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## Characteristics and outcomes of HIV-infected youth and young adolescents enrolled in HIV care in Kenya

Emily Koech<sup>a</sup>, Chloe A. Teasdale<sup>a,b</sup>, Chunhui Wang<sup>a</sup>, Ruby Fayorsey<sup>a</sup>, Terezah Alwar<sup>a</sup>, Irene N. Mukui<sup>c</sup>, Mark Hawken<sup>a</sup>, and Elaine J. Abrams<sup>a,b,d</sup>

<sup>a</sup>ICAP-Columbia University, New York

<sup>b</sup>Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, USA

<sup>c</sup>National AIDS & STI Control Program, Ministry of Health, Nairobi, Kenya

<sup>d</sup>College of Physicians & Surgeons, Columbia University, New York, USA

### Abstract

**Background**—The number of youth and adolescents (10–24 years) with HIV infection has increased substantially presenting unique challenges to effective health service delivery.

**Methods**—We examined routinely collected patient-level data for antiretroviral treatment (ART)-naive HIV-infected patients, aged 10–24 years, enrolled in care during 2006–2011 at 109 ICAP-supported health facilities in three provinces in Kenya. Loss to follow-up (LTF) was defined as having no clinic visit for 12 months prior to ART initiation (pre-ART) and 6 months for ART patients. Competing risk and Kaplan–Meier estimators were used to calculate LTF and death rates. Sub-distributional and Cox proportional-hazards models were used to identify potential predictors of death and LTF.

**Results**—Overall 22 832 patients were enrolled in care at 10–24 years of age, 69.5% were aged 20–24 years, and 82% were female. Median CD4<sup>+</sup> cell count was 332 cells/μl (interquartile range 153–561); 70.8% were WHO stage I/II. Young adolescents (10–14 years) had more advanced WHO stage and lower median CD4<sup>+</sup> cell count compared to youth (15–24 years) at enrollment (284 vs. 340 cells/μl;  $P < 0.0001$ ). Cumulative incidence of LTF and death at 24 months for pre-ART patients was 46.1% [95% confidence interval (CI) 45.4–46.8%] and 2.1% (95% CI 1.9–2.3%), respectively. For those on ART, 32.2% (95% CI 31.1–33.3%) were LTF and 3.9% (95% CI 1.7–2.3%) died within 24 months. LTF among pre-ART and ART patients was twice as high among youth compared to young adolescents.

**Conclusion**—LTF of young people with HIV in this Kenyan cohort was high and notably greater among youth compared to young adolescents. Novel strategies targeting these populations are urgently needed to improve retention.

Correspondence to Chloe A. Teasdale, ICAP-Columbia University, MSPH, 722 W168th Street, Room 1319, New York, NY 10032, USA. Tel: +1 212 304 7920; ct116@columbia.edu.

#### Conflicts of interest

The contents of this manuscript are solely the responsibility of the authors and do not necessarily represent the official views of PEPFAR or the CDC.

## Keywords

adolescents; antiretroviral therapy; Kenya; retention

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## Introduction

There is a growing population of adolescents and youth infected with HIV globally. It is estimated that in 2012, there were 5.4 million 10–24-year-olds living with HIV – approximately 900 000 young adolescents (10–14 years) and 4.5 million youth (15–24 years) [1]. Increased survival of perinatally-infected HIV-positive (HIV+) children through the expansion of HIV testing and treatment services has been well documented and is an important contributor to the growing population of HIV+ young adolescents [2-6]. New infections among 15–24-year-olds, primarily from sexual transmission, are also increasing in many resource-limited settings (RLS), particularly in sub-Saharan Africa (SSA). New HIV infections among 15–24-year-olds accounted for almost 40% of all new infections in 2012, with young women facing more than double the risk of acquisition compared to their male peers [1].

Whereas significant gains have been made in reducing mortality among HIV+ adults and children, similar achievements have not been recorded among young adolescents and youth: the WHO estimates a 50% increase in AIDS-related deaths among 10–19-year-olds between 2005 and 2012 [7]. The physical, emotional and psychological changes characteristic of adolescence and early adulthood may impact retention in HIV care and adherence to antiretroviral treatment (ART), leading to suboptimal health outcomes. Studies have reported poor retention, suboptimal adherence to ART and reduced viral suppression in this population compared to adults [8-11], and have identified a variety of individual, health systems and structural factors contributing to these poor outcomes [12,13]. The majority of studies were conducted in resource-rich countries whose populations may face different challenges from those in SSA.

Kenya has been significantly affected by the HIV epidemic with an HIV adult prevalence of 5.6% and an estimated 1.4 million people living with HIV as of 2012 [14]. HIV prevalence among 15–24-year-olds is 2.1% [15] and there are approximately 150 000 HIV+ adolescents (10–19 years) in Kenya [16]. This analysis describes demographic and clinical characteristics as well as loss to follow-up (LTF) and mortality outcomes of HIV+ young adolescents and youth enrolled in HIV care and treatment services during 2006–2011 at ICAP-supported health facilities in Kenya.

## Methods

### Study design and study population

We conducted a retrospective analysis using de-identified patient-level data from health facilities in Eastern, Nyanza, and Central Provinces of Kenya. All health facilities received support from ICAP-Columbia University through funding from the President's Emergency Plan for AIDS Relief (PEPFAR) [17]. All health facilities offered a standard set of ART

services, including HIV testing, pre-ART and ART, with counseling and retention support as per Kenyan national guidelines. The study population included ART-naive patients who enrolled in HIV care at 10–24 years of age between 1 January 2006 and 31 December 2011. Patient information was routinely collected during clinical visits using Kenyan national patient data collection forms and entered into on-site electronic databases by trained data clerks at each health facility. Data on patient death were ascertained from facility records. Data quality assessments were conducted biannually.

