Pediatric HIV Care Cascade in Southern Mozambique: missed opportunities for early ART and re-engagement in care.

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Abstract

Introduction: There were 170,000 children living with HIV in 2017 in Mozambique. Scaling-up HIV care requires effective retention along the cascade. We sought to evaluate the cascade in HIV care in children enrolled at the Manhiça District Hospital.

Methods: A prospective cohort of children <15 years was followed from enrollment in HIV care (January 2013-December 2015) until December 2016. Loss to follow up (LTFU) was defined as not attending the regular HIV hospital visits for ≥90 days following last visit attended.

Results: From the 438 children included (median age at enrollment in care of 3,6 (IQR:1.1-8.6) years), 335 (76%) were ART eligible and among those, 263 (78%) started at enrollment in HIV care. A total of 362 children initiated ART during the study period. Among those who started ART, the LTFU at 12, 24 and 36 months after ART initiation was 30%, 38%, and 40%, respectively. Median time to first LTFU episode was 5.8 (IQR:1.4-12.7) months. Children aged 5-9 years had an Subhazard Ratio of 0.24 (95%CI 0.12; 0.47) for LTFU compared to children <1 year of age. Re-engagement in care (RIC) was observed in 25% of the LTFU children.

Conclusions: Early infant diagnosis and frequent testing in HIV negative breastfeeding women could accelerate access to ART for children. Once on ART, attention must be given to the youngest children in the first six months after ART initiation in order to prevent LTFU. Additionally, elucidating the factors associated with RIC could help to fine-tune interventions which promote RIC in LTFU patients.

1 There are 2.1 million Mozambicans living with HIV and 170,000 of them are children under

2 15 years of age(1).

3 The cascade in HIV care describes the sequential stages of medical attention that people living

4 with HIV experience between diagnosis and achieving sustained viral suppression(2). The

5 WHO has adopted the UNAIDS 95-95-95 targets to reach 95% of people living with HIV

6 diagnosed; 95% of diagnosed initiating antiretroviral therapy (ART); and 95% on ART with

7 viral load suppression in order to end the AIDS epidemic by 2030(3). The pediatric HIV care

8 cascade has not been studied well and the available reports on the quality of pediatric HIV care

9 have documented high rates of loss to follow-up (LTFU) and early mortality(4–9).

10 Additionally, little is reported about the dynamics of re-engagement in care (RIC) in children

11 living with HIV who were LTFU.

12 This study aims to evaluate the HIV care cascade, factors associated with LTFU and the

13 dynamics of RIC in a cohort of children enrolled at the Manhiça District Hospital (MDH),

14 Mozambique.

15   **METHODS**

16 **Study setting**

17 The study was conducted at the MDH, a public hospital located in a semi-rural area in

18 southern Mozambique with an estimated overall HIV community prevalence in adults of 39.9%

19 [95% confidence interval (CI) 35.9-43.8%] in 2012 (10). Since 1996, the Manhiça Health

20 Research Centre has run a continuous health and demographic surveillance system (HDSS) for

21 vital events including births, deaths and migrations covering a total population of nearly

22 174,000 individuals(11). At the time of the study, children under age 18 months were diagnosed

23 with HIV infection through a DNA polymerase chain reaction (PCR) assay in the reference

24 laboratory. After age 18 months, serological testing was used for HIV diagnosis. Clinical

25 consultations were monthly but could be spaced to every two months or quarterly in children

26 with good clinical and immune response. Children ≥5 years of age were eligible for anti-

27 retroviral therapy (ART) if based on CD4+ T-lymphocyte (CD4) cell count below 350 cell/mm^3

28 or below 500 cell/mm^3, before and after May 2015 respectively, or WHO stage III-IV.

29 Universal treatment was recommended for all HIV-infected children <5 years of age(12).

30 Pharmacy pickup of ART was monthly for all children. First-line treatment was zidovudine

31 (AZT)+ lamivudine (3TC) + nevirapine (NVP) for children ≥5 years of age and <35kg and

32 tenofovir disoproxil fumarate (TDF)+3TC+efavirenz (EFV) for those ≥5 years of age and

33 ≥35kg. Children under 5 years who had previously received prophylaxis for prevention of

34 mother-to-child transmission (PMTC) were given AZT+3TC+lopinavir/ritonavir (LPVr) and

35 those who had not received prophylaxis for PMTC were given AZT+3TC+NVP according to

36 national guidelines (12,13).

