

Predictors of Lost to Follow Up (LTFU) among HIV Positive Patients Enrolled in 70 PEPFAR Supported Treatment Facilities in Edo, Bayelsa and Lagos States, Nigeria

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Abstract

This retrospective cross-sectional study examined demographic factors that predict Lost to Follow-up (LTFU) among HIV-positive patients on treatment based on patient-level data from 2000 to 2021 from 70 the President's Emergency Plan for AIDS Relief (PEPFAR)-supported facilities in Edo, Lagos and Bayelsa states of Nigeria. A total of 32,910 patients were identified for the descriptive analysis, although only 26,797 were included in the final model due to missing values for certain variables. Descriptive statistics describe the basic features of the data, while logistic regression identified patient characteristics at ART initiation that predicted LTFU. A stepwise forward and backward regression were used to select the variables to include in the model.

Despite improving adherence in each cohort initiated since 2005, a large proportion of patients (72%) were LTFU between 2005 and 2015. However, thereafter (2016 to 2020) Anti-Retroviral Therapy (ART)'s adherence improved with the average retrospective cumulative LTFU dropping to 27% for the period.

The predictive analysis suggests the following patient variables are significantly associated with LTFU at 95% CI: Patients initiated prior to 2018 were 57% more likely to become LTFU. HIV patients who reported post-secondary education as their highest education level were twice as likely to become LTFU in comparison to those with no education. Compared to their counterparts aged 25+, the patients' ages 0-19 and 20-24 subset are less likely to become LTFU. HIV patients who were divorced or separated were about 1.3 times more likely to be LTFU compared to their married counterparts. The tendency to be LTFU increases at WHO stage 2 and decreases as the patient's WHO clinical stage progresses from stage 3 to stage 4. Lastly, patients in Edo were 23 times more likely to become LTFU, while patients in Lagos were 4 times more likely to become LTFU compared to their Bayelsa counterparts.

Keywords: Lost to Follow up (LTFU), Anti-Retroviral Therapy (ART), LTFU Predictors, HIV/AIDS

1. Introduction and background

This operational research study was conducted under the USAID-funded Strategic HIV/AIDS Response Program (SHARP) TO2, which aimed to identify and support proven interventions for improving HIV/AIDS health service delivery and strengthening health systems with the Government of Nigeria (GoN) in Bayelsa, Edo and Lagos States. SHARP was implemented by Family Health International (FHI360) with the support of four partners: Achieving Health Nigeria Initiative (AHNi), Howard University Pharmaceutical and Continuing Education Center (HU-PACE), Abt Associates, and Khulisa Management Services. This particular study aims to determine the predictors of Lost-To-Follow Up (LTFU) among HIV positive patients enrolled in 70 selected PEPFAR-supported treatment facilities in Edo, Bayelsa and Lagos and recommendation for Nigeria HIV programs.

1.1 Problem Statement

Cuadros et al. (2013) noted that the HIV epidemic in Nigeria is complex like in other Sub-Saharan Africa countries, with substantial heterogeneity in HIV prevalence across different regions, specific high-risk groups, and diverse factors that drive the epidemic. UNAIDS (2017) estimated that of new infections in West and Central Africa in 2019, around two-thirds occurred in Nigeria. Nigeria's National Agency for the Control of AIDS (NACA 2017)

notes these statistics placed the country as having the second-largest HIV epidemic in the world after South Africa. Encouragingly, Nigeria has scaled up the antiretroviral program reaching about 90% of people living with HIV/AIDS (UNAIDS, 2020). The number of HIV-positive persons ART rose from 10,000 in 2002 to 344,789 in 2010 to 1,492,151 in 2020, mainly due to free ART services at the community and facility level. But patients in ART care still dropped out of organized treatment services – the rate at which the patients become Lost to the HIV treatment program varied by setting, but is estimated to range from 28% to 32.8% (Aliyu et al., 2019; Onoka et al. 2012).

Several studies, including Eguzo et al. (2015), demonstrate that LTFU contributes to poorer health outcomes for patients and constitutes resource wastage, as well as the promotion of HIV drug resistance. In a systematic review of 345 articles, Shiraze, Milton and Toby (2018), noted that variables such as age, location, gender, education level, occupation, employment status, marital status, religion, and or cultural belief, etc. impact retention in HIV care.