### Statistical analysis

Patients were stratified into three age groups: 10–14 years, 15–19 years, and 20–24 years, to examine demographic and clinical characteristics at enrollment and at ART initiation (only patients who started ART <25 years of age were included in analyses of ART outcomes). We also describe patient characteristics by year of enrollment and year of ART initiation by dividing the observation time into three periods: 2006–2007, 2008–2009, and 2010–2011. Data from facility medical charts included demographics and information on entry point into HIV care, as well as CD4<sup>+</sup> cell count and WHO stage at enrollment and ART initiation (a window of 3 months prior to and 1 month after the dates of enrollment and ART initiation were used). Descriptive analyses summarizing characteristics and comparing groups were performed using chi-square tests for comparing categorical variables and Wilcoxon signed-rank tests for continuous variables. LTF was defined as patients not recorded as dead or transferred out who did not have a recorded clinical visit within 12 months for patients not on ART (pre-ART) and within 6 months for patients after ART initiation.

Survival analyses of LTF and death for pre-ART patients were conducted using competing risk estimators with ART initiation and death considered competing risks for LTF in the pre-ART period and ART initiation considered a competing risk for pre-ART death. For the analysis of outcomes after ART initiation, Kaplan–Meier estimators were used to estimate the probability of LTF and death. Sub-distributional hazards models (for pre-ART outcomes) and Cox proportional-hazards models (for patients who start ART) were generated to identify patient and facility characteristics associated with LTF and death. Multivariable models were adjusted for age, sex, CD4<sup>+</sup> cell count and WHO stage at enrollment (for pre-ART analyses) and at ART initiation; models were also adjusted for calendar year, facility type, location and the availability of a CD4<sup>+</sup> machine onsite. Time-to-event analyses were conducted using age at enrollment and age at ART initiation as fixed covariates (all patients had one value for each of these variables). Statistical analyses were conducted using SAS 9.3 (SAS Institute Inc., Cary, North Carolina, USA) and Stata 12 (Stata Corp., College Station, Texas, USA).

### Ethical approval

All data were de-identified prior to analysis and the investigators had no access to identifiable patient information. Institutional Review Board (IRB) approval was obtained from the Kenya Medical Research Institute (KEMRI); the study was designated nonhuman patients research by the IRB Columbia University, and the Center for Global Health at the US Centers for Disease Control and Prevention (CDC) determined the study to not involve engagement in human patient research.

## Results

### Patient characteristics at enrollment

Between 2006 and 2011, 22 832 patients aged 10–24 years were enrolled in HIV care at 109 health facilities. Patient characteristics at enrollment by age group and year of enrollment are shown in Table 1. At enrollment, 69.5% of patients were 20–24 years of age and 82.2% were female. Among those with WHO stage and CD4<sup>+</sup> cell count at enrollment (19.3 and 58.7% missing data, respectively), the majority (70.8%) were WHO stage I or II, and the median overall CD4<sup>+</sup> cell count was 332 cells/μl [interquartile range (IQR) 153–561]. In the older-age categories, more than 80% of the patients were female compared to 53.4% of the 10–14-year-olds. WHO stage was generally higher and CD4<sup>+</sup> cell count lower among the 10–14-year-olds compared to the youth; 37.8% of the 10–14-year-olds were WHO stage III/IV compared to 27.2% of the 15–19-year-olds and 28.0% of the 20–24-year-olds ( $P<0.0001$ ). Median CD4<sup>+</sup> cell count was 284 cells/μl (IQR 104–518) among 10–14-year-olds compared to 15–19 and 20–24-year-olds who had median CD4<sup>+</sup> cell count of 340 cells/μl (IQR 161–580) and 340 cells/μl (IQR 162–562), respectively ( $P<0.0001$ ) (Table 1).

Compared to 2006–2007, fewer 10–14-year-olds were enrolled during 2010–2011 and as a proportion of all new enrollments in this cohort, 10–14-year-olds decreased over time (Table 1). The proportion of patients enrolling from VCT services declined from 36.7% in 2006–2008 to 21.2% in 2010–2011, whereas there was an increase in patients enrolling through PMTCT and ‘other’ testing venues which included home-based and other nonfacility testing venues. Overall, few patients were WHO stage IV at enrollment across all years (2.1%), and the proportion of patients with WHO stage III/IV declined from 44.4 to 16.9% from 2006–2007 to 2010–2011. Similarly, median CD4<sup>+</sup> cell count at enrollment increased from 245 cells/μl (IQR 95–475) to 391 cells/μl (IQR 205–620) from the earliest to the latest time period ( $P<0.0001$ ) (Table 1).

### Patient characteristics at antiretroviral treatment initiation

Among all enrolled 10–24-year-olds, 8016 (35.1%) initiated ART including 55.4% of 10–14-year-olds, 32.1% of 15–19-year-olds and 31.8% of 20–24-year-olds. Overall, 52.6% of patients were WHO stage III/IV at ART initiation and there were no differences in clinical status at ART initiation by age group (Table 2). CD4<sup>+</sup> cell count at ART initiation was also similar across age groups, with more than half of all patients having CD4<sup>+</sup> cell count less than 200 cells/μl at ART initiation (Table 2). The proportion of all patients initiating ART who were 10–14 years of age at enrollment decreased over time from 24.1% in 2006–2007 to 15.0% in 2010–2011, whereas the proportion of 20–24-year-olds starting ART increased (Table 2). There was a decline in the proportion of patients with advanced disease status (WHO stage III/IV) at ART initiation from 66.2% in 2006–2007 to 37.1% in 2010–2011 ( $P<0.0001$ ). The overall median CD4<sup>+</sup> cell count at ART initiation increased from 170 cells/μl (IQR 71–261) in 2006–2007 to 215 cells/μl (IQR 105–303) in 2010–2011 ( $P<0.0001$ ), and the proportion of patients with CD4<sup>+</sup> cell count below 200 cells/μl at ART initiation decreased from 59.9 to 47.4% (Table 2).

