Favorable Impact of Community Adherence Groups on retention in care and viral suppression rates among HIV-positive, ART-treated adults in Zambézia province, Mozambique

FINAL REPORT

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Executive summary

Background

In Mozambique, patients' retention in HIV care has been a consistent challenge. Community adherence groups (CAG) was one of the initial differentiated models of care (DMC) that was introduced in Mozambique in 2011 for combination antiretroviral therapy (ART)-treated adults (≥15 years of age) meeting pre-specified criteria (e.g., being deemed clinically "stable"). The overarching objective of CAG was to improve retention and adherence of patients receiving combination antiretroviral therapy (ART), through enhanced patient involvement and the creation of a community- and group-based platform to share the responsibilities of side effect monitoring and medication pick-ups. Routine viral load monitoring was introduced on a wide scale in 2016 following the introduction of "Test-and-Start", specifically initiating all HIV-positive persons on ART regardless of immune status (CD4 cell count). This study aimed to assess the impact of the CAG model on 6-month and 12-month retention as well as viral suppression rates.

Purpose and Question

The primary objective was to evaluate the effect of CAG participation on 6-month and 12-month retention and adherence (measured by viral suppression) among patients eligible for CAG participation. The study secondarily aimed to compare sociodemographic characteristics, retention-in-care rates, viral suppression rates, and factors associated with viral suppression, between patients who enrolled in CAG versus those who did not but were eligible to do so.

Methods

A cohort study was performed among adults (≥15 years of age) who enrolled in ART services between April 2012 and October 2017 and were eligible for CAG, at 123 supported health facilities within nine districts in Zambézia province, Mozambique. Patients were followed until September 2018. Routine patient-level data were analyzed; a multivariable regression analysis was done for the primary outcomes of i) retention-in-care (defined as 6- and 12-month retention in care as defined by completing scheduled ART pick-ups following CAG eligibility), and ii) viral suppression (defined as having a plasma HIV-1 RNA / viral load <1,000 copies/mL), with Cox

regression being used to determine cumulative incidence of lost-to-follow-up (LTFU), adjusting (restricted cubic splines) for sex, TB status at time of screening, year of CAG eligibility, and age at the time of ART initiation.

Results

A total of 90,008 patients were included in the cohort analysis; 67,103 (75%) were female, 62,741 (70%) were from rural areas, and median age at CAG eligibility was 30 years (IQR 24, 37). The 6-month retention was 80% overall, 79% in the non-CAG group versus 95% in the CAG group, while 12-month retention was 72% overall, 70% in the non-CAG group versus 92% in the CAG group. The odds of being retained at 6-months was approximately 4.5-fold (adjusted Odds ratio (aOR) = 4.65 [95% CI: 4.06, 5.34], $p<0.001$) higher for patients receiving ART via CAG support compared to those that were eligible for CAG but were receiving ART without CAG support. Similarly, for 12-month retention, the odds of being retained were also approximately 4.5-fold (aOR = 4.53 [4.16, 4.94], $p<0.001$) higher for those receiving ART via CAG support compared to those that were eligible but were not receiving their ART via CAG support. The adjusted hazard ratio (aHR) for becoming LTFU was ~84% lower for persons ever joining a CAG compared to those never having been in a CAG (aHR = 0.16 [0.15, 0.17], $p<0.001$).

In terms of viral suppression, the proportion of persons being virally suppressed at one year receiving ART via CAG support was 72% compared to 70% for those persons that were eligible for CAG but were not receiving their ART via CAG support. Persons enrolled in CAG had significantly higher odds of being virally suppressed (aOR = 1.33 [1.24, 1.42], $p<0.001$).

Conclusions

Participation in community adherence groups occurs predominantly among patients residing in rural areas, and among women and patients of older age. Retention among those CAG-eligible is relatively high in Zambézia and participating in CAG increases likelihood of retention even more. The higher viral suppression rate among CAG members further highlights the benefits of this differentiated care model. As Mozambique is currently progressing towards an aggressive scale-up of three-monthly drug dispensation (3MDD) for individuals on ART, this study emphasizes the importance of the continuation of promoting CAG as an effective alternative DMC to improve ART retention and adherence, especially in rural settings of Mozambique.

Background

Mozambique is challenged by a high HIV burden, with 2.2 million people currently living with HIV (2019) (1). Zambézia province, located in the central region of the country, is one of the poorest provinces, and has one of the highest HIV prevalence rates in Mozambique with 15.1% among reproductive-aged adults (15-59 years of age) (2).