2. Methods

2.1 Study Design, Setting and Research Theoretical Framework

To effectively inform and strengthen HIV treatment and ART patient support activities, the SHARP TO2 team commissioned this study to determine predictors of LTFU among HIV positive patients enrolled in 70 PEPFAR-supported facilities in Edo, Bayelsa and Lagos.

Quantitative analysis of routine ART data (secondary data) from January 2005 to December 2021 was used for the descriptive (2005-2021) and predictive (2018-2020) analysis. This analysis allowed us to:

- 1) Understand and describe LTFU trends in Nigeria from 2005 to 2021.
- 2) Understand and describe the demographic, clinical, and other characteristics of HIV patients on ART that were LTFU either temporarily or permanently over the period of review.
- 3) Develop a predictive analytical model that would assist in the future identification of patients at risk of becoming LTFU.

A review of relevant literature on the demographics of LTFU patients was also conducted. From this review, the team extracted information that was used to support, compare and/or complement the study findings.

2.2 Data Preparation to Establish the Study Population, Sample Technique, Sample Size, and Inclusion Criteria

2.2.1 File, Data Cleaning, and Consolidation

70 zip files, representing the 70 health facilities, were extracted from the national database. In total, the Zip files contained 36,996 XML files each of which represented a patient file, although 2 Zip files were empty which were then deleted.

The 36,994 records dated back to 1979; however, the data from 1979 to 2004 had very few records, possibly because of insufficient back capturing on the database. Thus, the number of unique patient records dropped from 36,994 to 36,162.

Certain sub-sections from each patient record (“Patient demographics, Encounters, and Regimen”) were extracted as separate databases. A total of 1,251,896 HIV encounters and regimen visits (569,276 HIV encounters and 685,620 regimen visits) were found from 1979 to 2020.

All patients (36,162) had at least one record in the encounters database, although some records were dropped due a lack of records in the regimen database. In the end, a total of 32,910 patients were considered for the descriptive analysis. However, only 26,797 were included in the final model due some observations having missing values for certain predictive variables.

2.2.2 Variable Definitions

Lost to follow up (LTFU): The difference in days between the visit date and the appointment date (next appointment date from the previous visit), at the time of the record. If a patient missed their appointment date for more than 90 days (before 2018) or 28 days (from 2019), they were classified as LTFU. In this study we considered three types of LTFU:

- *Current LTFU:* This is a patient’s LTFU status at the time of the study, in line with the current definition of LTFU.
- *Retrospective cumulative LTFU:* This looks at all records of past LTFU even if the patients are currently on treatment

- *The crude LTFU*: allow us to objectively assess the rate of LTFU in a cohort of 1,000 patients enrolled each year



Dead patients: There were 326 deaths in the dataset and any appointment date after death date was not considered when defining cumulative LTFU, these patients were automatically excluded from the LTFU analysis beyond the date of their death.

Transferred in/out patients: To avoid duplicating patients that transferred in and out, we used the patient unique IDs to identify patients and link their transfers. All duplicate records were deleted.

2.3 Data Preparation and Analysis

2.3.1 Descriptive Statistics

Descriptive statistics were used to describe the basic features of the data in the study, using Stata 15. Continuous variables (e.g. age, distance from health facilities) were summarized using mean or median depending on their distribution. Frequencies and proportions were used to summarize patient characteristics measured on a categorical scale (e.g. sex). The incidence rate of LTFU in the study population was also computed.

The following was considered in the study:

- **Patients currently on schedule vs. patients currently LTFU** for their ARV treatment.
- **Retrospective LTFU patients:** patients who were LTFU in the past (even if they are currently on schedule) to describe the reasons why they were LTFU and how this was resolved.
- **LTFU age groups:** among LTFU patients, two age groups were assessed, children (0-17) years old and adult all patients 18 years of age and above.
- **Clinical/pharmaceutical descriptions:** These variables documented patient interactions with the health facility (such as clinical service visits records and pharmaceutical visit records to collect ARVs) to understand if there were any clinical/medical and pharmaceutical barriers to accessing care.
- **Common factors among LTFU:** variables/data elements in the database that could affect patient's retention to ART care, or predict patients that are at risk of becoming LTFU:
 - **Demographics:** patient age, gender, location (state), education level, occupation, and marital status.
 - **Clinical /Pharmaceutical:** patient and service information recorded at the start of ART, such as WHO clinical stage (stage 1 to 4), functional status (working, ambulant or bed ridden), ART regimen, and ART initiation year.
 - **Follow up status at the end of the month:** This included transferred in or out, dead, stopped ART (continued on other care), defaulter (not seen in last month), LTFU, and Restarted. Patients recorded as dead were not included.