## Patient outcomes

**Pre-antiretroviral treatment outcomes**—Among all the enrolled patients, 5760 (24.9%) had only one recorded clinic visit; 87.7% were lost to follow-up, 4.2% were documented as dead and 8.1% were transferred out (data not shown). Mortality at 12 and 24 months for all patients was 1.8% [95% confidence interval (CI) 1.6–2.0] and 2.1% (95% CI 1.9–2.3), respectively, and was similar across age groups (Fig. 1). Pre-ART LTF for all the enrolled patients aged 10–24 years (including those with only one clinic visit) at 12 and 24 months was 41.0% (95% CI 40.3–41.7) and 46.1% (95% CI 45.4–46.8). Among pre-ART patients, LTF was higher among 15–19 and 20–24-year-olds compared to 10–14-year-olds at all time points after enrollment. At 12 months, LTF among 10–14-year-olds was 19.0% (95% CI 17.5–20.5) compared to 44.3% (95% CI 42.6–46.0) for 15–19-year-olds and 44.3% (95% CI 43.4–45.1) for 20–24-year-olds. At 24 months, LTF among 10–14-year-olds was 21.9% (95% CI 20.3–23.52), compared to 49.9% (95% CI 48.2–51.6) and 49.7% (95% CI 48.9–50.5) for 15–19 and 20–24-year-olds, respectively (Fig. 1).

**Antiretroviral treatment outcomes**—Mortality for patients who initiated ART was 2.7% (95% CI 2.4–3.1) at 12 months and 3.9% (95% CI 3.4–4.4) at 24 months (Fig. 2). Deaths among patients on ART were similar across the three age groups. Among all patients who initiated ART, LTF at 12 and 24 months was 20.9% (95% CI 20.0–21.8) and 32.2% (95% CI: 31.2–33.4). LTF was highest among the 20–24-year-olds; at 12 months after starting ART, 10.0% (95% CI 8.7–11.5) of 10–14-year-olds, 19.8% (95% CI 17.7–22.2) of 15–19-year-olds and 25.0% (95% CI 23.8–26.3) of 20–24-year-olds were lost to follow-up (Fig. 4). At 24 months, LTF among 10–14-year-olds was 18.5% (95% CI 16.6–20.6), 30.3% (95% CI 27.7–33.2) for 15–19-year-olds and 37.7% (95% CI 36.2–39.1) for 20–24-year-olds.

## Predictors of pre-antiretroviral treatment outcomes

Death among pre-ART patients was associated with male sex [adjusted sub-distributional hazards ratio (aSHR) 1.4, 95% CI 1.1–1.7], whereas younger age was found to be protective against mortality (10–14 vs. 20–24 years; aSHR 0.7, 95% CI 0.5–1.0) (Table 3). More advanced stage of disease was associated with increased hazard of pre-ART death (WHO stage IV vs. I; aHR 6.9, 95% CI 4.0–11.8), as was lower CD4<sup>+</sup> cell count at enrollment; patients with CD4<sup>+</sup> cell count below 100 cells/μl and those missing CD4<sup>+</sup> cell count had 1.7 (95% CI 1.2–2.3) and 1.8 (95% CI 1.4–2.5) increased hazards of death, respectively, compared to those with CD4<sup>+</sup> cell count above 350 cells/μl (Table 3).

Pre-ART LTF was lower among patients 10–14 years of age (10–14 vs. 20–24 years; aSHR 0.4, 95% CI 0.4–0.5) (Table 3). Advanced disease status and immunodeficiency were associated with lower rates of LTF. Patients with WHO stage III and IV had lower hazards of LTF compared to those with WHO stage I (WHO stage III vs. I, aSHR 0.8, 95% CI 0.7–0.9; WHO stage IV vs. I, aHR 0.8, 95% CI 0.7–1.0) (Table 3). Low CD4<sup>+</sup> cell count was also associated with lower hazards of LTF (CD4<sup>+</sup> <100 vs. >350 cells/μl, aSHR 0.4, 95% CI 0.3–0.6) (Table 3). Enrolling in care at a rural health facility was also protective against pre-ART LTF (aSHR 0.8, 95% CI 0.7–0.9).

## Predictors of antiretroviral treatment outcomes

Age was not found to be a significant predictor of death for patients who initiated ART (Table). Advanced disease status and lower CD4<sup>+</sup> cell count at ART initiation were associated with mortality for patients who initiated treatment (Table 3). The hazards of death were three-fold higher among patients with WHO stage III or IV at ART initiation compared to those with WHO stage I [WHO stage III vs. I, adjusted hazard ratio (aHR) 3.1, 95% CI 1.7–5.6; WHO stage IV vs. I, aHR 5.0, 95% CI 2.5–10.0]. Compared to those with CD4<sup>+</sup> cell count above 350 cells/μl at ART initiation, patients with CD4<sup>+</sup> cell count below 100 cells/μl had seven-fold higher hazards of death (aHR 7.7, 95% CI 3.7–15.8). Death among patients on ART was also associated with receiving care at a rural health facility (aHR 1.4, 95% CI 1.0–1.9) (Table 3).

Similar to the pre-ART patients, LTF among patients who initiated ART was associated with older age; 10–14-year-olds had lower hazard of LTF compared to 20–24-year-olds (aHR 0.6, 95% CI 0.5–0.6) (Table 3). Unlike pre-ART patients, those who started ART with more advanced disease status and lower CD4<sup>+</sup> cell count were more likely to be lost to follow-up. Patients with WHO stage IV were more likely to be lost to follow-up than those with WHO stage I (aHR 1.3, 95% CI 1.1–1.7), as were patients with CD4<sup>+</sup> cell count below 100 cell/μl compared to those with CD4<sup>+</sup> cell count above 350 cells/μl at ART initiation (aHR 1.3, 95% CI 1.1–1.5) (Table 3). Lower ART LTF was also associated with enrolling in care at a rural health facility (aHR 0.5, 95% CI 0.3–0.7).