37 **Study design and procedures**

38 This is a descriptive study of a prospective cohort including all children < 15 years newly

39 enrolled in HIV care at the MDH between January 2013 and December 2015. Children

40 transferred to MDH from another health facility were excluded from this analysis. Patients

41 were followed-up from their date of the enrollment in care through to December 2016, for a

42 maximum study period of four years.

43 Information about the frequency of clinical consultations, ART pharmacy pick-up and referrals

44 was extracted from the routinely collected data in the electronic MDH HIV pediatric database.

45 Mortality and sociodemographic data was extracted from HDSS database. Clinical information

46 was collected in a specific questionnaire in electronic format in Open Data Kit software 1.4

47 (14) during the clinical visits and uploaded into a database in Research Electronic Data Capture

48 Software 5.7.3 (14).

49 **Study definitions**

50 Care cascade indicators included proportion of children eligible for ART at enrollment in care,

51 proportion of children initiating ART during the first three months after enrollment in care

52 among those eligible, and proportion of children retained in HIV care at 12 months post-ART

53 initiation.

54 Enrollment in care was defined as having a first clinical consultation in the HIV clinic.

55 LTFU was defined for children on ART as not having attended their clinical consultation

56 appointment or pharmacy pickup for ≥90 days following last consultation /pharmacy visit

57 attended among patients considered alive and not transferred to another unit which implies a

58 delay of at least 60 days in ART pick-up. The date of the last attended visit was considered the

59 date of LTFU.

60 Among patients considered LTFU, RIC was defined as the date that the patient returned to

61 clinic or the pharmacy. Those participants who had RIC followed by a new LTFU episode

62 during the study period were classified as "RIC & LTFU".

63 Immunosuppression was defined as severe suppression (<15%), moderate suppression (15 to

64 <25%) and no evidence of suppression (≥25%)(15).

65 Socioeconomic status (SES) was represented by a wealth index generated by an asset-based,

66 multiple-correspondence analysis to categorize the household SES into five wealth quintiles as

67 previously described (16). The two lowest quintiles were grouped as 'low SES' and the

68 remaining three quintiles as "higher SES".

69 Z-scores for nutritional status evaluation were calculated using the WHO Child Growth

70 Standard 2006(17). Stunting was defined as height-for-age z-score (HAZ) <-2 standard

71 deviations (SD). Underweight was defined as weight-for-age z-score (WAZ) <-2SD for

72 children <10 years. Wasting was defined as weight-for-height Z-score (WHZ) <-2SD for

73 children <5 years and body mass index (BMI)-for-age Z-score (BAZ) <-2SD for children 5–19

74 years.

75 Anemia was defined as Hb≤ 8g/dl (12).

76 Health problems were self-reported by the parents/caregivers.

77 **Statistical considerations**

78 Data was analyzed using Stata statistical software version 15 (Stata Corp., College Station,

79 Texas, USA)(18).

80 Medians and interquartile ranges (IQR) were calculated to describe continuous variables and

81 categorical variables were summarized using frequencies.

82 Cumulative incidence estimation was used to describe LTFU incidence post-ART initiation

83 among children who started ART at enrollment or during follow-up, excluding those initiating

84 ART during the last 90 days of the study or those who were transferred before ART initiation.

85 Censored individuals were included in the denominator.

86 Competing-risks regression for death and migration according to the method of Fine and Gray

87 (19) was used to assess which variables were related to the first episode of LTFU. A

88 multivariable model was built performing a stepwise selection of the variables with

89 significance lower than 0.20 in the bivariable analysis.

90 **Ethics statement**

91 This study was approved by the Mozambican National Bioethics Committee and the Barcelona

92 Hospital Clinic Institutional Review Board. Written informed consent was obtained from the

93 parents/caregivers of all children.

94 **RESULTS**

95 **Baseline characteristics of the cohort at enrollment in HIV care**

96 Among 438 children enrolled in HIV care, the proportion of enrollment by year was 0.43

97 (95%CI:0.39-0.48), 0.31 (95%CI:0.27-0.36) and 0.25 (95%CI:0.22-0.30) in 2013, 2014 and

98 2015, respectively. Median age at enrollment was 3.6 (IQR:1.1-8.6) years and 209 (48%) were

99 female (Supplemental Digital Content: baseline characteristics).

