global AIDS Update 2022. Geneva: Joint United Nations Programme on HIV/ AIDS. Licence: CC BY-NC-SA 3.0 IGO. 2022.
15 UNCEF. 2023 Global Snapshot on HIV and AIDS: Progress and priorities for children, adolescents and pregnant women, 2023. Available: https://www.childrenandaids.org/sites/default/files/2023-11/231130%20UNCEF_HIV_Global_Snapshot_2023UPDATED_0.pdf
16 Booysen F, Bachmann M, Matebesi Z, *et al*. The socio-economic impact of HIV/AIDS on households in South Africa: pilot study in Welkom and Qwaqwa, Free State Province. 2009;26.
17 Booysen F, Van Der Berg S. The role of social grants in mitigating the socio-economic impact of HIV/AIDS in two free state communities. *South African J Economics* 2005;73:545–63.
18 Munyayi FK, van Wyk BE. Determinants and rates of retention in HIV care among adolescents receiving antiretroviral therapy in Windhoek, Namibia: a baseline cohort analysis. *BMC Public Health* 2023;23::458.
19 Okoboi S, Ssali L, Yansaneh AI, *et al*. Factors associated with long-term antiretroviral therapy attrition among adolescents in rural Uganda: a retrospective study. *J Int AIDS Soc* 2016;19:20841.
20 World Health Organization. Global update on HIV treatment 2013: results, impact and opportunities: WHO report in partnership with UNICEF and UNAIDS, 2023. Available: https://iris.who.int/bitstream/handle/10665/85326/9789241505734_eng.pdf;jsessionid=B98E988DF5509E1C12576852805B8403?sequence=1
21 World Health Organization. Consolidated guidelines on HIV prevention, testing, treatment, service delivery and monitoring: recommendations for a public health approach; Licence: CC BY-NC-SA 3.0 IGO. 2021.
22 Judd A, Sohn AH, Collins IJ. Interventions to improve treatment, retention and survival outcomes for adolescents with perinatal HIV-1 transitioning to adult care: moving on up. *Curr Opin HIV AIDS* 2016;11:477–86.
23 Neilan AM, Karalius B, Patel K, *et al*. Association of risk of viremia, immunosuppression, serious clinical events, and mortality with increasing age in perinatally human immunodeficiency virus-infected youth. *JAMA Pediatr* 2017;171:450–60.
24 World Heath Organization. Adolescent health, 2023. Available: https://www.who.int/health-topics/adolescent-health#tab=tab_1
25 Tesha E-D, Kishimba R, Njau P, *et al*. Predictors of loss to follow up from antiretroviral therapy among adolescents with HIV/AIDS in Tanzania. *PLoS One* 2022;17:e0268825.
26 Amour MA, Shayo GA, Matee MM, *et al*. Predictors of mortality among adolescents and young adults living with HIV on antiretroviral therapy in Dar es Salaam, Tanzania: a retrospective cohort study. *J Int AIDS Soc* 2022;25:e25886.
27 Lamb MR, Fayorsey R, Nuwagaba-Biribonwoha H, *et al*. High attrition before and after ART initiation among youth (15-24 years of age) enrolled in HIV care. *AIDS* 2014;28:559–68.
28 Nglazi MD, Kranzer K, Holele P, *et al*. Treatment outcomes in HIV-infected adolescents attending a community-based antiretroviral therapy clinic in South Africa. *BMC Infect Dis* 2012;12:21.
29 Nimkar S, Valvi C, Kadam D, *et al*. Loss to follow-up and mortality among HIV-infected adolescents receiving antiretroviral therapy in Pune, India. *HIV Med* 2018;19:395–402.
30 Okonji EF, Wyk BV, Mukumbang FC. Two-year retention in care for adolescents on antiretroviral therapy in Ehlanzeni district, South Africa: a baseline cohort analysis. *AIDS Care* 2023;35:374–84.
31 Nimwesiga C, Taremwa IM, Nakanjako D, *et al*. Factors associated with retention in HIV care among HIV-positive adolescents in public antiretroviral therapy clinics in Ibanda District, Rural South Western Uganda. *HIV AIDS (Auckl)* 2023;15:71–81.
32 World Health Organization. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection: recommendations for a public health approach: World Health Organization. 2016.
33 Enane LA, Davies M-A, Leroy V, *et al*. Traversing the cascade: urgent research priorities for implementing the “treat all” strategy

for children and adolescents living with HIV in sub-Saharan Africa. *J Virus Erad* 2018;4:40–6.
34 Meloni ST, Agaba P, Chang CA, *et al*. Longitudinal evaluation of adherence, retention, and transition patterns of adolescents living with HIV in Nigeria. *PLoS One* 2020;15:e0236801.
35 Guyo TG, Toma TM, Haftu D, *et al*. Proportion of Attrition and Associated Factors Among Children Receiving Antiretroviral Therapy in Public Health Facilities, Southern Ethiopia. *HIV AIDS (Auckl)* 2023;15:491–502.
36 Vreeman RC, Ayaya SO, Musick BS, *et al*. Adherence to antiretroviral therapy in a clinical cohort of HIV-infected children in East Africa. *PLoS One* 2018;13:e0191848.
37 Sengendo J, Nambi J. The psychological effect of orphanhood: a study of orphans in Rakai district. *Health Transit Rev* 1997;7 Suppl:105–24.
38 Chanie ES, Tesgera Beshah D, Ayele AD. Incidence and predictors of attrition among children on antiretroviral therapy at University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, 2019: Retrospective follow-up study. *SAGE Open Med* 2022;10:20503121221077843.
39 Collini P, Obasi A. *Cotrimoxazole Prophylaxis*. London: BMJ publishing Group Limited, 2006.
40 Date AA, Vitoria M, Granich R, *et al*. Implementation of co-trimoxazole prophylaxis and isoniazid preventive therapy for people living with HIV. *Bull World Health Organ* 2010;88:253–9.
41 Gebremedhin KB, Haye TB. Factors Associated with Anemia among People Living with HIV/AIDS Taking ART in Ethiopia. *Adv Hematol* 2019;2019:9614205.
42 World Health Organization. Consolidated guidelines on HIV prevention, testing, treatment, service delivery and monitoring: recommendations for a public health approach. 2021.