## Discussion

We present findings from a large cohort of young adolescents (10–14 years) and youth (15–24 years) enrolled in HIV services in Kenya, with youth making up the vast majority (86%) of patients. Demographic, clinical and immunologic characteristics of patients at enrollment into care differed by age group, with young adolescents having more advanced disease status and youth being predominantly female. Characteristics of the patient population changed over time from 2006 to 2011, with fewer young adolescents enrolling in care and initiating ART, whereas more youth were enrolled through PMTCT services. High rates of LTF were found; 25% did not return after the first visit and overall 41% were lost to follow-up in the first 12 months of the pre-ART period. Similarly, among those initiating treatment, 21% were lost within 12 months. The rate of LTF among 15–24-year-olds was more than double than that found among 10–14-year-olds in both the pre-ART period and after ART initiation, whereas mortality was similar among all age groups. These findings underscore the urgent need to recognize the growing population of young people with HIV infection and identify approaches to engage and retain them in HIV care.

In this cohort, young adolescents had more advanced disease and lower CD4<sup>+</sup> cell count compared to youth. Although we did not have information on mode of transmission, these data suggest that young adolescents were most likely perinatally-infected and not identified and/or enrolled in HIV care late, at advanced disease, which has been described in other adolescent cohorts in SSA [5]. The vast majority of patients included in this analysis were youth (15–24 years) of whom more than 80% were female – a finding consistent with seroprevalence studies in SSA, showing disproportionately higher prevalence of HIV among

young women [18]. Over time, an increasing proportion of youth were enrolled through PMTCT services suggesting that HIV testing in antenatal care is an important venue for identifying HIV infection in young women. Successful identification of young women through PMTCT highlights the need for innovative strategies to test young men who are less likely to access routine health services and test for HIV [19].

Whereas young adolescents and youth differed with regard to clinical and immunologic characteristics at enrollment, both groups had similarly compromised health status at ART initiation. Late ART initiation in this cohort may be related to late enrollment into care at advanced stages of disease. Late ART initiation may also reflect the challenges encountered in timely treatment initiation including regular follow-up of pre-ART patients and health system delays. Reasons for delays in ART initiation among adults include distance and cost, prolonged adherence preparation and patients' unwillingness to initiate treatment [20-22], but factors specific to youth have not been characterized.

Overall, we found high rates of LTF prior to and after ART initiation; by 12 months after enrollment, 41% of pre-ART patients were LTF and among those who started ART, 21% were lost at 12 months after initiation. The higher rate of LTF in pre-ART patients is consistent with previous findings from adult cohorts in SSA, which have shown greater loss of patients before ART initiation [23-25]. Rates of LTF among adolescents and youth before ART initiation have not been widely reported; however, on ART LTF reported from this cohort is somewhat higher than other cohorts of youth and adolescents [8,11], and is also higher than LTF reported for Kenyan adult cohorts [26,27]. We report LTF among all patients 10–24 years enrolled in care, including those who never returned after the first visit; and our estimates may therefore be a more accurate reflection of LTF in care programs. The low mortality rate in our cohort, which is lower than adolescent mortality in Zimbabwe [8], is likely an underestimate of the true number of deaths resulting from lack of documentation.

We found that age was strongly associated with LTF in both the pre-ART period and after ART initiation, with patients aged 15–24 years being more than twice as likely to be lost to follow-up compared to 10–14-year-olds. Bygrave *et al.* [8] reported similar findings among patients on ART in Zimbabwe. The high rates of LTF among youth may be a result of previously identified factors including high levels of mobility as well as emotional and psychological distress among youth [12,28]. Better retention of younger children may also result from differences in service delivery by age group; children below 15 years were more likely to enroll in designated pediatric care clinics, whereas youth at least 15 years would have been enrolled and followed in the adult care clinic. It is possible that pediatric programs were better able to retain patients compared to programs serving adults [29,30]. There is some evidence suggesting that youth-friendly services improve retention of younger patients [11]. We observed lower LTF among patients enrolled at rural sites, which may be related to patient proximity; in a recent analysis from Kenya, patients who were lost to follow-up and traced in the community reported that greater distances were a reason for disengagement from care [31].

As expected, mortality in both the pre-ART period and after ART initiation was highest among patients with advanced disease. Mortality was also somewhat higher at rural sites,

possibly indicating greater resources for providing care at better equipped urban facilities. In contrast, LTF in the pre-ART period was associated with less advanced disease status and higher CD4<sup>+</sup> cell count. This finding is in keeping with the adult literature, showing that healthier status at enrollment in care is associated with greater pre-ART LTF [23,24,32]. In this cohort, LTF after ART initiation was associated with more advanced disease, which is not consistent with previous findings [23,25,33]. As noted, many patients had advanced disease and immunologic status at ART initiation which could have put them at greater risk for mortality, but these deaths may not have been well documented due to high rates of LTF.

The strengths of this analysis include the large and representative sample of over 22 800 patients from 109 health facilities in Kenya in both urban and rural areas. This is one of the largest reports of outcomes for this population from a RLS. The analysis is also unique in presenting data on patients prior to ART initiation; there are limited pre-ART data for adults and even less on this age group. Limitations of the analysis include data quality and completeness. Critical data, such as WHO stage and CD4<sup>+</sup> cell count were missing for up to a quarter or more of all patients. Furthermore, information on deaths was obtained from patient and facility records and is almost certainly an underestimate of the true number of deaths.

Overall, the findings from this cohort suggest that greater efforts are needed to understand and address factors contributing to LTF and mortality among young adolescents and youth. Our findings draw attention to the vulnerability of patients in this age group and serve to reiterate the urgent need for innovative approaches to engage and retain young people in order to optimize care and treatment outcomes.