100 Advanced WHO stage (III-IV) was present in 39 (9%) children but 134 (31%) did not have a

101 WHO staging at enrollment. However, when including anemia and wasting as advanced stage,

102 the number of children considered to have advanced WHO at enrollment was 106 (24%).

103 Severe immunosuppression was present in 86 (25%) of the 345 with a CD4 result and moderate

104 immunosuppression in 128 (37%). Although data on immunosuppression and WHO stage was

105 missing for 21% and 24% children respectively, only 29 (7%) were missing both. Median

106 values of WAZ, WHZ, BAZ were -1.18 (95%CI: -1.35; -1.01), -0.34 (95%CI: -0.52; -0.16) and

107 -0.27 (95%CI: -0.41; -0.14), respectively. A health problem during the month before

108 enrollment in care was reported by 71 (16%) patients, 40 (56%) of them requiring

109 hospitalization.

110 Seventy-seven (18%) of children were 10-25 years of age at enrollment in care. Among these,

111 39% and 23% presented with moderate and severe immunosuppression respectively. Only one

112 (1%) reported PTV, while 44% reported not receiving PTV and 55% were unknown.

113 **Twelve -month pediatric HIV Care Cascade post-ART initiation.**

114   Of 335 (76%) enrolled children who were ART eligible, 263 (78%) started ART within 3

115   months of enrollment in care (Figure 1), with a median time between enrollment and ART

116   initiation of 17 (IQR 6-35) days.

117   At 12 months post-ART initiation, 165 (63%) of the 263 children who initiated ART had been

118   continuously retained in care (Figure 1), while 51(20%) presented at least one LTFU episode,

119   10 (4%) had died, and 35 (13%) had transferred to another facility. No differences in mortality

120   at 12 months post-ART initiation were observed by age group (p =0.268).

121   Among the 66 not eligible and the 37 with missing data for ART eligibility at enrollment, 58

122   (56%) became eligible during the 12-month follow-up period and all of them initiated ART.

123   **Incidence of LTFU over 36 months following ART initiation.**

124   We then assessed LTFU in children who initiated ART at any time prior to the last 90 days of

125   the study period. This population of 362 children included the 263 who initiated ART within 3

126   months of enrollment, 44 who initiated ART later and 55 children who become eligible and

127   initiated ART in the above specified time period.

128

129   Figure 2 shows the cumulative incidence of LTFU from ART initiation until the end of the

130   study period, among the 362 children who initiated ART. The median time of follow-up from

131   ART initiation to the end of the study period (December 31, 2016) was 32.6 (IQR:20.8-39.9)

132   months.

133   At 12, 24 and 36 months post-ART initiation, of the 362 children having initiated ART, there

134   were a total of 107 children [30% (95%CI:25-35)], 136 children [38% (95%CI:33-43)] and 146

135   children [40% (95%CI:35-46)] respectively, with at least one LTFU episode. The LTFU

136   incidence rate was 41 (95%CI:34,50), 34 (95%CI:29,41) and 31 (95%CI:27,37) per 100

137   children years at month 12, 24, and 36 respectively.

138   Among the 146 children who fulfilled the definition for an LTFU episode the median time from

139   ART initiation until the first LTFU episode was 5.8 (IQR:1.4-12.7) months.

Factors associated with first episode of LTFU post-ART initiation

141   We then assessed factors associated with first episode of LTFU post-ART initiation including

142   the 362 children who initiated ART at any time prior to the last 90 days of the study period.

143   Bivariable competing risks proportional sub-hazards regression identified younger age at ART

144   initiation (p<0.0001), unknown immunosuppression status (p=0.0007), lower/unknown SES

145   (p=0.0497) and advanced WHO stage (p=0.0837) as significantly associated with increased

146   incidence of LTFU (Table 1).

147   In the multivariable model, younger age at ART initiation and unknown immunosuppression

148   status were the independent factors associated with LTFU. Children aged 5-9 years had an

149   adjusted sub-hazard ratio (aSHR) of 0.36 (95%CI:0.20;0.61) for LTFU compared to children

150   <1year of age p<0.0001 (Table 1). Those with unknown immunosuppression status (no CD4

151   results) had an aSHR of 2.50 (95%CI: 1.56; 4.01) compared to those with no

152   immunosuppression even after adjustment for WHO stage. Those with moderate or severe

153   immunosuppression showed a trend for higher LTFU but did not reach significance. At 2 years

154   post ART initiation, children aged 5-15 years of age at ART initiation had a 34% risk of LTFU

155   whereas children aged < 1 year at ART initiation had close to a 62% risk of LTFU (Figure 2b).

