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Factors Affecting Retention to Care of HIV-Positive Adolescents on Antiretroviral Therapy at Kaberamaido General Hospital, Eastern Uganda: A Mixed-Methods Survival Analysis

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Research Article

Keywords: HIV, adolescents, antiretroviral therapy, retention in care, loss to follow-up, survival analysis, Uganda, Kaberamaido

Posted Date: April 22nd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9159714/v1

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Additional Declarations: No competing interests reported.

Abstract

Background: Retention in HIV care among adolescents living with HIV (ALHIV) remains a critical public health challenge in rural sub-Saharan African settings. Despite scaled-up antiretroviral therapy (ART) programmes, Ugandan adolescents continue to exhibit suboptimal retention outcomes, threatening national and global 95-95-95 targets. At Kaberamaido General Hospital in Eastern Uganda, an ART dropout rate of approximately 22% among adolescents was recorded in 2023, this required an urgent approach to understand and respond.

Methods: A mixed-methods design was employed at Kaberamaido General Hospital. Quantitatively, a systematically sampled cohort of 108 adolescents aged 10–19 years enrolled in ART was followed over a 30-month observation period. Survival analysis included Kaplan-Meier curves, life table estimation, landmark analysis, and Cox proportional hazards regression to identify independent predictors of attrition. Model fit was validated by Schoenfeld residuals and log-log survival plots. Qualitatively, 15 semi-structured in-depth interviews (IDIs) and focus group discussions (FGDs) were conducted with adolescents, caregivers, peer supporters, and healthcare providers. Transcripts were analyzed thematically using NVivo 14. Quantitative and qualitative strands were integrated in a convergent triangulation design.

Results: The overall incidence rate of attrition was 0.022 per person-month. The 12-month retention probability of 0.81 fell below the national target of 90%, and only 50% of the cohort remained in care at 30 months. Landmark analysis demonstrated that attrition hazard was disproportionately concentrated within the first 12 months of treatment. Five independent predictors were identified: prior extended absence (adjusted hazard ratio [AHR] = 3.97, 95% CI [2.18, 7.24], $p < .001$), absence of social support (AHR = 2.89, 95% CI [1.54, 5.43], $p = .001$), geographic access barriers (AHR = 2.19, 95% CI [1.19, 4.02], $p = .011$), non-disclosure of HIV status (AHR = 1.88, 95% CI [1.04, 3.40], $p = .037$), and low adolescent-friendly service exposure (AHR = 2.11, 95% CI [1.16, 3.84], $p = .014$). Qualitative themes identified seasonal flooding, peer support erosion, faith-based treatment abandonment, community stigma, and a passive health system retention architecture as key contextual mechanisms.

Conclusions: Retention failure in this setting is driven psychosocial vulnerability, social support deficits, geographic barriers, and health system responsiveness gaps — not by demographic profile alone. Targeted interventions during the first 12 months of ART, proactive follow-up systems, mental health integration, and community-level stigma engagement are urgently required.

1. INTRODUCTION

Retention in HIV care is a foundational requirement for achieving viral suppression, preventing disease progression, and interrupting onward transmission. The Joint United Nations Programme on HIV/AIDS (UNAIDS) 95-95-95 targets stipulate that 95% of persons diagnosed with HIV should receive sustained ART and that 95% of those on ART should achieve viral suppression [1]. Adolescents aged 10–19 years represent the population group in which these targets are least likely to be achieved globally, with

consistently lower rates of adherence, higher rates of loss to follow-up, and lower viral suppression compared to adults and children [2,3].

Approximately 1.7 million adolescents were living with HIV globally in 2022, with the majority residing in sub-Saharan Africa [1]. In Eastern and Southern Africa alone, approximately 1.1 million adolescents were living with HIV, and the region contributed to nearly 50% of global AIDS-related adolescent deaths [4]. Adolescence is characterized by rapid biopsychosocial transitions — identity formation, increasing autonomy, peer orientation, and developmental neurological changes in prefrontal executive function — that collectively complicate the management of a chronic condition requiring lifelong daily medication and regular clinical contact [5]. These developmental challenges are compounded in sub-Saharan African settings by structural vulnerabilities including poverty, HIV-related stigma, geographic access barriers, and an insufficient supply of adolescent-responsive health services [6,7].

In Uganda, adolescents aged 10–19 years account for a significant proportion of the national HIV burden. The Uganda Population-based HIV Impact Assessment (UPHIA) 2020–2021 reported an HIV prevalence of 1.1% among adolescents aged 15–19, with retention in ART identified as a critical challenge [8]. The Uganda Ministry of Health (MoH) has established a national retention target of 90% at 12 months, yet programme data indicate persistent shortfalls, particularly in rural and geographically isolated districts [8,9]. Evidence-based interventions introduced nationally — including Differentiated Service Delivery (DSD) models, multi-month dispensing, and community ART groups — have improved outcomes in some settings, but their translation to rural contexts with limited infrastructure has been uneven [9].

Kaberamaido General Hospital serves a predominantly rural population in Kaberamaido District, Eastern Uganda, a setting characterized by geographic dispersion, proximity to Lake Kyoga, seasonal flooding, and limited transportation infrastructure. District Health Information Software 2 (DHIS2) records for 2023 indicated an ART dropout rate of approximately 22% among adolescents at the facility — substantially above national programme expectations and a direct threat to district-level progress toward the 95-95-95 targets [10]. Despite the introduction of adolescent-friendly service components, a persistent evidence gap existed: no locally-grounded, quantitative analysis of the specific individual, socio-cultural, and health system determinants of adolescent retention had been conducted at this facility.

This study addressed that gap. It investigated the factors affecting retention to care among HIV-positive adolescents on ART at Kaberamaido General Hospital, employing a convergent mixed-methods survival analysis design. The three specific objectives were to: (1) determine the individual factors affecting retention; (2) determine the socio-cultural factors affecting retention; and (3) determine the health system factors affecting retention. The study provides both quantified hazard estimates for modifiable predictors and rich contextual accounts of the mechanisms through which these predictors operate, generating locally-relevant evidence to guide targeted programmatic interventions.