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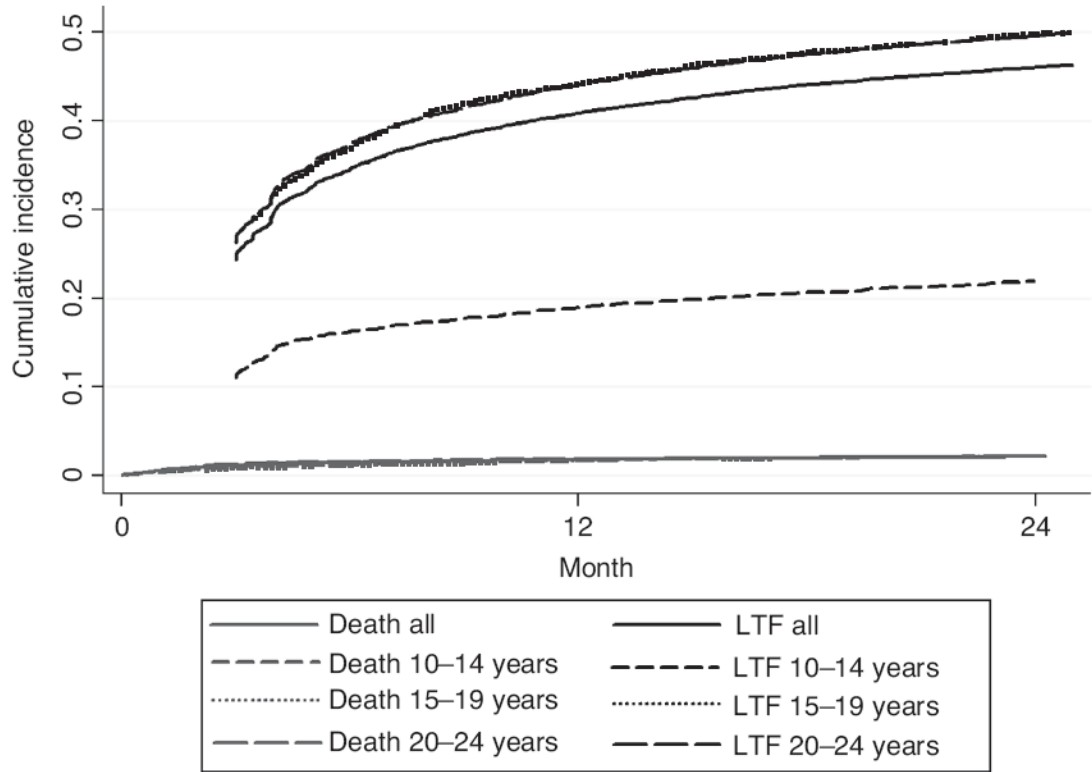
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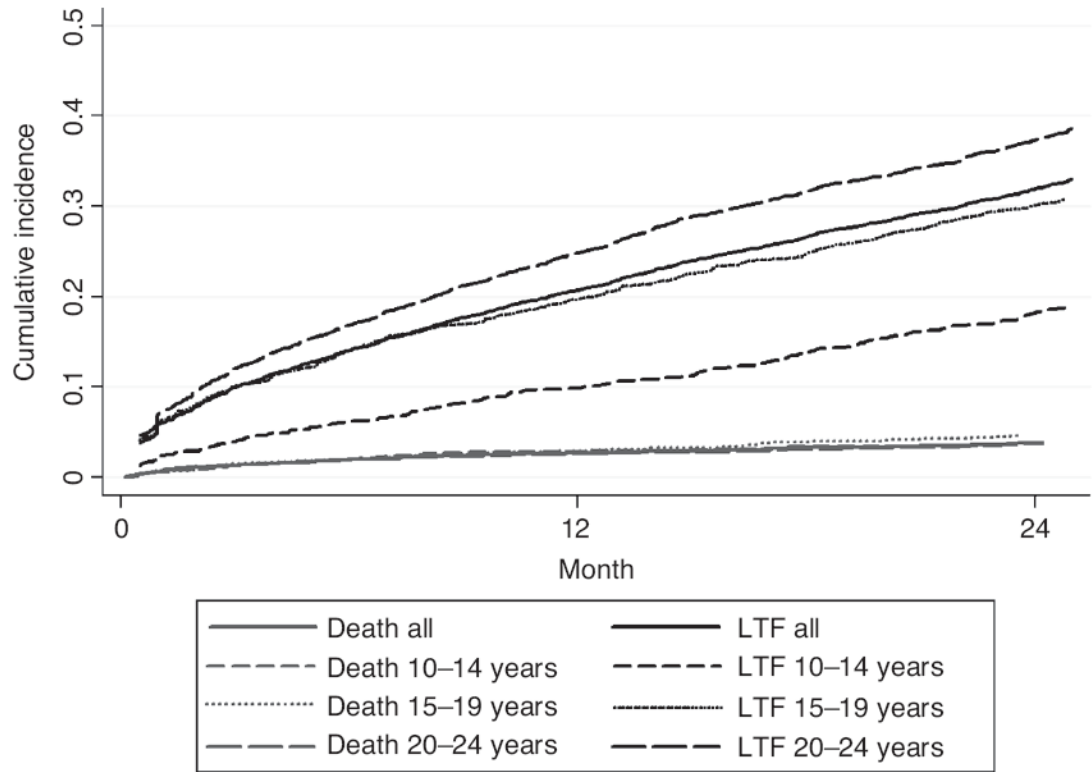


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**Fig. 1.** Cumulative incidence of pre-antiretroviral treatment death and loss to follow-up among adolescents and youth (15–24 years) enrolled at 109 Kenyan health facilities during 2006–2011 ( $N=22\ 832$ ).



**Fig. 2.** Cumulative incidence of death and loss to follow-up after antiretroviral treatment initiation among adolescents and youth (15–24 years) enrolled at 109 Kenyan health facilities during 2006–2011 ( $N=8016$ ).

**Table 1**  
Patient characteristics at enrollment into HIV care among adolescent and youth patients (10–24 years) at 109 health facilities in Kenya during 2006–2011 (N=22 832)<sup>a</sup>.