2.3.2 Inferential Statistics/ Predictive Analysis

A logistic regression model was used to identify patient characteristics at ART initiation that were linked to LTFU in Edo, Bayelsa, and Lagos. A stepwise forward and backward regression with a threshold of 0.2 was used to select the variables to include in the model. Variables that were selected by both stepwise regressions were included in the model. Days between ART initiation and diagnosis were excluded by the model. The model's goodness of fit was then tested and deemed to be of good fit.

2.4 Ethical Consideration

Ethical clearance from the National Health Research Ethics Committee of Nigeria (NHREC) was received.

Patient names and personal identifying information (PII) were not used in the analysis. The use of unique identifiers (Unique ID Numbers from the dataset) was sufficient for analysis and avoiding duplicating patient records. Data was shared through secured and encrypted electronic data-sharing platforms. Data cleaning and analysis were done on password-protected computers and applications. All study team members agreed to a confidentiality agreement, i.e. not to share, disclose or use the data for any other purpose than the study.

3. Results

3.1 Study Population and Variables

3.1.1 Patient ART Initiation Trends (2005-2020)

The number of patients initiated to ART from 2004 to 2020 (Figure 1) increased annually, with the numbers accelerating in 2014. 2017 had the highest number of initiations recorded on the database (over 3,500 patients), although a drop in 2018 has largely persisted.

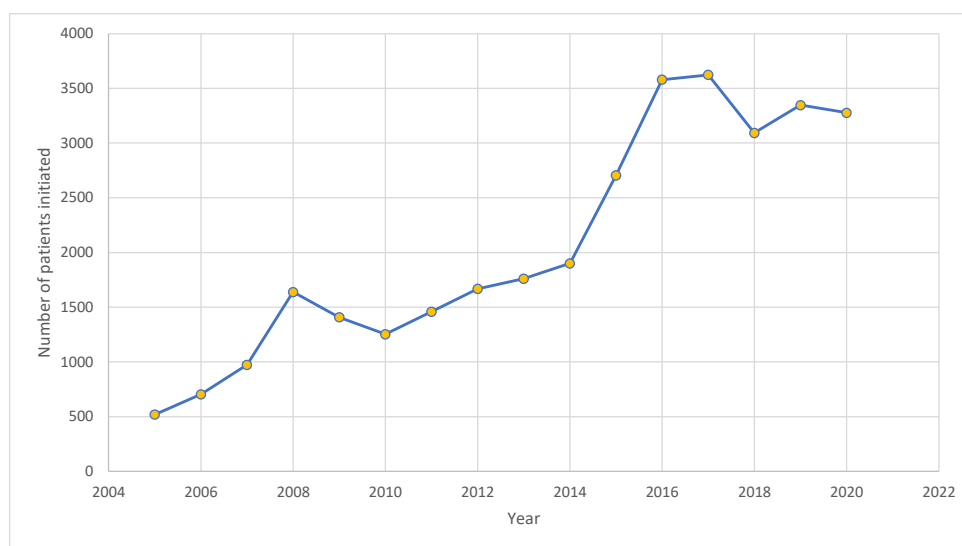


Figure 1. Trends in patients initiated to ART (2004-2020)

3.1.2 Retrospective Cumulative LTFU Trends (2005-2020)

In terms of LTFU and client retention, the database reveals improving patient adherence in each cohort of patient initiated since 2005. Before 2016, client adherence to treatment was below 30% (Figure 2), although that increased to 49% in 2015. Likewise, prior to 2015, a large proportion of patients were LTFU at least once (51% to 80%) with an average LTFU over the ten-year period of 72%. Thereafter, from 2016, the situation reversed, with patients' adherence to ART improving drastically and LTFU dropping.

Between 2016 to 2020, adherence to treatment ranged from 69% to 78%, and LTFU averaged only 27%, although 2019 saw a slight increase in LTFU (31%).