2. METHODS

2.1 Study Design and Setting

A mixed-methods design was employed, integrating quantitative survival analysis and qualitative thematic inquiry to provide complementary levels of explanatory depth. The study was conducted at Kaberamaido General Hospital, Kaberamaido District, Eastern Uganda, a government referral hospital serving a largely rural catchment area with high proportions of subsistence farming households. The district is situated adjacent to Lake Kyoga and is characterised by seasonal flooding during the March–May long rains and October–November short rains, which periodically interrupt road access and affect healthcare utilization. The hospital operates an established ART clinic with approximately 148 adolescent patients enrolled as at the study commencement date.

2.2 Study Population and Eligibility Criteria

The quantitative study population comprised adolescents aged 10–19 years living with HIV who were enrolled in ART care at Kaberamaido General Hospital with at least six months of clinic history in the records. Exclusion criteria included critically ill adolescents with severe cognitive impairment precluding informed assent, individuals who had transferred out with documentation, and records with incomplete data on the primary outcome. The qualitative study population comprised adolescents currently enrolled in care, one previously disengaged adolescent retrieved for interview, caregivers, a peer supporter and community health worker, and healthcare providers involved in adolescent ART delivery.

2.3 Sample Size and Sampling Procedures

The quantitative sample size was calculated using the Leslie Kish formula for cross-sectional surveys, based on an estimated retention proportion of 65% from prior Ugandan studies, a 95% confidence level ($Z = 1.96$), and a 5% margin of error, yielding an initial sample of 389. Application of the Finite Population Correction Factor to the known population of 148 adolescents yielded a final required sample of $n = 108$. The final analytic sample of $n = 108$ was obtained through systematic random sampling from clinic registers. Of 250 clinical records initially screened, 129 met eligibility criteria and 108 provided consent, representing a participation rate of 83.7%.

The qualitative component employed purposive sampling to achieve maximum variation across stakeholder roles, gender, age, and treatment experience. A final sample of 15 participants was retained: seven adolescents currently on ART, one previously disengaged adolescent retrieved for interview, two caregivers, one peer supporter/community health worker, and three healthcare providers. Data saturation was assessed iteratively during analysis.

2.4 Data Collection

Quantitative data were collected using a structured questionnaire developed in English, translated into Ateso and Luo (the dominant local languages), pretested on five participants not included in the main

study, and administered electronically via Kobo Collect by trained research assistants. The instrument captured sociodemographic characteristics, self-reported adherence behaviours, psychosocial indicators (stigma, mental health symptoms, social support adequacy), disclosure status, health system utilisation variables, and reasons for missed appointments. The dependent variable, retention in care, was operationalised as continued engagement evidenced by clinic attendance records and ART prescription data. Loss to follow-up was defined as absence of more than 90 days after the last scheduled visit without documented transfer or death, consistent with Uganda MoH programme guidelines.

Qualitative data were collected through semi-structured IDIs and FGDs conducted by the principal investigator and a trained research assistant, in Ateso/Luo with English transcription. Interview guides were informed by the SEM framework and designed to allow emergence of new themes. Interviews ranged from 33 to 61 minutes in duration. All interviews were audio-recorded with participant consent and transcribed verbatim.

2.5 Data Analysis

Quantitative analysis was conducted in STATA version 18. Descriptive statistics summarized participant characteristics. Survival analysis proceeded in four stages: (1) overall cohort Kaplan-Meier survival curves and life table estimates at six-month intervals; (2) a landmark analysis using month 12 as the landmark time point to evaluate the front-loading of attrition hazard; (3) univariate Cox proportional hazards regression for each predictor; and (4) a multivariate Cox model incorporating all variables from the three study objectives simultaneously. The proportional hazards assumption was evaluated for all model covariates using Schoenfeld residuals tests and visual inspection of log-log survival plots. A four-item Adolescent-Friendly Service (AFS) composite score was constructed from summing favourable responses across four health system indicators (awareness of adolescent services, provider respectfulness, waiting time, and active follow-up received).

Qualitative data were analysed using framework thematic analysis in NVivo 14. Transcripts were coded by the principal investigator and verified by an independent coder. Emergent themes were organised deductively within the SEM framework and inductively to capture setting-specific mechanisms. Quantitative and qualitative findings were integrated in a convergent triangulation design: quantitative hazard estimates and survival trajectories were used to identify the timing and magnitude of attrition patterns, and qualitative themes were systematically examined for their ability to provide mechanistic explanation for those patterns.

2.6 Ethical Considerations

Ethical approval was obtained from the Clarke International University Research and Ethics Committee. Permission was obtained from Kaberamaido District Health Office and Kaberamaido General Hospital management. Written informed consent was obtained from all adult participants; for adolescents aged 10–17 years, parental or guardian consent was obtained alongside adolescent assent. Participant

identities were protected through anonymisation using study codes. All data were stored on password-protected devices accessible only to the research team.

3. RESULTS

3.1 Cohort Characteristics

The sample was predominantly female (56.5%, n = 61) and rural-residing (83.3%, n = 90). The mean age was 14.08 years (SD = 3.80), with 51.9% aged under 15 years. Half the sample had no formal education or primary-level education only (50.0%). The cohort contributed a combined total of 2,451 person-months of follow-up over the 30-month observation window. The overall incidence rate of attrition was 0.022 per person-month, equivalent to 2.2 disengagement events per 100 person-months (Table 1).

Table 1: *Demographic Characteristics and Person-Time Summary for the Study Cohort (N = 108)*

Variable	Category	n	%
Gender	Male	47	43.5
	Female	61	56.5
Age group	< 15 years	56	51.9
	15–19 years	52	48.1
	Mean age (SD)	14.08 (3.80)	—
Education	None/primary	54	50.0
	Secondary	23	21.3
	Tertiary	6	5.6
Residence	Rural	90	83.3
	Urban	18	16.7
Person-months	Total	2,451	—
Incidence rate	Per person-month	0.022	—

Note. Incidence rate = attrition events / person-months of follow-up.

3.2 Overall Retention and Survival Estimates

The Kaplan-Meier life table (Table 2) demonstrated progressive decline in retention across the 30-month observation period. Retention was high at 0.94 (95% CI [0.88, 0.97]) at six months, falling to 0.81 (95% CI [0.73, 0.88]) at 12 months — a value 9 percentage points below the Uganda MoH national target of 90%. Subsequent declines continued: 0.71 at 18 months (95% CI [0.62, 0.79]), 0.57 at 24 months (95% CI [0.48,

0.66]), and 0.50 at 30 months (95% CI [0.40, 0.59]). The median time to disengagement was 28.00 months (95% CI [22.5, 33.1]).