	Total		10–14 years		15–19 years		20–24 years	
	N	%	n	%	n	%	n	%
Sex	22 832	100	3095	13.6	3860	16.9	15877	69.5
Male	4052	17.8	1443	46.6	673	17.4	1936	12.2
Female	18772	82.2	1652	53.4	3185	82.6	13 935	87.8
Point of entry into HIV care								
VCT	6813	29.8	565	18.3	1012	26.2	5236	33.0
PMTCT	4093	17.9	76	2.5	755	19.6	3262	20.6
TB/HIV	768	3.4	205	6.6	150	3.9	413	2.6
Inpatient	847	3.7	159	5.1	122	3.2	566	3.6
Outpatient	720	3.2	180	5.8	123	3.2	417	2.6
Other <sup>b</sup>	7306	32.0	1563	50.5	1287	33.3	4456	28.1
Unknown	2285	10.0	347	11.2	411	10.6	1527	9.6
WHO stage								
Stage I	6929	37.6	518	21.0	1269	40.8	5142	40.0
Stage II	6124	33.2	1017	41.2	995	32.0	4112	32.0
Stage III	4991	27.1	851	34.5	785	25.2	3355	26.1
Stage IV	382	2.1	81	3.3	64	2.0	237	1.9
Missing	4406	19.3	628	20.3	747	19.4	3029	19.1
CD4 <sup>+</sup> cell count median (IQR)	332 (153–561)		284 (104–518)		340 (161–580)		340 (162–562)	
350+	4489	47.7	614	41.7	754	48.4	3121	48.9
200–350	1946	20.7	296	20.1	334	21.4	1316	20.6
100–199	1277	13.6	204	13.8	202	13.0	871	13.6
<100	1709	18.1	360	24.4	269	17.2	1080	16.9
Missing	13411	58.7	1621	52.4	2301	59.6	9489	59.8
Enrollment year								
2006	2964	13.0	488	15.8	513	13.3	1963	12.4

	Total		10–14 years		15–19 years		20–24 years	
	N	%	n	%	n	%	n	%
2007	4025	17.6	604	19.5	643	16.7	2778	17.5
2008	4138	18.1	625	20.2	679	17.6	2834	17.8
2009	4440	19.5	580	18.7	683	17.7	3177	20.0
2010	4307	18.9	528	17.1	727	18.8	3052	19.2
2011	2958	13.0	270	8.7	615	15.9	2073	13.1
Facility type								
Public primary	4919	21.8	575	18.8	878	23.2	3466	22.1
Public secondary/tertiary	15 233	67.6	2026	66.2	2501	66.0	10 706	68.3
Private and others	2372	10.5	459	15.0	411	10.8	1502	9.6
Site location								
Urban/ semi-urban	12 835	57.0	1795	58.7	2044	53.9	8996	57.4
Rural	9689	43.0	1265	41.3	1746	46.1	6678	42.6
Total			2006–2007	2008–2009	2010–2011			
	22 832	100	6989	30.6	8578	37.6	7265	31.8
Age group (years)								
10–15	3095	13.6	1092	15.6	1205	14.0	798	11.0
15–20	3860	16.9	1156	16.6	1362	15.9	1342	18.5
20–24	15 877	69.5	4741	67.8	6011	70.1	5125	70.5
Sex								
Male	4052	17.8	1295	18.5	1552	18.1	1205	16.6
Female	18772	82.2	5689	81.5	7023	81.9	6060	83.4
Point of entry into care								
VCT	6813	29.8	2565	36.7	2707	31.6	1541	21.2
PMITCT	4093	17.9	956	13.7	1632	19.0	1505	20.7
TB/HIV	768	3.4	346	5.0	291	3.4	131	1.8
Inpatient	847	3.7	283	4.0	351	4.1	213	2.9
Outpatient	720	3.2	142	2.0	165	1.9	413	5.7
Other <sup>b</sup>	7306	32.0	1893	27.1	2734	31.9	2679	36.9
Unknown	2285	10.0	804	11.5	698	8.1	783	10.8

WHO stage	Total		10–14 years		15–19 years		20–24 years	
	N	%	n	%	n	%	n	%
Stage I	6929	37.6	1479	27.3	2592	36.3	2858	48.7
Stage II	6124	33.2	1535	28.3	2567	36.0	2022	34.4
Stage III	4991	27.1	2238	41.2	1844	25.9	909	15.5
Stage IV	382	2.1	174	3.2	127	1.8	81	1.4
Missing	4406	19.3	1563	22.4	1448	16.9	1395	19.2
CD4 <sup>+</sup> , cell count median (IQR)	332 (153–561)		245 (95–475)		319 (145–532)		391 (205–620)	
350+	4489	47.7	781	37.6	1681	45.8	2027	55.2
200–350	1946	20.7	392	18.9	801	21.8	753	20.5
100–199	1277	13.5	371	17.9	497	13.5	409	11.1
<100	1709	18.1	533	25.6	693	18.9	483	13.2
Missing	13 411	58.7	4912	70.3	4906	57.2	3593	49.5
Facility type								
Public primary	4919	21.8	564	8.1	1735	20.5	2620	37.0
Public secondary/tertiary	15 233	67.6	5710	82.1	5792	68.3	3731	52.6
Private and others	2372	10.5	682	9.8	950	11.2	740	10.4
Site location								
Urban/semi-urban	12 835	57.0	4736	68.1	4853	57.3	3246	45.8
Rural	9689	43.0	2220	31.9	3624	42.8	3845	54.2

<sup>a</sup>All the variables were statistically associated with age group or enrollment year cohort ( $P < 0.001$ ).

<sup>b</sup>‘Other’ testing venues which included home-based and other nonfacility testing venues.

**Table 2**  
Patient characteristics at antiretroviral treatment initiation among adolescent and youth patients (10–24 years) at 109 health facilities in Kenya during 2006–2011 (N=8016)<sup>a</sup>.