In line with the 95-95-95 goals as articulated by UNAIDS, it is desired that 95% of people living with HIV know their status, 95% of people who know their positive status are receiving combination antiretroviral therapy (ART) and 95% of people on ART have a suppressed viral load, allowing for the control of the epidemic by 2030. In an attempt to markedly improve ART coverage rates (corresponding with the 2nd 95 goal), Mozambique began implementing the "Test-and-Start" (T&S) strategy in 2016, in a phased manner (3). Various differentiated service delivery (DSD) models are being developed and implemented to improve the patients' adherence and retention in care and to decongest already over-crowded health facilities. By the end of 2019, nationwide, 40% of ART-treated patients were enrolled in a minimum of one differentiated models of care (DMC), with 9% receiving their ART via CAG support (4). The community adherence support group (CAG, "*Grupos de Apoio de Adesão Comunitária-GAAC*") strategy is one of the implemented DSD models that has proven to improve retention in care of patients on ART and was initially introduced in Zambézia province in 2011 (5–7).

The main objective of CAG is to improve the retention of patients on ART, through greater patient involvement and the creation of a community- and group-based platform to share responsibility of antiretroviral medication pick-up and promote adherence. The national strategy recommends that CAG members (3-6 members per group) are at least 15 years of age; are not pregnant or lactating (women already enrolled who become pregnant are only temporarily withdrawn); know their HIV-positive status; have been on ART (first line regimen or alternative) for at least six months; are clinically stable and without any active WHO clinical stage 3 or 4 disease; and have had regular ART pick-ups in the last three months. Patients who were lost to follow-up (LTFU) but returned to care can also be included in a group if determined to be otherwise stable and are virally suppressed or have a CD4 cell count of ≥200 copies/mL (8). Members of a CAG have clinical consultations and undergo routine clinical evaluation according to a monthly rotating system,

whereby members who do not have a scheduled clinical visit during a given month, will receive their ART from the group member who had a scheduled clinical visit that month and picked up ART for the other members of the group (9).

Regarding viral load monitoring, before the implementation of the T&S strategy, viral load (VL) tests were only indicated in analyses for patients suspected of treatment failure. In 2016, Mozambique adopted the T&S strategy (3) with a gradual expansion throughout the country. With the introduction of T&S, VL monitoring became part of routine care for all patients receiving ART for more than six months (and for pregnant or breastfeeding women who have been on ART for more than three months). As such, all patients, including patients in CAG, should receive routine VL monitoring to ascertain the efficacy of their ART and ensure that they are being optimally treated.

With published findings from Mozambique showing the benefits of CAG on retention-in-care rates (5,6), with this study, we proposed to evaluate the effect of CAG participation not only on retention in care, but also to evaluate the effect on ART adherence, as ascertained via the routine measurement of plasma HIV-1 RNA levels (viral load) once available in Zambézia province (following the implementation and scale-up of the "Test and Start" (e.g., commence ART immediately in all persons regardless of immune (CD4 cell count) status) strategy). In order to obtain data on VL suppression from routinely collected samples, we restricted this evaluation to districts within Zambézia province where the T&S strategy was already being implemented at the time of the design of this evaluation.

Evaluation Purpose and Questions

The general objective was to evaluate the effect of CAG participation on 6-month and 12-month retention and adherence (measured by viral suppression; i.e., the proportion of patients with VL values less than <1,000 copies/mL; with having a viral load >1000 copies/mL meeting the definitional threshold of treatment failure per existing national guidelines) among patients eligible for CAG participation.

Specific objectives were:

1. To identify the proportion of patients who ever enrolled and those who never enrolled in CAG but were eligible for CAG, and compare their sociodemographic characteristics;

2. To compare retention-in-care rates (6-month and 12-month) of patients ever in CAG to those of whom were never in CAG and describe factors associated with retention;

3. To compare the viral suppression rate, as per routine monitoring, among patients retained in care ever in CAG to those of patients never in CAG, and describe factors associated with viral suppression;

4. To identify the proportion of patients who are currently in CAG and those currently not in CAG and compare their sociodemographic characteristics (current meaning at end of study period, on 20th September 2018).