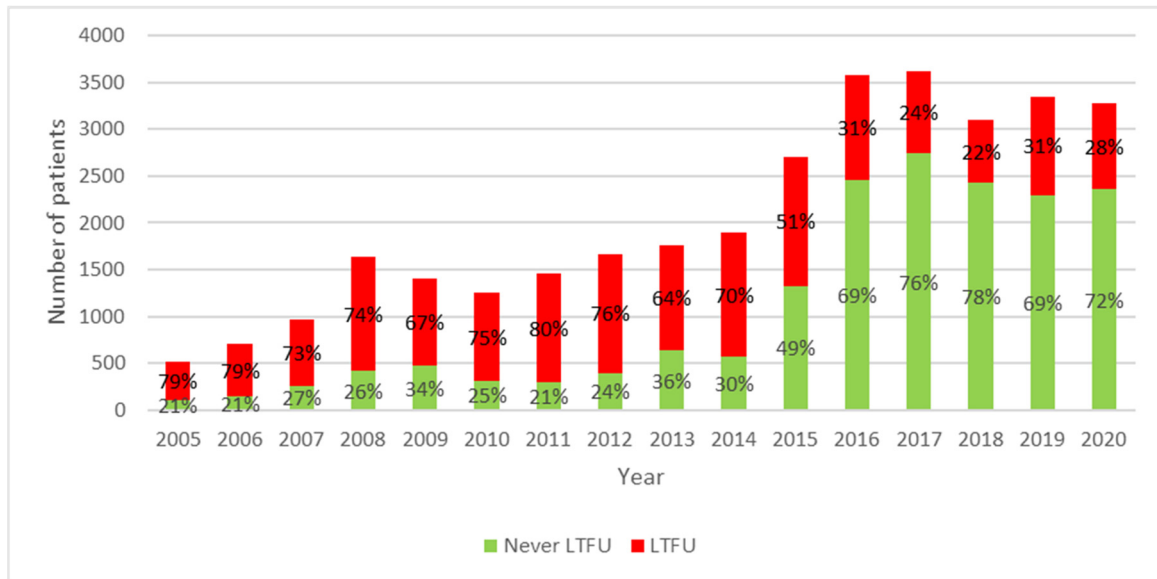


Figure 2. % LTFU vs never LTFU of total patients initiated per year (2005-2020)

3.1.3 Crude LTFU Incidence Rate Per 1,000 person-years (2005- 2021)

The crude LTFU incidence rate allows an objective assessment of LTFU in a cohort of 1,000 patients enrolled each year. Figure 3 shows a general trend of declining crude LTFU incidence, except for 2020, when the incident rate increased, most likely due to the COVID-19 pandemic, but thereafter dropped to its lowest level in 2021.