	Total		Age at enrollment							
	N	%	10–14 years	15–19 years	20–24 years	n	%	n	%	
	8016	100	1716	21.4	1240	15.5	5060	63.1		
Age at ART initiation (years)										
10–14	1623	20.3	1623	94.6	0	0	0	0	0	0
15–19	1235	15.4	93	5.4	1142	92.1	0	0	0	0
20–24	4655	58.1	0	0	98	7.9	4557	90.1		
>25 years at ART	503	6.3	0	0	0	0	0	0	503	9.9
Sex										
Male	1818	22.7	840	49.0	350	28.3	628	12.4		
Female	6196	77.3	876	51.0	889	71.7	4431	87.6		
WHO stage										
Stage I	929	15.8	110	9.5	153	16.9	666	17.5		
Stage II	1858	31.6	445	38.4	267	29.5	1146	30.1		
Stage III	2833	48.3	546	47.2	447	49.5	1840	48.3		
Stage IV	250	4.3	57	4.9	37	4.1	156	4.1		
Missing	2146	26.8	558	32.5	336	27.1	1252	24.7		
ART initiation year										
2006	668	8.3	204	11.9	131	10.6	333	6.6		
2007	1222	15.2	298	17.4	178	14.4	746	14.7		
2008	1385	17.3	325	18.9	228	18.4	832	16.4		
2009	1634	20.4	346	20.2	224	18.0	1064	21.0		
2010	1715	21.4	324	18.9	249	20.1	1142	22.6		
2011	1145	14.3	194	11.3	182	14.7	769	15.2		
2012	244	3.0	24	1.4	47	3.8	173	3.4		
CD4 <sup>+</sup> cell count median (IQR)	189 (87–284)		199 (80–341)		185 (73–277)		188 (91–275)			
350+	725	12.9	259	23.4	107	12.4	359	9.9		



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	Age at enrollment							
	Total		10–14 years		15–19 years		20–24 years	
	N	%	n	%	n	%	n	%
200–350	1898	33.8	289	26.1	286	33.1	1323	36.4
100–199	1420	25.3	236	21.3	217	25.1	967	26.6
<100	1568	28.0	322	29.1	255	29.5	991	27.2
Missing	2405	30.0	610	35.6	375	30.2	1420	28.1
Facility type								
Public primary	1538	19.4	264	15.5	237	19.3	1037	20.8
Public secondary/tertiary	5530	69.8	1198	70.5	848	69.2	3484	69.8
Private and others	851	10.8	238	14.0	141	11.5	472	9.5
Site location								
Urban/semi-urban	4705	59.4	1028	60.5	730	59.5	2947	59.0
Rural	3214	40.6	672	39.5	496	40.5	2046	41.0
Year of ART initiation								
Total			2006–2007	2008–2009	2010–2011			
Sex	8014		2585	32.3	3248	40.5	2183	27.2
Male	1818	22.7	625	24.2	739	22.8	454	20.8
Female	6196	77.3	1958	75.8	2509	77.2	1729	79.2
Age at ART initiation (years)								
10–14	1623	20.3	623	24.1	672	20.7	328	15.0
15–19	1235	15.4	419	16.2	470	14.5	346	15.9
20–24	4655	58.1	1313	50.8	1910	58.8	1432	65.6
>25 years at ART	503	6.3	230	8.9	196	6.0	77	3.5
WHO stage								
Stage I	929	15.8	156	8.7	361	15.0	412	24.8
Stage II	1858	31.6	450	25.1	773	32.1	635	38.2
Stage III	2833	48.3	1096	61.1	1183	49.1	554	33.3
Stage IV	250	4.3	92	5.1	95	3.9	63	3.8
Missing	2146	26.8	791	30.6	836	25.7	519	23.8

	Total	Age at enrollment						
		10–14 years		15–19 years		20–24 years		
	N	%	n	%	n	%	n	%
CD4 <sup>+</sup> cell count median (IQR)	189 (87–284)	170 (71–261)	189 (88–280)	215 (105–303)				
350+	725	12.9	203	13.0	307	13.0	216	12.7
200–350	1898	33.8	428	27.5	791	33.6	679	40.0
100–199	1420	25.3	423	27.5	607	25.8	390	23.0
<100	1568	28.0	505	32.4	649	27.6	414	24.4
Missing	2405	30.0	1027	39.7	894	27.5	484	22.2
Facility type								
Public primary	1538	19.4	230	8.9	642	20.0	666	31.4
Public secondary/tertiary	5530	69.8	2101	81.5	2211	68.7	1218	57.3
Private and others	851	10.8	246	9.6	365	11.3	240	11.3
Site location								
Urban/semi-urban	4705	59.4	1822	70.7	1846	57.4	1037	48.8
Rural	3214	40.6	755	29.3	1372	42.6	1087	51.2

<sup>a</sup> All the variables were statistically associated with age group or enrollment year cohort ( $P < 0.001$ ), except for site location by age group ( $P = 0.57$ ).

**Table 3** Predictors of death and loss to follow-up among adolescents and youth enrolled in care and those started on antiretroviral treatment at 109 healthcare facilities in Kenya (pre-antiretroviral treatment,  $N = 22\ 832$ ; antiretroviral treatment,  $N = 8016$ ).