Table 2: *Kaplan-Meier Life Table: Cumulative Probability of Retention at Six-Month Intervals (N = 108)*

Time (months)	Patients at Risk	Events (n)	S(t)	95% CI Lower	95% CI Upper
0	103	0	1.00	—	—
6	103	6	0.94	0.88	0.97
12	89	14	0.81	0.73	0.88
18	78	11	0.71	0.62	0.79
24	63	15	0.57	0.48	0.66
30	54	8	0.50	0.40	0.59

Note. S(t) = Kaplan-Meier estimated probability of remaining in care at time t. Events = disengagement from care (loss to follow-up, death, or transfer-out without documentation).

The landmark analysis, restricted to the 88 participants who remained in care through the first 12 months, demonstrated that the median retention threshold was not reached across the subsequent 18-month post-landmark period: more than 50% of this subgroup remained in care at the final observation. This finding provides compelling evidence that the hazard of attrition is disproportionately concentrated within the first 12 months of ART. Adolescents who successfully complete the initial year demonstrate a markedly reduced subsequent risk of disengagement — a pattern consistent with the Initial Engagement Hypothesis described in the literature [11].

3.3 Individual Factors Affecting Retention

3.3.1 Demographic Predictors

Kaplan-Meier analyses stratified by gender revealed directional differences: female participants-maintained retention above 0.50 throughout the 30 months (final S(30) ≈ 0.55) while males fell below 0.50 at approximately 24 months (final S(30) ≈ 0.46.

Kaplan-Meier analyses stratified by age group showed that younger adolescents (9–14 years) showed higher retention (S(30) ≈ 0.58) than older adolescents (15–19 years, S(30) ≈ 0.43).

However, log-rank tests confirmed no statistically significant difference by gender ($\chi^2(1) = 0.72$, $p = .395$) or age group ($\chi^2(1) = 2.22$, $p = .136$). Univariate Cox regression similarly found no significant demographic effects (male gender: CHR = 1.27, 95% CI [0.66, 2.36], $p = .396$; older age: CHR = 0.50, $p = .139$). These null findings suggest that the dominant barriers in this setting operate with structural universality transcending demographic categories.

Variable	Category	n	Events	CHR	95% CI	p
Gender	Female (ref)	61	21	1.00	—	—
	Male	47	33	1.27	(0.66, 2.36)	.396
Age (years)	9–14 (ref)	56	24	1.00	—	—
	15–19	52	30	0.50	(0.87, 2.56)	.139

Note. CHR = Crude Hazard Ratio. 95% CI = 95% Confidence Interval. Ref = reference category. Events = disengagement from ART care.

3.3.2 Psychosocial Predictors: Stigma, Mental Health, and Disclosure

Stigma was highly prevalent: 68.5% of participants reported shame or embarrassment related to HIV status, 48.1% had experienced overt discrimination, and 58.3% acknowledged that fear of stigma directly affected their willingness to attend clinic appointments. A composite stigma score dichotomised at low (score 0–1, n = 37) versus high (score 2–3, n = 71) showed a significant association with attrition: high stigma burden more than doubled the hazard (CHR = 2.14, 95% CI [1.14, 4.02], p = .018). Fear of stigma affecting attendance (CHR = 1.87, p = .043) and experienced discrimination (CHR = 1.78, p = .047) independently predicted disengagement.

Mental health burden was substantial. Clinically significant depressive symptoms (defined as “often” or “always” experiencing sadness or depression in the preceding month) were present in 39.8% of participants and constituted the strongest psychosocial predictor of attrition (CHR = 2.31, 95% CI [1.37, 3.90], p = .002). Significant anxiety burden was similarly prevalent (36.1%) and significant (CHR = 2.08, 95% CI [1.23, 3.52], p = .006). The near-complete absence of formal mental health services at the facility level represents a critical programmatic gap given the magnitude of this burden.

Three-quarters of participants (73.1%) had disclosed their HIV status to at least one person, most commonly a healthcare provider (89.9%) or parent/guardian (86.1%); disclosure to peers was substantially lower (27.8%). The 30-month retention gap between disclosers (S(30) = 0.54) and non-disclosers (S(30) = 0.25) — a 29 percentage-point differential — was statistically significant (log-rank $\chi^2(1) = 5.84$, p = .016). Disclosure to family members was particularly protective (CHR = 2.41, 95% CI [1.37, 4.24], p = .002), consistent with family-level social support activation enabling caregivers to facilitate transport, monitor adherence, and provide logistical continuity.

3.3.3 Self-Reported Adherence Behaviour

Nearly two-thirds of participants (63.0%) reported having missed at least one scheduled clinic appointment; 36.1% reported going more than three consecutive months without clinic contact in the preceding year — the operational definition for loss to follow-up under Uganda MoH guidelines. Cross-tabulation of self-reported extended absence (Q33) against chart-based attrition confirmed substantial

concordance (Cohen's κ = 0.64): 76.9% of self-reported extended absentees were confirmed as lost to follow-up or attrited in clinical records. This validates Q33 as a simple, low-cost clinical screening instrument.

Prior extended absence was the single strongest individual predictor identified in the study: CHR = 4.81, 95% CI [2.74, 8.43], p < .001 in univariate analysis, and AHR = 3.97, 95% CI [2.18, 7.24], p < .001 in the adjusted model. A clear dose-response gradient was evident across appointment regularity categories: participants who never attended on time carried an eight-fold crude hazard of attrition (CHR = 8.72, 95% CI [2.98, 25.53], p < .001) compared to those who always attended on time.