Evaluation Design/methods/limitations

Type of evaluation

This was a program evaluation conducted internally by a collaborative team from Friends in Global Health (FGH) and Vanderbilt University Medical Center (VUMC). The evaluation was an observational cohort study of patients on ART eligible for CAG, using patient-level data routinely collected for program monitoring.

Study population and Sampling strategy

Data from adult (≥15 years of age) patients enrolled in ART services in 123 health facilities of nine districts in Zambézia province were collected from April 1, 2012 to September 2018 and included in the analysis. Inclusion criteria were as follows: patients ≥15 years of age who enrolled in ART services between 01 April 2012 to 30 September 2017 and who were eligible for CAG. As a proxy for CAG eligibility we used a minimum of four medication pick-ups within the first

six months of enrollment in ART services (i.e., proxy for retention in care for first six months). Individuals who were registered as in a CAG but with no other group members (i.e., a group with only one member) were considered as non-CAG. No specific exclusion criteria were used.

Methods

Routinely collected patient-level data were obtained from a secondary data source, OpenMRS, which is an electronic patient tracking system database where individual patient-level data are securely stored. These data are entered into the system from paper-based patient medical records and ART pick-up forms ("FILA" or "*Ficha Individual de Levantamento de Antiretrovirais*" – Individual ART pick up form) from the health facility pharmacies. Data for analysis were extracted and transferred to a secure deidentified database. Data of VL analysis results done for routine monitoring were included in the evaluation analysis, being the first VL result collected after 2016. Prior to the T&S strategy being implemented, targeted viral load analysis was performed only if a patient had suspected therapeutic failure.

Quality assurance

Programmatic data used in this evaluation were subject to routine data verification processes conducted by trained members of FGH's Monitoring and Evaluation (M&E) team; these data were securely saved on password-protected databases stored on secure servers at district- and provincial-level offices. Trained members of the FGH and VUMC evaluation team completed the required data collection and confirmed completeness of extracted datasets.

Analysis plan

An exploratory analysis was performed using descriptive statistics, with frequency tables for categorical variables and means (standard deviation)/medians (interquartile range) for continuous variables. Univariate comparisons were performed using the Wilcoxon-Mann-Whitney test for continuous variables and categorical variables were compared via the chi-square test.

A generalized estimating equation (GEE) model with logistic link was used to determine factors associated with 6- and 12-month retention. The primary outcome was retention status, i.e., an indicator variable taking the value of 1 if the patient was retained at 6- or 12-months, and 0 otherwise. CAG membership was used as a cluster variable to account for the nesting design (nested in district, further nested in CAG group); people from the same CAG were expected to be correlated. For multivariable regression, we adjusted for sex, age, education, marital status, TB status, and district. Continuous variables were adjusted using restricted cubic splines with three knots equally spaced, relaxing linearities assumptions on the logit scale. Multiple imputation, with 20 imputation runs, were used to estimate missing values for both education and marital status. Final estimates were combined using Rubin's rule. Cox regression model with mixed-effects, adjusted for sex, TB status at time of enrollment, year of CAG eligibility, age at ART initiation, and time from eligibility, was used to estimate the hazard of being ART LTFU at the end of the study period.

Definitions used in the evaluation
- A person was defined as not-retained at 6-months if there was no scheduled ART pick-up in the interval: ([180 minus 59 days] after enrollment, 180 days after enrollment);
- A person was defined as not-retained at 12-months if there was no scheduled ART pick-up in the interval: ([365 minus 59 days] after enrollment, 365 days after enrollment);
- A person was defined as LTFU by the end of the study duration if he/she had no scheduled ART pick-up in the interval: ([Final date minus 59 days], Final date);
- Viral suppression was defined as having a viral load <1,000 copies/mL.

Remark 1: CAG membership is a dynamic and fluid variable. A person may enroll in CAG right after being eligible or even years after that. For the retention analysis, we considered a person as a CAG member if she/he was enrolled in a CAG before the 6- or 12-months retention, which is computed at 6 or 12 months after CAG eligibility. Thus, if a patient was eligible for CAG, say in January 2017, but for any reason only became a CAG member in October 2017, s/he will be considered a non-CAG member in a 6-month retention analysis, but will be considered a CAG member in a 12-month retention analysis. This is because the 6-month retention is calculated six months after eligibility date, and 12-month retention is calculated at twelve months after eligibility.