Re-engagement in care after a LTFU episode

157   We then assessed the dynamics of RIC among the 146 children who had a LTFU episode during

158   the study period. Longer median times between ART initiation and the end of the study period

159   allowed demonstration of LTFU-RIC cycles after ascertainment of child status through HDSS

160 and clinical records (p=0.0156). The overall median follow up time for the 146 children with

161 an LTFU episode was 32.4 (IQR:23.6-40.8) months.

162 By the end of the study period, of the 146 children with initial LTFU episodes recorded, 94

163 (64%) had never come back to the health unit, 5 (3%) had died after becoming LTFU, 10 (7%)

164 had migrated to another district and 37 (25%) had re-engaged. Median time to RIC was 4.6

165 (IQR:3.2-6.2) months.

166 Of those 37 children who were LTFU and RIC, 22 (60%) continued RIC at the end of the study

167 period and 15 (40%) presented another LTFU episode. Median age at ART initiation was 2.3

168 (IQR:0.5-9.5) years for those who continued RIC and 2.5 (IQR:0.7-11.0) years for those who

169 RIC and presented another LTFU episode and median follow time was 35.7 (IQR:30.4-40.8)

170 months and 39.4 (IQR:31.9-43.4) months, respectively.

171 Of the 64% of LTFU who never returned, the median age at ART initiation was 1.7 (IQR:0.9-

172 4.9) years and follow up time was 30.6 (IQR:20.5-38.7) months.

173 **DISCUSSION**

174 This analysis documents that younger age at ART initiation increases the risk for LTFU, mainly

175 occurring in the first six months post-ART initiation. Not having a CD4 result was also

176 associated with a high risk of LTFU. A follow up time of over three years allowed us to estimate

177 that one quarter of LTFU children re-engaged in care in a median time of 4.6 months after

178 LTFU.

179 A high rate of LTFU, particularly for younger children, has also been observed in pediatric

180 cohorts from Kenya, Mozambique, Rwanda and Tanzania in 2005-2011 (20). However, few

181 studies have explored mothers' reasons for LTFU which may include lack of money for

182 transportation and/or medication side effects (21). Nearly half of the children had moderate to

183 severe immunosuppression at enrollment in care. Similar levels in other pediatric cohorts from

184 Mozambique in 2013 (22) and other sub-Saharan African countries in 2004-2012 (23) suggest

185 little improvement over time. Another 20% were missing a CD4 result, which could indicate a

186 lower quality of care and it was associated with a 2.3 higher risk of LTFU as compared to non-

187 immunosuppressed children.

188 The decrease in numbers of children enrolled at the MDH between 2013 and 2014-2015 was

189 likely related to Mozambique's decentralization of HIV care to lower level health facilities,

190 since the MTCT rate remained relatively stable in Mozambique (24).

191 The high proportion of children with immunosuppression along with the elevated median age

192 at enrollment in care points toward a missed opportunity for more timely diagnosis both in

193 infants with known perinatal HIV exposure and/or in infants whose mothers acquired HIV

194 infection in pregnancy or during breastfeeding. The implementation of point-of-care infant

195 HIV diagnosis in 2017 may improve early diagnosis in infants with known perinatal HIV

196 exposure. However, HIV incidence in postpartum women in Mozambique in 2008-2011 was

197 3.20/100 women-years (95%CI:2.3;4.5) with an associated MTCT rate of 21% (95%CI:5;36)

198 (25). Similar incidence (average 4%) in pregnant and breastfeeding women have also been

199 observed in other Sub-Saharan Africa countries (26). Mozambican guidelines recommends

200 HIV testing every three months for key populations, sero-discordant couples, blood donors,

201 pregnant women and her partners (27). Reduction of time between tests as well as self-testing

202 options for lactating mothers living in areas of high HIV incidence may be promising

203 interventions to ensure that seroconversions during breastfeeding are diagnosed in a timely

204 fashion.