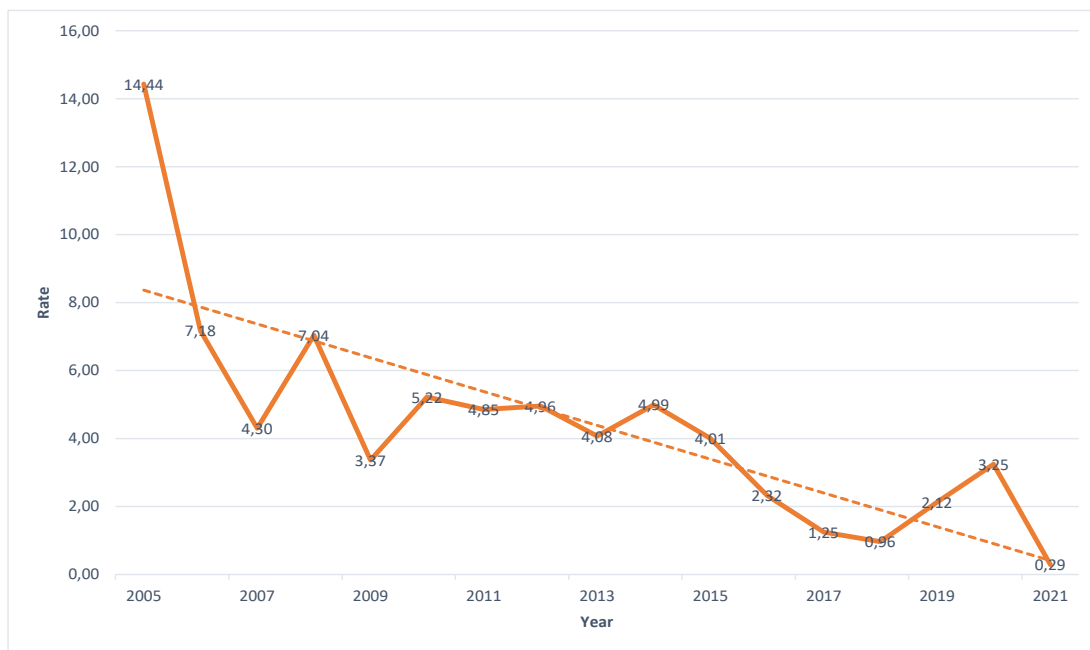


Figure 3. Crude LTFU incidence rate per 1,000 persons (2005-2021)

3.2 Predictive Analysis of LTFU Demographic Information (2018 - 2020)

We calculated odds ratios (both unadjusted and adjusted) to better understand which variables contributed to LTFU. The unadjusted OR provides insight into how strongly each variable affects patients and contributes to increasing their risk of becoming LTFU. The adjusted OR provides insight into how the combination of variables increases a patient’s risk of becoming LTFU – i.e., the model that describes all the combined factors that makes a patient likely to become LTFU.

The threshold that we considered significant is any variable that had P-value < 0.05. It is important to note that, when the P-value is significant, if the OR is less than 1 it has a protective effect on the concerned population making them less likely to produce the outcome (i.e. less likely to become LFTU).

3.2.1 Unadjusted Odds Ratios of LTFU Predictors

Table 1 shows unadjusted odd ratios for the patient's demographic and clinical characteristics that could be associated to LTFU of patients in the 70 facilities data reported from 2018 to 2020.

Table 1. Logistic Regression Table of Unadjusted Predictors of LTFU (2018-2020)

Variables	Unadjusted OR	P-value
N=26,797	OR (95% CI)	
DEMOGRAPHIC PREDICTORS OF LTFU		
Sex		
Female	Ref*	
Male	0.89 (0.58 - 1.08)	<0.001
Age Group		
0 - 9	Ref*	
10 - 19	0.83 (0.68 - 1.03)	0.085
20 - 24	0.76 (0.61 - 0.96)	0.021
25+	1.05 (0.55 - 1.24)	0.048
Education Level		
None	Ref*	
Primary	0.97 (0.87-1.10)	0.661
Quranic	0.69 (0.42-1.13)	0.139
Secondary	0.86 (0.78-0.96)	0.005
Post-Secondary	0.87 (0.78-0.97)	0.013
Occupation		
Employed	Ref*	
Student	0.85 (0.76-0.95)	0.005
Retired	0.76 (0.56-1.03)	0.074
Unemployed	0.75 (0.71-0.79)	<0.001
Marital Status		
Married	Ref*	
Single	0.84 (0.79-0.89)	<0.001
Divorced	1.75 (1.53-1.99)	<0.001
Separated	1.46 (1.23-1.74)	<0.001
Widow	1.12 (0.89-1.42)	0.336
State		
Bayelsa	Ref*	
Edo	15.88 (14.20-17.76)	<0.001
Lagos	3.72 (3.50-3.94)	<0.001

Variables	Unadjusted OR	
N=26,797	OR (95% CI)	P-value
CLINICAL AND PHARMACEUTICAL PREDICTORS OF LTFU		
Year of ART Initiation		
Before 2018	Ref*	
2018-2020	0.60 (0.57-0.63)	<0.001
WHO Clinical Stage at ART initiation		
Stage I	Ref*	
Stage II	1.01 (0.95-1.08)	0.715
Stage III	0.76 (0.72-0.81)	<0.001
Stage IV	0.47 (0.40-0.55)	<0.001

The unadjusted OR highlights the isolated variables associated with LTFU:

Demographic variables: patients' sex, age, education level, occupation, marital status and state were all associated with LTFU:

- 1) **Sex:** Out of a total population of 26,797 HIV patients (70% female and 30% male), females are slightly more likely to become LTFU.
- 2) **Age:** The risk of becoming LTFU increases with age after 24.
- 3) **Education level:** Educated patients at secondary level or higher were less likely to become LTFU. Education was protective against LTFU.
- 4) **Occupation status:** Employed persons are at higher risk of becoming LTFU compare to unemployed persons and students. Retirement showed no significance.
- 5) **Marital status:** Divorced patients were 1.8 times more likely to become LTFU and separated patients 1.5 times more likely to become LTFU – making these two subsets almost twice more likely to become LTFU compared to their married counterparts.
- 6) **States:** Patients in Edo were 15.9 times more likely to become LTFU and patients in Lagos 3.7 times more likely to become LTFU compared to their Bayelsa's counterparts.