Table 3.*Multivariate Cox Proportional Hazards Regression: Independent Predictors of Attrition from ART Care (N = 108)*

Variable (Category vs Reference)	CHR	AHR	95% CI	p-value	Sig.
Prior extended absence (Yes vs No)	4.81	3.97	[2.18, 7.24]	< .001	***
Absence of social support (None vs Any)	3.41	2.89	[1.54, 5.43]	.001	**
Geographic barrier (Yes vs No)	2.74	2.19	[1.19, 4.02]	.011	*
Low AFS score (Low vs High)	2.53	2.11	[1.16, 3.84]	.014	*
Non-disclosure (No vs Yes)	2.18	1.88	[1.04, 3.40]	.037	*
High composite stigma (High vs Low)	2.14	1.91	[0.99, 3.69]	.054	†
Gender (Male vs Female)	1.27	1.32	[0.65, 2.67]	.438	ns
Age (15–19 vs < 15)	0.96	1.21	[0.42, 3.44]	.722	ns
DSD model (FBIM vs FBGM)	1.28	1.30	[0.66, 2.57]	.450	ns

Note. CHR = Crude Hazard Ratio. AHR = Adjusted Hazard Ratio. AFS = Adolescent-Friendly Service composite score. DSD = Differentiated Service Delivery. FBIM = Facility-Based Individual Management. FBGM = Facility-Based Group Model. *** p < .001; ** p < .01; * p < .05; † borderline significant; ns = not significant.

3.4 Socio-Cultural Factors Affecting Retention

3.4.1 Community-Level Stigma

Cross-tabulation of stigma perception items by residential setting revealed that rural participants reported significantly higher rates of clinic-avoidance stigma (63.3% rural vs. 33.3% urban, $\chi^2(1) = 5.92$, p = .015) and experienced discrimination (52.2% rural vs. 27.8% urban, $\chi^2(1) = 4.37$, p = .037). Stigma-driven non-attendance was significantly more prevalent among older adolescents (34.6% of those aged 15–19 vs. 14.3% of those aged 9–14, $\chi^2(1) = 5.83$, p = .016), consistent with developmental theory on

heightened social identity protection in later adolescence. Citing stigma as a reason for missed appointments was independently associated with a 2.31-fold elevated crude hazard of attrition (CHR = 2.31, 95% CI [1.30, 4.11], p = .004).

3.4.2 Social Support as a Protective Factor

Family support was the most commonly endorsed adherence scaffold (68.5%), followed by phone reminders (56.5%), health worker counselling (53.7%), and peer support groups (36.1%). The social support gradient was the largest single outcome differential observed in the study: combined family and peer support was associated with 30-month retention of 0.71, compared to 0.63 for family support alone, 0.55 for peer support only, 0.38 for health system support only, and 0.17 for no consistent support — a 54 percentage-point difference across the extremes. Absence of any social support carried a 5.47-fold elevated crude hazard compared to combined support (p = .001); in the adjusted model, absence of social support retained a 2.89-fold hazard (AHR = 2.89, 95% CI [1.54, 5.43], p = .001).

3.4.3 Qualitative Findings: Faith, Community Norms, and Support Erosion

Thematic analysis produced two major socio-cultural themes. The first, the Faith–Medical Paradox, described a structured cultural and religious framework that provided public validation for ART discontinuation as an expression of spiritual commitment. Participants described pastoral authority being invoked to sanction stopping treatment, and FGD data from community leaders confirmed that ART discontinuation for faith-based healing was community-endorsed and publicly rewarded in some congregational settings, extending the challenge well beyond individual counselling.

> *"My mother said we have prayed enough and the pastor laid hands on me. He said the virus is burned by the Holy Spirit. If I keep taking the pills, it shows I don't have faith in God's power. So, I threw the bottle in the pit latrine." — Participant 02, Female, 15*

The second theme, Family Support as a Contested Resource, revealed that the quantitative construct of family support encompasses a wide qualitative spectrum, from actively protective (caregivers who attend clinic, collect medications, and provide daily reminders) to wholly absent (adolescents managing care entirely in secret to avoid disclosure consequences). A peer supporter FGD account documented the collapse of monthly home visit infrastructure following the end of donor-funded outreach during the 12–24-month period corresponding precisely to the steepest phase of quantitative attrition, providing strong mixed-methods triangulation for the interpretation that support erosion — rather than declining individual motivation — is the proximal driver of late-phase retention decline.

> *"We used to visit every adolescent at home once a month. The donor funding stopped last year. Now we have no fuel, no airtime. We want to do the work but we cannot reach them." — FGD Participant, Peer Supporter, Female, approx. 22*

3.5 Health System Factors Affecting Retention

3.5.1 Geographic Access

Geographic access barriers were the most prevalent structural factor in the study: the combined geographic barrier variable (citing long distance and/or lack of transport money as reasons for missing appointments) was reported by 49.1% of participants (n = 53), rising to 53.3% among rural participants. Seasonal analysis indicated that 64.2% of geographic barrier reports were concentrated in the March–May long rains. In the adjusted model, the combined geographic barrier remained an independent predictor of attrition (AHR = 2.19, 95% CI [1.19, 4.02], p = .011). Qualitative interviews vividly illustrated the mechanism: seasonal flooding rendered roads physically impassable, and transport costs for difficult terrain increased fourfold, creating conditions of physical impossibility rather than mere inconvenience.

> *"When the floods come, the road to the hospital becomes a river. My bicycle cannot swim. I look at my empty pill bottle and then at the water; the water is stronger than the medicine that day." — Participant 04, Male, 17*

> *"Usually, the boda-boda is 5,000 shillings. During the floods, they ask for 20,000 because the path is dangerous. I am a student; where do I find such money just to go pick up a tin of tablets?" — Participant 09, Female, 19*

3.5.2 Adolescent-Friendly Service Indicators

Table 4 summarises the distribution of the four AFS composite indicators. Less than 40% of participants were aware of adolescent-specific services at the facility (38.0%). Provider attitude was inconsistent: only 35.2% reported always respectful workers, while 16.7% reported never respectful. Waiting time exceeded one hour for 36.1% of participants. Most critically, 68.5% had never received a follow-up call or home visit from facility staff, indicating a passive rather than proactive retention architecture.

Table 4.*Distribution of Adolescent-Friendly Service Indicators and Cox Regression Results (N = 108)*

Indicator	Response	n	% (N=108)	CHR	p
Q24: Adolescent services	Yes	41	38.0	Ref	—
	No/Don't know	67	62.0	2.06	.024
Q25: Worker respectfulness	Always	38	35.2	Ref	—
	Sometimes	52	48.1	1.72	.120
	Never	18	16.7	3.14	.003
Q26: Waiting time	< 30 min	22	20.4	Ref	—
	30 min–1 hr	47	43.5	1.58	.324
	> 1 hour	39	36.1	2.47	.049
Q27: Follow-up received	Yes	34	31.5	Ref	—
	No	74	68.5	2.89	.004
AFS composite (per unit)	—	108	—	0.68	.005

Note. CHR = Crude Hazard Ratio. Ref = reference category. AFS composite per-unit CHR of 0.68 indicates a 32% reduction in attrition hazard per additional AFS component endorsed. Q24 Don’t know responses (n = 29) classified with “No” for regression.