205 This analysis revealed that 25% of those LTFU re-engaged in care. However, this number is

206 likely to be underestimated since we did not have sufficient follow-up time for all of the LTFU

207   in the study. Additionally, further studies are needed in order to evaluate the impact that LTFU-

208   RIC cycles have on immunosuppression, nutritional status and other clinical parameters. RIC

209   has been described very little in the literature, especially in children. In a study of adults in

210   Kenya, the cumulative incidence of re-engaging in care, to either a new clinic or the original

211   clinic was 14% (95%CI:7;23%) at three months and 60% (95%CI:48;69%) at six months after

212   the most recent attended clinic appointment (28).

213   Understanding a child's LTFU-RIC cycles is fundamental to having a more global view of

214   retention, limiting LTFU and accelerating time to RIC in this vulnerable population. Assessing

215   routinely collected data could contribute to identifying factors associated with RIC and

216   designing specific interventions. However, paper-based charts, lack of unique identifiers and

217   high rates of transfer and migration complicate the task. Considering the 5.8-month median

218   time from ART initiation to the first LTFU episode in the PECA cohort, there is a window of

219   opportunity for interventions during the first 6 months in all children initiating ART both to

220   minimize LTFU and to promote timely RIC.

221   The Expanded Programme on Immunization (EPI) programs in sub-Saharan African countries

222   have a high vaccination coverage and extend to rural areas such as the Manhiça district (29).

223   A systematic review on integration of HIV testing during immunization clinic visits in SSA

224   reported over 90% acceptability by mothers (30). Such programs could also be used as a

225   platform to send reminders to mothers and children HIV counselling and visits.

226   Our study has several limitations. First, enrollment in the study happened during the first

227   consultation. The diagnosis of HIV was not made during the study and we cannot guarantee

228   the identification of false positives. However, we assume compliance with the Mozambican

229   guidelines that all children under 18 months should be diagnosed and confirmed by virological

230   methods, which minimizes the possibility of bias. Second, the high proportion of missing data

231 in CD4 and WHO stage could have resulted in underestimates of ART eligibility. Third, lack

232 of systematic active tracing of LTFU children results in some children classified as LTFU who

233 are actually silent. Incomplete identification of deaths, despite HDSS access, could also results

234 in some deaths being classified as LTFU, further contributing to overestimates of. Fourth, the

235 median of follow-up from ART initiation to the end of the study was 32 months. Censored data

236 could have affected the estimation of LTFU at 36 months post-ART initiation and proportion

237 of the RIC after LTFU.

238

239 **Conclusions**

240 The high LTFU found in this study highlights the special attention that should be given to

241 younger children during the first six months after ART initiation in order to prevent LTFU.

242 Once LTFU, only a quarter of those children return to the health unit, mostly within the first

243 months after drop out. Elucidating factors associated with RIC could help to refine

244 interventions which promote RIC.

245

Competing interests

We declare no competing interests.

Authors' contributions

Conceived and designed the study: ELV, DN, SFL, LDF. Implemented the study: LDF, SFL, TN, SM, MR, RG, EB, supervised by ELV, DN and CM. Analyzed the data: AC, ELV, OJA, AS. Wrote the paper: SFL, TN, LDF, ELV, DN. All authors contributed to refinement of the study protocol and approved the final manuscript.

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Supplemental digital content

Table: Socio-demographic and clinical characteristics of children at enrollment in care

Characteristics at enrollment in care		n (%)*
Gender	Male	229 (52%)
	Female	209 (48%)
Age in years, Median (IQR)		3.6 (IQR:1.1-8.6)
Age in years	<1	93 (21%)
	1-4	165 (38%)
	5-9	103 (24%)
	10-15	77 (18%)
Age (years) at ART initiation (n=365)		2.8 (IQR:1.3-8.1)
Year of enrollment in care	2013	190 (43%)
	2014	136 (31%)
	2015	112 (26%)
Mother and father living with the child	Both present	363 (83%)
	One or both absent	75 (17%)
Socioeconomic index (SES)	Low SES	186 (43%)
	Higher SES	180 (41%)
	Unknown	72 (16%)
WHO stage at first visit	I-II	227 (52%)
	III-IV	106 (24%)
	Unknown	105 (24%)
Immunosupression	No	131 (30%)
	Moderate	128 (29%)
	Severe	86 (20%)
	Unknown	93 (21%)
Anemia	No	264 (60%)
	Yes	54 (12%)
	Unknown	120 (27%)
HIV diagnosis method among children <18 months (n=136)	Virological	70 (52%)
	Serological	28 (20%)
	Unknown	38 (28%)
HIV diagnosis method among children ≥18 months (n=302)	Virological	12 (4%)
	Serological	208 (69%)
	Unknown	82 (27%)
Health problem during the month before enrollment in care	Yes, without hospitalization	40 (9%)
	Yes, with hospitalization	31 (7%)
	No	309 (71%)
	Unknown	55 (13%)
Stunting	No	209 (48%)
	Yes	205 (47%)
	Unknown	24 (5%)