Clinical and pharmaceutical variables: the year of ART initiation, the patient's WHO clinical stage at initiation, and the patient regimen as isolated variables were all factors associated with LTFU:

- 1) *Year of ART initiation:* Patient initiated from 2018 to 2020 were less likely to become LTFU compared to their counterparts initiated prior 2018.
- 2) *WHO clinical stage at ART initiation:* Patients initiated to ART at WHO clinical stage 3 or 4 were less likely to become LTFU, compared to those initiated in stage 1. Patients at stage 2 did not hold any significance.

3.2.2 Adjusted Odds Ratio of LTFU Predictors

Table 2 shows adjusted odd ratios for the patient's demographic and clinical characteristics that could be associated to LTFU from 2018 to 2020.

The adjusted values only include variables that showed a significant risk of patients becoming LTFU when combined with all other variables to create the predictive model.

Table 2. Logistic Regression Table of adjusted Predictors of LTFU (2018-2020)

Variables	Adjusted Odd Ratios	P-value
N=26,797	OR (95% CI)	
DEMOGRAPHIC PREDICTORS OF LTFU		
Sex		
Female	Ref*	
Male	1.01 (0.95 – 1.07)	0.781
Age Group		
0 - 9	Ref*	
10 - 19	0.61 (0.47 - 0.80)	<0.001
20 - 24	0.74 (0.55 - 0.99)	0.040
25+	0.84 (0.66 - 1.06)	0.150
Education Level		
None	Ref*	
Primary	0.86 (0.77 - 0.98)	0.018
Quranic	1.07 (0.63 - 1.83)	0.795
Secondary	0.98 (0.88 – 1.10)	0.754
Post-Secondary	1.41(1.25 – 1.59)	<0.001
Occupation		
Employed	Ref*	
Student	1.17 (1.02 – 1.33)	0.020
Retired	0.77 (0.54 - 1.12)	0.172
Unemployed	1.03 (0.97-1.10)	0.339
Marital Status		
Married	Ref*	
Single	1.02 (0.95 - 1.10)	0.525
Divorced	1.35 (1.17- 1.56)	<0.001
Separated	1.28 (1.06– 1.55)	0.010
Widow	1.27 (0.98 – 1.65)	0.076
State		
Bayelsa	Ref*	
Edo	23.40 (20.44 – 26.78)	<0.001
Lagos	3.95 (3.68 – 4.22)	<0.001
CLINICAL AND PHARMACEUTICAL PREDICTORS OF LTFU		
Year of ART Initiation		
After 2018	Ref*	
Before and during 2018	0.57 (0.53-0.61)	<0.001
WHO Clinical Stage at ART initiation		
Stage I	Ref*	
Stage II	1.08 (1.01 – 1.16)	0.032
Stage III	0.73 (0.68 - 0.78)	<0.001
Stage IV	0.71 (0.60 - 0.85)	<0.001

* Ref= Group against which other subsets are compared;

**Colour codes: Green= adjusted variable with isolated significance; All values below 0.05 are significant.

In combining variables, patients' *age, education level, occupation, marital status, state, year of initiation, and WHO's clinical-stage at ART initiation* show a significant risk of becoming LTFU, as discussed below:

- 1) **Year of initiation:** The chance of being LTFU is much higher for patients initiated before 2018. Indeed, the chance of becoming LTFU is reduced by 43% in patients initiated after 2018.
- 2) **Age:** The risk of becoming LTFU is high for very young children and those older than age 25. The 10-19 and 20-24 age groups are less likely to get LTFU compared to children between the ages 0-9, and those older than 25 years. Protection against LTFU completely disappears among those aged 25+.
- 3) **Education level:** In contrast to that seen in the unadjusted OR analysis, more advanced education is associated with a greater risk of becoming LTFU. Patients with post-secondary education were 1.5 times more likely to become LTFU compared to their non-educated counterparts. Patients with primary school education were 14% less likely to be LTFU compared to non-educated patients.
- 4) **Marital status:** Divorced and separated patients were 1.3 times more likely to become LTFU compared to their married counterparts.
- 5) **Occupation:** Students are 1.17 more likely to be LTFU compared to employed persons.
- 6) **States:** Patients getting treatment in Edo were 23 times more likely to become LTFU while patients in Lagos were 4 times more likely to become LTFU compared to their Bayelsa counterparts.
- 7) **WHO Clinical Stage at ART initiation:** While the risk of LTFU is slightly higher among those in WHO stage 2 compare to WHO stage 1 (0.8 more), this reduces with advancing WHO clinical stages – patients at WHO stage 3 and 4 are respectively 27% and 29% less likely to become LTFU compare to patients in WHO stage 1.