The AFS composite score demonstrated a continuous protective effect: each additional unit of AFS exposure was associated with a 32% reduction in attrition hazard (CHR per unit = 0.68, 95% CI [0.52, 0.89], p = .005). In the adjusted model, low AFS composite score retained independent significance as a predictor of attrition (AHR = 2.11, 95% CI [1.16, 3.84], p = .014). DSD model type (FBGM vs. FBIM vs. FTDR), by contrast, was not a significant predictor in either univariate or adjusted analyses, consistent with the interpretation that it is the adolescent-responsiveness of service delivery — not the administrative model category — that drives retention outcomes.

3.5.3 The Visibility Paradox and Passive Retention Architecture

Provider qualitative accounts identified two critical health system mechanisms that questionnaire data alone could not detect. The first was the Passive Retention Architecture: with over 200 adolescent files and insufficient staff to contact every missed patient, the facility operated on a wait-and-see basis, marking non-attenders as defaulted and awaiting their voluntary return. This structural constraint directly explains the 68.5% rate of participants who had never received proactive follow-up contact.

"We do not have the staff to call every patient who misses. We have over 200 adolescent files. When someone does not come, we mark them as defaulted and wait for them to return. By the time they come back — if they come — the viral load has climbed. We know this is wrong, but we do not have a system to help us." — P13, ART Clinic Nurse, Male, 34

The second mechanism was the Visibility Paradox: the facility's dedicated Wednesday adolescent clinic, designed as an adolescent-responsive service feature, had been publicly identified by the community as "the HIV day." Rather than providing a confidential, adolescent-specific environment, the scheduled clinic day functioned as a community-level disclosure mechanism, producing a new form of structural stigma that deterred attendance. This finding has direct implications for the design of adolescent-specific services, demonstrating that without built-in confidentiality architecture, differentiated scheduling can inadvertently amplify, rather than reduce, stigma-related barriers.

"We started a Wednesday adolescent clinic two years ago. Attendance was good at first. But then families in the community noticed that Wednesday is the HIV day for young people. Some children asked to go back to the general clinic to hide among adult patients. The special day created a new stigma." — P14, Adherence Counsellor, Female, 29

4. Discussion

4.1 Overall Retention and the Front-Loading of Attrition Risk

The 12-month retention probability of 0.81 falls 9 percentage points below the Uganda MoH national target of 90% and is consistent with retention deficits documented in comparable rural Ugandan settings [12,13]. The 30-month retention of 0.50 is substantially below the 24-month rates above 85% reported from urban Kampala-based facilities [14], but the gap is not attributable to demographic profile — gender and age were non-significant in both univariate and multivariate analyses — but to the cumulative burden of geographic, psychosocial, and systemic barriers specific to the rural Kaberamaido context. This finding adds to a growing literature demonstrating that demographic characteristics are unreliable proxies for retention risk in settings where structural barriers are pervasive [2,3].

The landmark analysis provides the most programmatically actionable finding of the study. By demonstrating that the hazard of attrition is overwhelmingly concentrated within the first 12 months — adolescents who survive the initial year face a markedly lower subsequent risk — the data establish a clear intervention window. This finding is consistent with the Initial Engagement Hypothesis proposed by Holmes et al. (2022) [11], describing the first year as a combined psychological adjustment and logistical learning period. Nachega et al. (2018) [15] similarly reported that treatment fatigue erodes motivation once acute immunological benefits become less tangible, a process that accelerates between months 12 and 24 when the Kaplan-Meier curve shows its steepest decline. The qualitative data identify the dissolution of donor-funded peer support infrastructure during precisely this period as the proximal mechanism, providing strong mixed-methods triangulation.

4.2 Individual Factors

The absence of significant gender and age effects contrasts with regional literature. Enane et al. (2021) [2] reported higher loss-to-follow-up risk among male adolescents in Western Kenya due to masculine identity barriers to clinical engagement. The absence of this effect in Kaberamaido is most plausibly explained by the structural universality of the dominant barriers in this setting: flooding, transport cost, and stigma operate with equal force across gender categories, masking any underlying demographic differentials.

The psychosocial findings are the most clinically urgent in the study. Clinically significant depressive symptoms were present in 39.8% of participants — in a cohort with a mean age of 14.08 years — and constituted the strongest psychosocial predictor of attrition (CHR = 2.31). This prevalence and effect size align with Pantelic et al.'s (2019) systematic review [16], demonstrating that internalized stigma and depressive symptomatology are the two psychosocial constructs most robustly associated with suboptimal ART adherence across sub-Saharan African adolescent populations. The near-total absence of mental health integration within the ART clinic represents a critical evidence-to-practice gap that must be prioritised.

The disclosure findings extend Weiss et al.'s (2019) social support activation model [17], which posits that family-level disclosure enables caregivers to provide logistical continuity for ART engagement. The qualitative data operationalised this mechanism with precision: a 16-year-old male participant described stopping medication entirely when he ran out because he could not explain to his uninformed family why he needed hospital visits. The 29 percentage-point gap in 30-month retention between disclosers and non-disclosers quantifies the survival significance of this mechanism.

Prior extended absence as the single strongest predictor across all domains (AHR = 3.97) has immediate clinical utility. The validation of Q33 against chart-based attrition (Cohen's $\kappa = 0.64$) demonstrates that this single questionnaire item correctly identifies 77% of patients who will subsequently be lost to follow-up, providing a simple, low-cost screening instrument compatible with the Proactive Surveillance approach recommended by WHO (2021) [18] for adolescent ART programmes in resource-limited settings.

4.3 Socio-Cultural Factors

Community-level stigma in this setting is consistent with Stangl et al.'s (2019) concept of structural stigma [19]: in closely-knit rural communities with limited opportunities for anonymous care-seeking, HIV clinic attendance carries a high and visible social cost. The FGD data revealed a community-wide surveillance norm in which Wednesday clinic attendance was universally recognised as an HIV marker — a structural stigma mechanism that individual counselling approaches cannot dismantle.