Underweight (in children between 0 and 10yrs) (n=361)	No	252 (70%)
	Yes	93 (26%)
	Unknown	16 (4%)
Wasting	No	331 (76%)
	Yes	46 (11%)
	Unknown	61 (14%)

*Results expressed as n (%) unless otherwise specified.

N=438 unless otherwise specified.

IQR: Interquartile Range

Severe suppression was defined as CD4 percentage <15%, moderate suppression as CD4 percentage 15 to <25% and no evidence of suppression as CD4 percentage ≥25%. Stunting was defined as Height-for-age z-score (HAZ) < −2SD. Underweight was defined as Weight-for-age z-score (WAZ) < −2 SD for children <10 years. Wasting was defined as Weight-for-Height Z-score (WHZ) < −2 SD for children <5 years and body mass index (BMI)-for-Age Z-score (BAZ) < -2 SD for children 5–19 years. Anemia was defined as hemoglobin concentrations of ≤8 g/dL. Socioeconomic Index (SES) was represented by a wealth index generated by an asset-based multiple correspondence analysis to categorize the household SES into five wealth quintiles. The two lowest quintiles were grouped as 'low SES' and the remaining three quintiles as "higher SES".
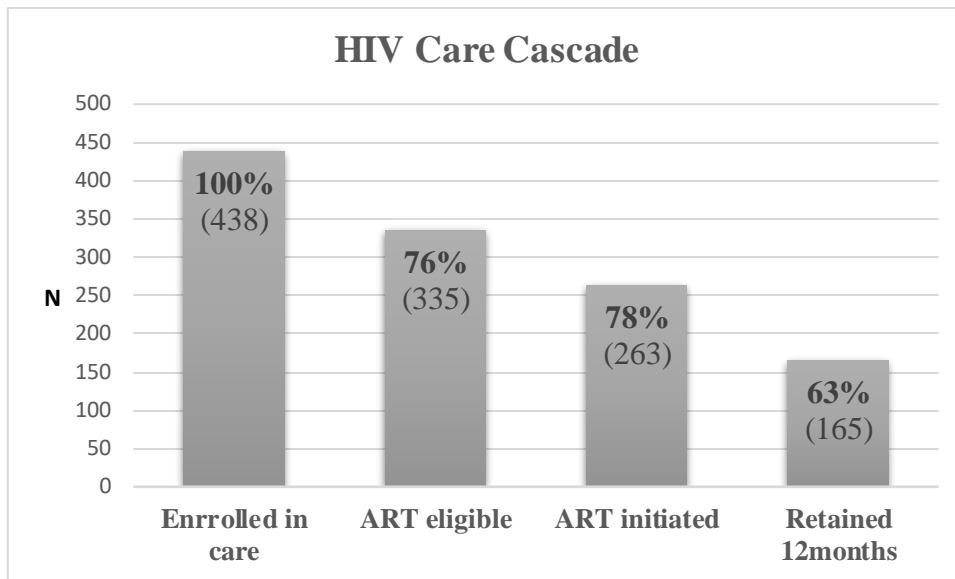
Figure 1: HIV Care Cascade from enrollment to 12-month retention conditioned on the previous step of the cascade.