	Pre-ART				ART			
	Death		LTF		Death		LTF	
	Adjusted SHR	95% CI	Adjusted SHR	95% CI	Adjusted HR	95% CI	Adjusted HR	95% CI
Age category								
10-14	<b>0.7</b>	<b>0.5-1.0</b>	<b>0.4</b>	<b>0.4-0.5</b>	1.1	0.8-1.6	<b>0.6</b>	<b>0.5-0.6</b>
15-19	0.9	0.7-1.2	1.0	0.9-1.1	1.1	0.8-1.6	<b>1.0</b>	<b>0.9-1.0</b>
20-24	1	Ref.	1	Ref.	1	Ref.	1	Ref.
25-49	-	-	-	-	0.8	0.4-1.5	0.6	0.5-0.7
Sex								
Male	<b>1.4</b>	<b>1.1-1.7</b>	1.01	1.0-1.1	1.0	0.8-1.4	0.9	0.8-1.0
Female	1	Ref.	1	Ref.	1	Ref.	1	Ref.
Region								
Eastern province	1.0	0.6-1.8	1.0	0.8-1.3	0.8	0.6-1.2	<b>1.7</b>	<b>1.1-2.5</b>
Nyanza province	0.9	0.6-1.4	<b>1.4</b>	<b>1.1-1.6</b>	<b>0.7</b>	<b>0.4-1.0</b>	<b>1.9</b>	<b>1.3-2.8</b>
Central province	1	Ref.	1	Ref.	1	Ref.	1	Ref.
Point of entry into care								
VCT	1	Ref.	1	Ref.	1	Ref.	1	Ref.
PMTCT	<b>0.5</b>	<b>0.3-0.7</b>	1.2	1.1-1.3	<b>0.6</b>	<b>0.3-1.0</b>	1.2	1.0-1.4
TB/HIV	1.2	0.8-2.0	1.0	0.9-1.2	1.0	0.5-1.7	1.0	0.8-1.2
Inpatient	<b>1.8</b>	<b>1.1-2.8</b>	1.2	1.0-1.4	1.1	0.6-2.1	1.0	0.8-1.3
Outpatient	1.0	0.6-1.6	0.8	0.7-1.0	1.7	0.9-3.0	1.1	0.7-1.6
Other	1.0	0.8-1.4	1.0	0.9-1.1	1.0	0.7-1.3	0.9	0.8-1.0
Unknown	1.0	0.6-1.7	0.8	0.7-1.0	1.1	0.7-1.6	0.9	0.8-1.1
WHO stage at enrollment/ART initiation								
Stage I	1	Ref.	1	Ref.	1	Ref.	1	Ref.
Stage II	<b>2.1</b>	<b>1.5-2.9</b>	<b>0.9</b>	<b>0.8-1.0</b>	<b>1.9</b>	<b>1.0-3.5</b>	0.9	0.8-1.1
Stage III	<b>3.7</b>	<b>2.8-4.9</b>	<b>0.8</b>	<b>0.7-0.8</b>	<b>3.1</b>	<b>1.7-5.6</b>	1.0	0.9-1.2
Stage IV	<b>6.9</b>	<b>4.0-11.8</b>	<b>0.8</b>	<b>0.7-1.0</b>	<b>5.0</b>	<b>2.5-10.0</b>	<b>1.3</b>	<b>1.1-1.7</b>

	Pre-ART						ART					
	Death			LTF			Death			LTF		
	Adjusted SHR	95% CI	Adjusted SHR	95% CI	Adjusted HR	95% CI	Adjusted HR	95% CI	Adjusted HR	95% CI		
Missing	2.7	1.8-4.0	1.5	1.4-1.7	1.9	1.0-3.5	1.1	0.9-1.2				
CD4 <sup>+</sup> cell count at enrollment/ART initiation												
350+	1	Ref.	1	Ref.	1	Ref.	1	Ref.	1	Ref.		
200-350	0.8	0.6-1.3	<b>0.5</b>	<b>0.4-0.6</b>	<b>2.4</b>	<b>1.1-5.4</b>	1.1	1.0-1.3				
100-199	1.3	0.8-2.1	<b>0.3</b>	<b>0.2-0.4</b>	<b>3.9</b>	<b>1.8-8.7</b>	1.2	1.0-1.4				
<100	<b>1.7</b>	<b>1.2-2.3</b>	<b>0.4</b>	<b>0.3-0.6</b>	<b>7.7</b>	<b>3.7-15.8</b>	<b>1.3</b>	<b>1.0-1.5</b>				
Missing	<b>1.8</b>	<b>1.4-2.5</b>	1.5	0.3-1.7	<b>3.3</b>	<b>1.4-7.6</b>	1.2	1.0-1.4				
Calendar year of enrollment/ART initiation												
2006	<b>0.4</b>	<b>0.2-0.6</b>	<b>1.9</b>	<b>1.6-2.1</b>	0.6	0.3-1.0	<b>0.4</b>	<b>0.2-0.8</b>				
2007	0.9	0.6-1.3	<b>1.8</b>	<b>1.4-2.2</b>	0.6	0.3-1.0	<b>0.6</b>	<b>0.3-1.0</b>				
2008	0.8	0.5-1.1	<b>1.6</b>	<b>1.3-2.0</b>	0.9	0.5-1.3	0.8	0.4-1.3				
2009	0.8	0.6-1.2	<b>1.4</b>	<b>1.2-1.7</b>	0.8	0.5-1.2	0.8	0.6-1.1				
2010	0.9	0.6-1.2	1.1	1.0-1.4	1.0	0.6-1.5	0.9	0.7-1.1				
2011	1	Ref.	1	Ref.	1	Ref.	1	Ref.				
Setting												
Urban/semi-urban	1	Ref.	1	Ref.	1	Ref.	1	Ref.				
Rural	<b>2.1</b>	<b>1.4-3.3</b>	<b>0.8</b>	<b>0.7-0.9</b>	<b>1.4</b>	<b>1.0-1.9</b>	<b>0.5</b>	<b>0.3-0.7</b>				
Facility type												
Primary	1.0	0.7-1.6	0.9	0.8-1.1	0.9	0.7-1.4	0.8	0.65-1.2				
Secondary/other	1	Ref.	1	Ref.	1	Ref.	1	Ref.				

ART, antiretroviral treatment; CI, confidence interval; HR, hazard ratio; LTF, loss to follow-up; SHR, sub-distributional hazards ratio. Bold text indicates  $P < 0.05$ .