The 54 percentage-point gap in 30-month retention between adolescents with combined family and peer support and those with no support is the largest single outcome differential in the study and constitutes the most compelling empirical argument for community-embedded retention programming in the literature from this setting. The peer supporter FGD account, documenting the collapse of monthly home

visit infrastructure following the end of donor funding during precisely the 12–24-month period of maximum attrition risk, provides a causal narrative that connects programme-level funding decisions to individual-level outcomes. This finding has direct implications for the sustainability architecture of adolescent HIV support programmes: building community support functions into permanent health system infrastructure, rather than short-cycle donor-funded projects, is essential.

The Faith–Medical Paradox findings align with Moshabela et al.'s (2017) Hierarchy of Healing framework [20], describing rural African health-seeking as an oscillation between biomedical, traditional, and faith-based systems. The FGD data added a critical new dimension: in some Kaberamaido congregational settings, ART discontinuation for faith-based healing is not merely privately chosen but publicly applauded, transforming the challenge from individual compliance to community norm. This elevates the response required from pastoral counselling to structured faith community engagement, consistent with evidence-based approaches implemented in East Africa [21].

4.4 Health System Factors

The non-significant association between DSD model type and attrition risk replicates findings from Zakumumpa et al. (2020) [22], who demonstrated that DSD model effectiveness is heavily conditioned by implementation fidelity and contextual adaptation. The AFS composite score — measuring the quality of adolescent-responsive delivery within any model — was a significant independent predictor (AHR = 2.11), confirming that it is what the clinic does for adolescents, not what category of model it uses, that determines retention outcomes.

The combined geographic barrier variable affected more than half the rural cohort and retained independent significance after full adjustment (AHR = 2.19), with the seasonal concentration during March–May providing a specific and actionable intervention target. The mechanism identified qualitatively — seasonal flooding converting inconvenience into physical impossibility — is consistent with findings from flood-prone Namibian districts [23]. The implication is straightforward: advance multi-month dispensing before the rainy season, timed to cover the March–May window, would directly address the most prevalent barrier in this cohort.

The Visibility Paradox identified by the adherence counsellor has important implications for the field. It directly challenges the standard WHO prescription for dedicated adolescent clinic days by demonstrating that without confidentiality architecture, adolescent-specific scheduling can inadvertently function as a community HIV disclosure mechanism, amplifying the very stigma it aims to mitigate. The finding that Q26 (waiting time > one hour) and Q18 (fear of stigma affecting attendance) compound rather than operate independently — as extended waiting constitutes prolonged involuntary public HIV disclosure — provides a mechanistic explanation for why reducing waiting time is a dual intervention: improving service quality while simultaneously reducing stigma exposure duration.

4.5 Multivariate Synthesis

The five independent predictors identified in the adjusted model — prior extended absence, absence of social support, geographic access barriers, non-disclosure, and low AFS composite score — together define a retention risk profile that is entirely modifiable. Crucially, none of these factors is demographic, structural, or immutable: all five have corresponding evidence-based interventions. The multivariate model confirms that in this cohort, retention is determined primarily by the interplay of prior engagement history, social support availability, stigma-driven access barriers, and health system responsiveness, rather than by demographic profile or DSD model type. This has a direct policy implication: interventions targeting demographic categories are unlikely to be effective; interventions targeting modifiable psychosocial, community, and health system factors are likely to be.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Retention in ART care at Kaberamaido General Hospital falls significantly short of national targets: 81% at 12 months against the 90% MoH standard, and 50% by 30 months. The landmark analysis establishes that the hazard of attrition is disproportionately concentrated within the first 12 months of treatment, providing a clear window for targeted intervention investment. Five independent predictors — prior extended absence, absence of social support, geographic access barriers, non-disclosure, and low adolescent-friendly service exposure — together explain the retention failure observed and all are modifiable. The mixed-methods design demonstrates that these predictors operate through specific, identifiable mechanisms including seasonal flooding, peer support infrastructure collapse, community stigma norms, faith-based ART discontinuation, and a passive health system retention architecture — none of which demographic-targeted or DSD-model-centric approaches alone can address.

5.2 Recommendations

5.2.1 For the Uganda Ministry of Health

Based on the evidence presented, the Ministry of Health should:

1. Establish a context-specific seasonal continuity protocol for flood-prone districts including Kaberamaido, providing advance three-month multi-dose ART dispensing from January to cover the March–May high-risk window, pre-positioned ART stock at community health worker stations within walking distance of flooded zones, and formal agreements with district CHW networks for medication relay during flooding periods.
2. Incorporate proactive follow-up — defined as at minimum one contact within 14 days of a missed appointment — as a mandatory quality indicator for all adolescent ART services, measurable through the national Health Management Information System (HMIS). Community health workers and peer supporters should be formally designated as the primary delivery mechanism with permanent air-time stipends and transport allowances, independent of donor-project infrastructure.

3. Integrate mental health screening and psychological first aid into standard adolescent ART clinic visits, given that clinically significant depressive symptoms were present in 39.8% of this cohort and constituted the strongest psychosocial predictor of attrition.

5.2.2 For Kaberamaido General Hospital Management

4. Implement a structured intensification package at the 10-month mark for all adolescent patients, comprising a dedicated extended counselling session addressing psychosocial factors, medication beliefs, disclosure challenges, and social support availability — timed to precede the period of maximum attrition risk identified in the landmark analysis.
5. Commit to a maximum waiting time of 30 minutes for adolescent appointments through dedicated scheduling slots; deliver mandatory adolescent-sensitive communication training to all ART clinic staff at least annually; and address the Visibility Paradox by redesigning adolescent clinic scheduling to incorporate confidentiality architecture that reduces inadvertent community HIV disclosure.
6. Incorporate Q33 (prior extended absence) into routine clinical consultations as a validated screening instrument for high-risk patient identification, enabling proactive re-engagement before full disengagement occurs.

5.2.3 For Community and Faith-Based Organisations

7. The district health team should develop a structured faith-community HIV integration programme in which faith leaders are trained as ART retention advocates, linking biomedical and spiritual frameworks rather than positioning them as alternatives. This approach has demonstrated efficacy in comparable East African settings and directly addresses the community-endorsed ART discontinuation documented in this study.