The percentage in each column was calculated using as denominator the number of children in the previous column.
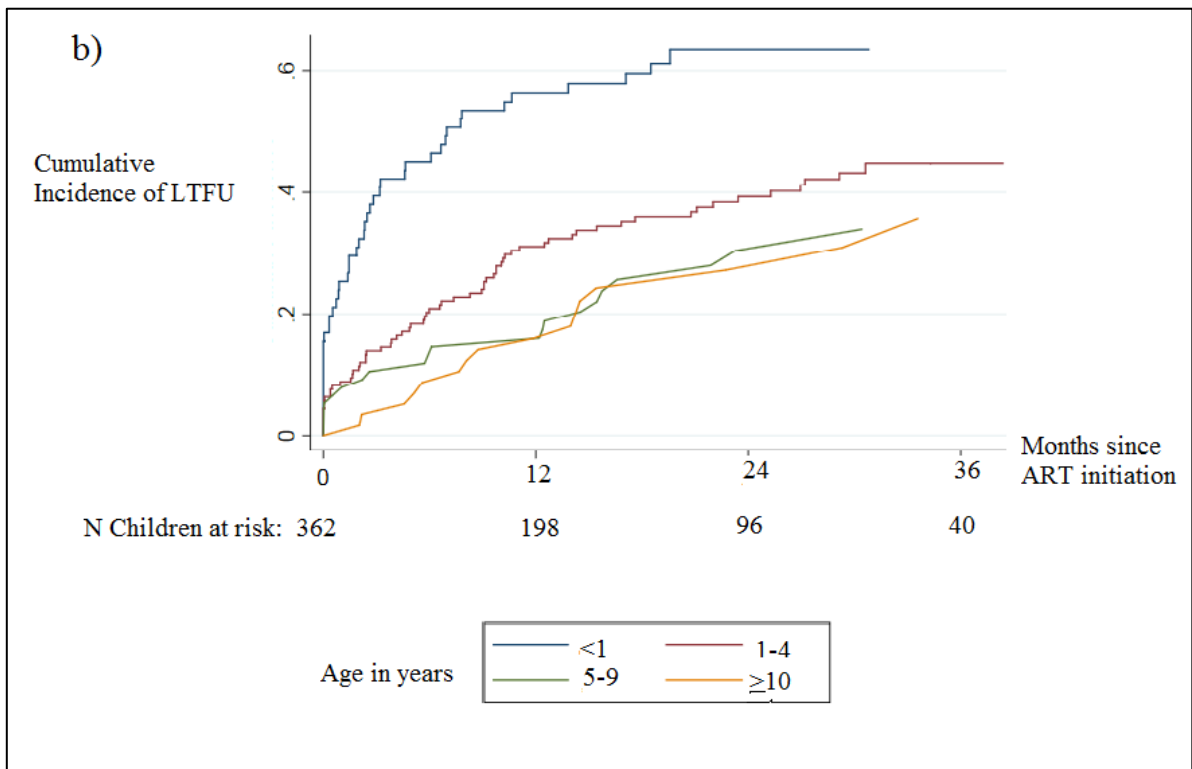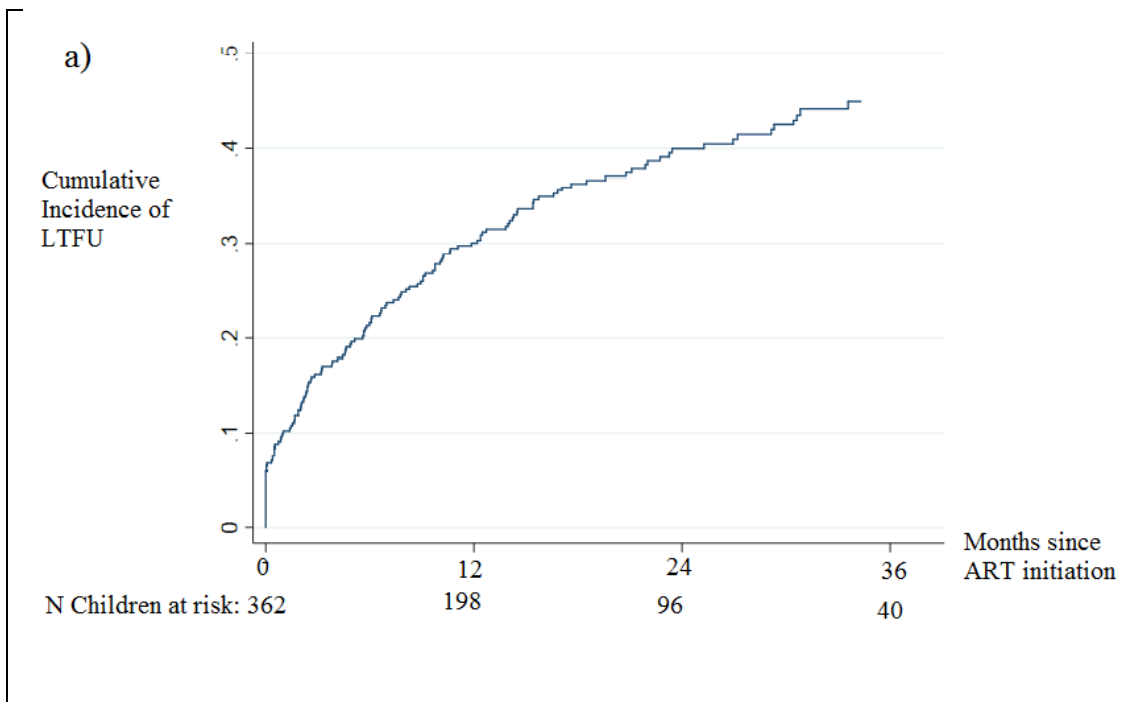
Enrolled in care: with a first clinical visit.