3.2.3 Predictors of LTFU among Adolescents 10 to 19 Years Old

The Table 3 shows adjusted odd ratios for the patient's demographic and clinical characteristics that could be associated to LTFU among adolescent patients (10-19 years old) from 2018 to 2020.

Table 3. Logistic Regression Table of adjusted Predictors of LTFU among 10 to 19 years old (2018-2020)

Variables	Adjusted Odd Ratios	
N=749	OR (95% CI)	P-value
DEMOGRAPHIC PREDICTORS OF LTFU		
Sex		
Female	Ref*	
Male	1.08 (0.78 - 1.48)	0.652
Education Level		
None	Ref*	
Primary	1.13 (0.76 - 1.67)	0.553
Quranic		
Secondary	0.51 (0.30 - 0.85)	0.010
Post-Secondary	2.34 (0.38 - 14.30)	0.356
Marital Status		
Married	Ref*	
Single	1.55 (0.66 – 3.63)	0.309
State		
Bayelsa	Ref*	
Edo	9.83 (5.37 – 17.99)	<0.001
Lagos	1.80 (1.18 – 2.73)	0.006

Variables	Adjusted Odd Ratios	
N=749	OR (95% CI)	P-value
CLINICAL AND PHARMACEUTICAL PREDICTORS OF LTFU		
Year of ART Initiation		
After 2018	Ref*	
Before and during 2018	1.14 (0.76 – 1.73)	0.552
WHO Clinical Stage at ART initiation		
Stage I	Ref*	
Stage II	0.93 (0.61 - 1.41)	0.724
Stage III	0.69 (0.46 - 1.02)	0.061
Stage IV	1.20 (0.53 – 2.69)	0.665

* Ref = Group against which other subsets are compared;

**Colour codes: Green = unadjusted variable with isolated significance; All values below 0.05 are significant.

Among adolescent patients (10-19), two variables were significant risks to leading to LTFU: **education level and the state of residence**. Adolescents with less education were more at risk of LTFU, compared to secondary school adolescents. And adolescents from Edo were 10 times more likely to become LTFU and those from Lagos were 2 times more likely to become LTFU compare to adolescents from Bayelsa.

4. Discussion

Retaining patients on antiretroviral therapy (ART) is key to achieving global targets in response to the HIV epidemic. Loss to follow-up (LTFU) can be substantial, with unknown outcomes for patients lost to ART programs.

In this study we calculated the cumulative LTFU incidence from 2005 to 2020. The findings show that:

- in 2018 the LTFU incidence was at 19%, the best record of all times since 2005, but this incidence increased to 38% in 2019 before shooting to 61% in 2020. These findings are corroborated by a study conducted by Aliyu, A et al (2019) on predictors of LTFU in ART-experienced patients in Nigeria (2004–2017) that reported a cumulative LTFU proportion of 30% in Nigeria in 2017 which is slightly higher but close compare to the 24% cumulative LTFU we found in Edo, Bayelsa and Lagos in 2017.
- While the cumulative incidence of LTFU increased from 2018 to 2020, LTFU of newly-enrolled patients for each year appears to have been well managed. During 2018, health facilities recorded the lowest LTFU among newly-initiated patients (22%), although this increased in 2019 to 31% of newly-enrolled patients, but improved slightly in 2020 to 28% despite the COVID-19 quarantine measures. This means that most LTFU in these years was among longer-standing patients, compared to newly-enrolled patients, although COVID presented general challenges to retaining all ART patients.
- While other countries also saw increasing LTFU during the 2020 COVID pandemic (Melissa Hagen et al, 2020), the Crude LTFU incidence rate (per 1,000 persons) presented in Figure 3 shows that the LTFU increased slightly in 2020, but dropped in 2021, most likely reflecting steadily improving quality of ART initiation and care services over time, including FHI360's Multidrug Dispensation supply support.