5.2.4 For Future Researchers

8. Future studies should collect GPS-verified distance from home to clinic with seasonal travel-time instruments, to enable formal dose-response modelling of geographic access and to test whether flooding produces a statistically distinct sub-period hazard peak in the March–May window.
9. A validated family support quality index should be developed and tested, distinguishing active-facilitation, passive-tolerance, and secret-adherence family environments, to determine whether the large hazard reduction observed for family support is concentrated in specific sub-types of involvement.

5.3 Contributions to Knowledge

This study makes three principal contributions to the empirical literature on adolescent ART retention. First, it provides the first quantified survival analysis of ART retention in a flood-prone, rural Ugandan district, introducing seasonal environmental disruption as a formally modelled and independently

significant predictor. Second, the landmark analysis demonstrates that the hazard of attrition is overwhelmingly concentrated in the first 12 months, a finding not apparent from cross-sectional studies and with direct implications for intervention timing. Third, the validation of a single self-report item (prior extended absence, Q33) as a high-concordance clinical screening instrument (Cohen's $\kappa = 0.64$) offers an immediately deployable tool for risk-stratified retention support in resource-limited settings.

5.4 Study Limitations

Several limitations should be acknowledged. Geographic access was operationalised through self-reported proxy measures rather than GPS-verified distance, which may introduce measurement imprecision. Regimen type could not be formally modelled in the primary Cox analysis due to near-homogeneous TLD distribution (87.0%); sensitivity analysis results for the non-TLD subgroup (n = 14) should be interpreted cautiously given small cell sizes. The qualitative component was limited to 15 participants at a single facility; qualitative transferability should be assessed against local contextual conditions. The caregiver sub-sample (n = 2) is small, limiting the representativeness of the caregiver perspective. Self-reported adherence data carry potential social desirability bias, though the substantial concordance with chart-based records (Cohen's $\kappa = 0.64$) suggests this was minimised by the confidentiality assurances provided.

Declarations

Ethics approval and consent to participate: Ethical approval was obtained from the Clarke International University Research and Ethics Committee. Permission was granted by Kaberamaido District Health Office and Kaberamaido General Hospital management. Informed consent and adolescent assent were obtained from all participants.

Consent for publication: All participants provided consent for anonymised data to be used in academic publication.

Availability of data and materials: The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare no competing interests.

Funding: This study was conducted as part of a Master of Public Health dissertation at Clarke International University. No external funding was received.

Authors' contributions: EA conceived the study, collected and analysed the data, and wrote the manuscript. AF supervised the study design, and critically reviewed the manuscript. RO guided the analytical plan, reviewed the manuscript and contributed to the discussion. All authors read and approved the final manuscript.

Acknowledgements: The authors are grateful to the staff and management of Kaberamaido General Hospital, the adolescent patients and caregivers who participated in the study, the research assistants, and the Clarke International University Faculty of Public Health.

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Figures

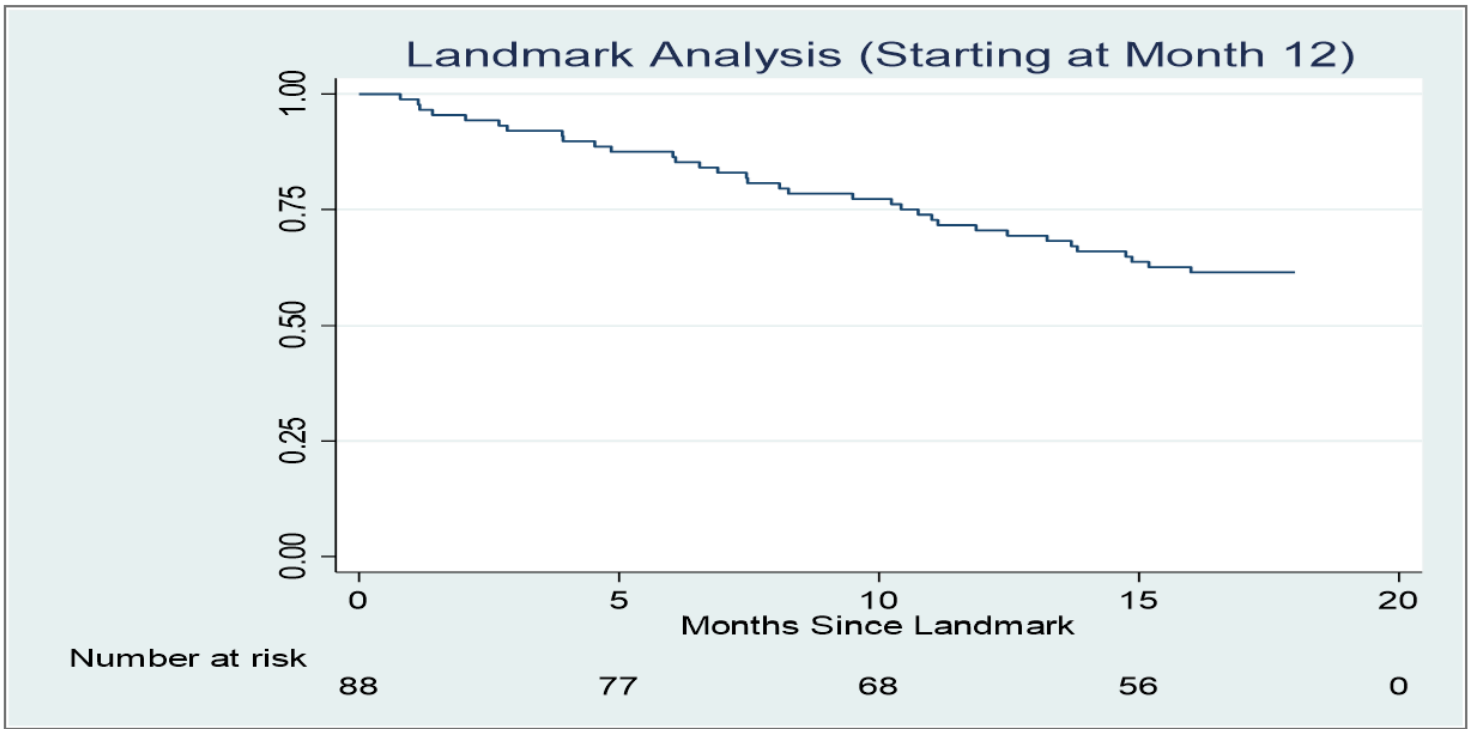


Figure 1

Landmark analysis: Probability of Retention Among Patients Retained Through 12 Months (n = 88)