ART eligible at enrollment in care according to national criteria explained in methods.

ART initiated: those who initiated ART within 3 months of enrollment in care.

Retained 12months: retention 12 months after ART initiation with no episode of LTFU.

Figure 2: Cumulative Incidence of LTFU after ART initiation among children who

initiated ART at any time before the final 90 days of the study period (N=362) for the

overall population (a) and according to age group (b) Cumulative incidence is expressed
as the proportion of LTFU in a given time period. LTFU: lost to follow-up.

Table 1: Cox regression of factors associated with first episode of LTFU after ART initiation with competing-risks for death and migration.

Factors		Univariable Model			Multivariable Model*		
		SHR	(95% Conf. Interval)	p-value	SHR	(95% Conf. Interval)	p-value
Gender *(n = 362)*	male	1		0.6511	1		0.8697
	female	1.08	(0.78; 1.49)		0.97	(0.64; 1.47)	
Age at ART initiation *(n = 362)*	<1	1		< 0.0001	1		< 0.0001
	1-4	0.50	(0.33; 0.74)		0.41	(0.25; 0.68)	
	5-9	0.32	(0.19; 0.55)		0.24	(0.12; 0.47)	
	10-15	0.31	(0.18; 0.54)		0.26	(0.13; 0.53)	
Year of enrollment in care *(n = 362)*	2013	1		0.3053			
	2014	1.33	(0.92; 1.93)				
	2015	1.12	(0.73; 1.71)				
Time from enrollment in care to ART intitiation		1	(1-1)	0.046			
Mother & father status *(n = 362)*	Both present	1		0.3164			
	One or both absent	0.80	(0.51; 1.24)				
Socioeconomic index (SES) *(n = 304)*	Low SES	1		0.0839			
	Higher SES	0.72	(0.50; 1.04)				
Immunosupression *(n = 296)*	No	1		0.4609			
	Moderate	1.33	(0.84; 2.11)				
	Severe	1.22	(0.76; 1.96)				
Anemia *(n = 275)*	no	1		0.0290			
	yes	1.67	(1.05; 2.65)				

WHO stage at enrollment in care *(n = 243)*	I-II	1		0.0431	1	0.0554
	III-IV	1.70	(1.02; 2.84)		1.66	(0.99; 2.78)
Health problem during the month before enrollment in care1 *(n = 312)*	Yes	1		0.4699		
	No	0.84	(0.53; 1.34)			
Stunting *(n = 343)*	no	1		0.5108		
	yes	0.89	(0.64; 1.25)			
Wasting *(n = 309)*	no	1		0.0395		
	yes	1.67	(1.03; 2.73)			

*Number of observations = 243

SHR: Subhazal Ratio

Severe suppression was defined as CD4 percentage <15%, moderate suppression as CD4 percentage 15 to <25% and no evidence of suppression as CD4 percentage ≥25%. Stunting was defined as Height-for-age z-score (HAZ) < −2SD. Underweight was defined as Weight-for-age z-score (WAZ) < −2 SD for children <10 years. Wasting was defined as Weight-for-Height Z-score (WHZ) < −2 SD for children <5 years and body mass index (BMI)-for-Age Z-score (BAZ) < -2 SD for children 5–19 years. Anemia was defined as hemoglobin concentrations of ≤8 g/dL,

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