Several patient demographic and clinical factors contribute to LTFU. After adjusting for other demographic variables, the most significant predictors of LTFU amongst the 25,115 sampled HIV patients in this study were found to be:

- **Adult (25+) of age plus post-secondary education:** HIV patients who reported post-secondary education as their highest education were 2 times more likely to be LTFU when compared to those with no education. Also, patients between the ages of 25+ are more likely to be LTFU. This combination may be explained by a general sense of invincibility and decreased vulnerability among these individuals. Economic and academic pursuits may also be underlying drivers, as found by Mobolanle Balogun et al (2019) who reported that most LTFU patients in Southwest Nigeria are educated adults and the main reasons for LTFU were long distances to health facilities (56%) and feeling healthy (6.7%). Agolory SG (2017) also reported high LTFU among adults (mean age 34) in Lagos from 2004 to 2012; Paul Wekesa (2020) also reported high LTFU among adults aged 20-35 years in central Kenya. These authors suggest that adults with education are generally more aware

of HIV treatment options, and prefer personalized private drug collection services because they are afraid of being stigmatized.

- **Divorced or separated:** One of the most notable findings is that HIV patients who were either divorced or separated are about 1.3 times more likely to be LTFU compared to their married counterparts. This is in line with Paul Wekesa et al (2020) who reported a high tendency for LTFU among divorced or separated persons in central Kenya. Practically, for patients to remain in ART care, they need emotional support. Non-married patients may suffer from additional stress or insufficient family support for effective adherence to ART treatment.
- **WHO clinical stage 2:** The tendency to be LTFU increases at WHO stage 2 and decreases as the patient's WHO clinical stage progresses from stage 3 to stage 4. This is in contradiction with Paul Wekesa et al (2020) who reported that a more advanced WHO disease stage was predictive of ART LTFU in Kenya (WHO 3 and 4 were 1.94 & 4.24 times more likely to lead to LTFU compared to patients at WHO stage 1). According to our findings, WHO 2 stage patients in Nigeria should be prioritized for more effective and adequate ART treatment programs.
- **Year of ART initiation:** Those initiated prior to 2018 were 57% more likely to become LTFU. This is the result of the improvement of HIV/AIDS services which include better service delivery and access to ARVs, better patient case management, and support (patient follow-up).
- **Edo State residents:** Finally, patients initiated to ART in Edo were 23 times more likely to become LTFU while patients in Lagos were 4 times more likely to become LTFU compared to their Bayelsa counterparts. Teams from Edo and Lagos need to learn from best practices used in Bayelsa to improve their adherence's service support.

5. Conclusions and recommendations

5.1 Conclusions

Many studies have shown high variability in LTFU rate in HIV programs, due to differences in patient demographics between regions/states within the same country, between populations within the same community, between years within the same health facilities, and even due to political and health events such as war, migration, epidemics etc. as seen during the COVID-19 pandemic.

It is important for HIV programs to study the specific reasons leading to LTFU using methodologies that are adapted to the local context. For this study, we noted that patients initiated after 2018 were less likely to become LTFU compared to patients initiated before then. This suggests improving quality of care, but also a higher risk among longer-term patients compared to recently-enrolled patients. We also noted high LTFU among post-secondary educated patients, aged 25+ years, divorced or separated; and WHO clinical stage 1 and 2 patients, as well as patients who were initiated in Edo and Lagos.

5.2 Recommendations

Persons 25+ of age with a post-secondary education:

- a. Structured facility ART treatment in mainly public health services may not be appreciated by many of them; hence the need to explore and scale-up alternative ART care and treatment services delivery, such as private-sector services, targeted programs like home-based care, individualized care and community ART programs.
- b. Develop strategies to facilitate more efficient dispensation of ARVs for working young professional and students.

Divorced or separated patients and WHO clinical stage 2:

- c. Implement more targeted HIV prevention, case identification, and treatment programs for these categories of persons.
- d. Develop strategies to better support patients at WHO stage 1 and 2 to understand that adherence will prevent the disease to develop to the next stage

State specific: Teams from Edo and Lagos need to learn from the good practices in Bayelsa that allows them to have the lowest rate of LTFU

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The authors declare that there are no competing or potential conflicts of interest.

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