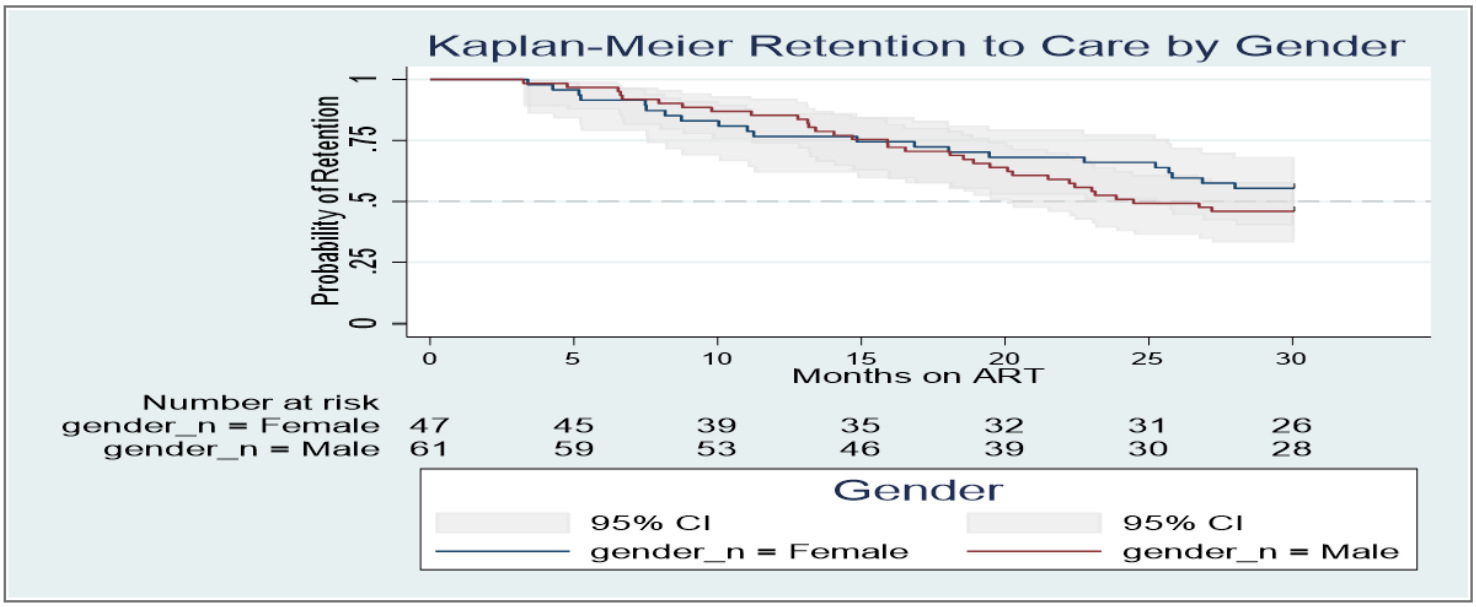


Figure 2

Kaplan-Meier analyses stratified by gender

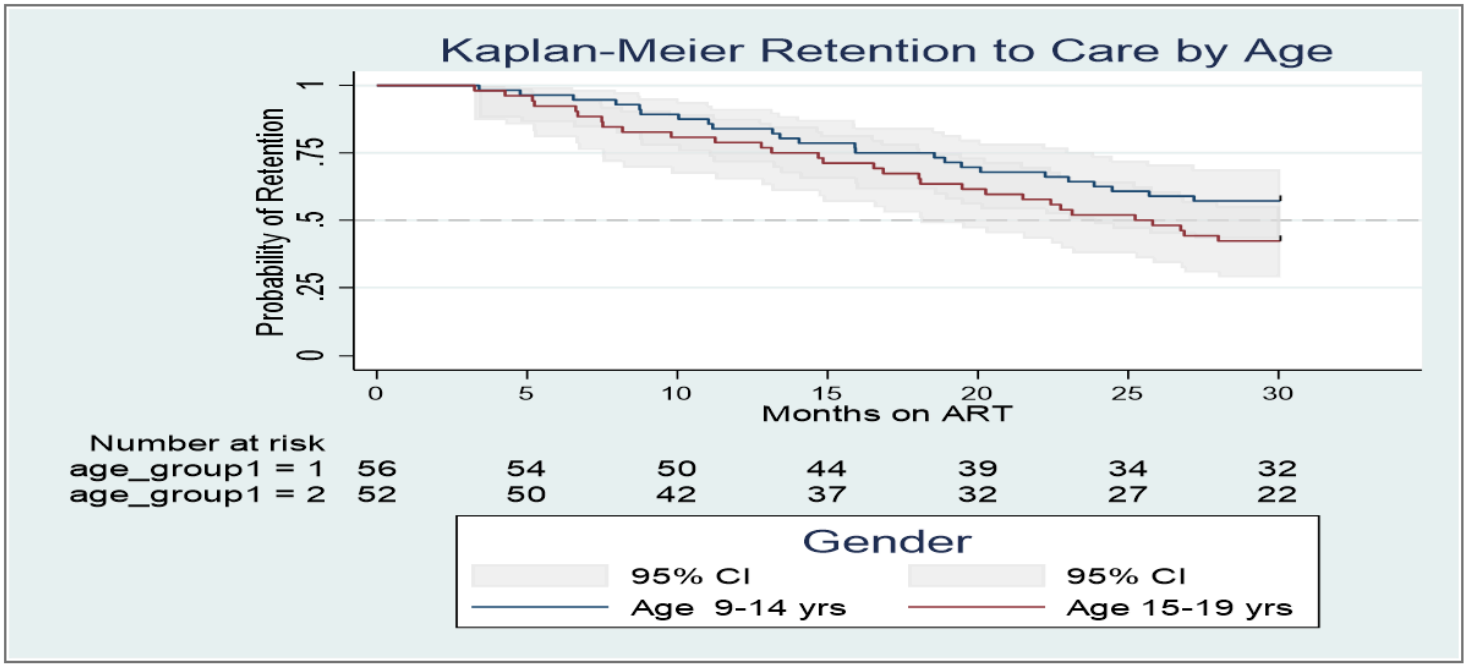


Figure 3

Kaplan-Meier analyses stratified by Age group