By taking this approach, we aim to minimize selection bias, in the sense that CAG and non-CAG members being compared have the same follow-up after eligibility, i.e., were adherent to treatment for the same amount of time.

Remark 2: The length of CAG membership was calculated as the time from entry into the CAG until the end of follow-up (within evaluation period).

Ethical considerations

Prior to the execution of any of the procedures for this research, approval was sought by the Zambézia Bioethics Committee for Health. This secondary data analysis is covered under the VUMC/FGH's "blanket" protocol for program evaluations entitled, "*Quality Improvement for HIV Care and Treatment in Zambézia province of the Republic of Mozambique under the President´s Emergency Plan for AIDS Relief (PEPFAR)*" (CGH HSR #: 2016-163a), which was approved by the Centers for Disease Control and Prevention in Mozambique (CDC-MZ) and by Mozambique and VUMC IRB ethics committees.

Stakeholder engagement

FGH technical teams have ongoing collaborations with key stakeholders working in the health facilities and communities in which we are supporting and engaged. The concept proposal and plan for this secondary data analysis evaluation was developed in collaboration with Provincial Health Directorate (DPS-Z) and approved by our sponsoring institution, CDC-MZ.

Deviations from Scope of Work (SOW)/protocol

There was no deviation from any SOW or protocol.

Limitations of design

The evaluation was conducted using secondary data and results interpretation depends on the completeness of the data. Multiple imputation was used to address the missing data. When CAG identification was missing, the individuals were considered as non-CAG member, and although being a small number, this could have led to an underestimation of CAG membership.

We used a proxy to determine CAG eligibility: participants should have a minimum of six months on ART, not be pregnant or lactating at the time of eligibility verification, be at least 15 years of age, and have at least four ART pick-ups in a six month period. These criteria were used as some information used in the MOH-defined criteria for eligibility were not available in the electronic database (e.g., viral load or WHO clinical staging). However, as described in the introduction, there is a more extensive list of eligibility criteria (e.g., clinical stability) and the outcomes of this analysis might be subject to a certain degree of bias.

Retention was calculated 6- or 12-months after CAG eligibility. This was, as explained in Remark 1, to minimize selection bias: participants that enrolled in any CAG only years after being eligible should be more likely to be retained than a participant from the non-CAG group (group that did not enroll in any CAG) who had just become CAG eligible. While this may lead to a reduction in the number of CAG participants, as only those who enrolled in a CAG soon after eligibility were considered for 6- and 12-months retention, all participants were followed for the same period of time, which guarantees a fairer comparison. This approach, however, assumes that a person that enrolled in any CAG is considered in a CAG for the analysis. That is, if a participant enrolled in CAG 3 months after eligibility, he/she will be considered a CAG member for the 6- and 12-month retention analysis. As a sensitivity analysis, we also re-fitted the models including only patients that were in a CAG for at least 75% of the time analysis period; i.e., to be considered for the 6-month retention analysis, patients who were only enrolled in a CAG for 45 days or less (25% of 180 days) were removed from the analysis. Similarly, patients who were CAG members for less than 90 days (25% of 365 days) were also removed from the 12-month retention analysis. Results for both analyses showed similar results and are not presented.

The evaluation was done with a CAG population of patients that were ever in CAG, however patients could have just entered or been leaving the support group during the evaluation period. For women enrolled in CAG, becoming pregnant resulted in a temporary withdrawal from the

CAG group. Finally, patients could have been transferred to another differentiated care model as other strategies had started to be implemented at the end of the study period, however, there is no formal registration in the electronic database at the time of the study.

Findings

Patient Characteristics

Data were collected for 131,089 patients who had initiated treatment for HIV between April 1, 2012 to September 30, 2017. Eligibility for CAG was defined as a minimum of four pick-ups within the first six months, resulting in the inclusion of 90,008 (68.7%) patients in the analysis.

In total, 90,008 people were eligible to enter a CAG, and 17,018 (19%) enrolled in a CAG. Among the eligible patients (n=90,008), 3,468 were identified as having no other member in the CAG (i.e., they were assigned a unique CAG code that was not matched with any other participant) and were thus considered as non-CAG and were included in this analysis among the 72,990 non-CAG individuals but who met the CAG eligibility criteria. **Table 1** below shows the characteristics of the study population, stratified by ever being a CAG member versus never having been (during the evaluation period). The median age was 30 years (interquartile range [IQR]: 24-37) years at CAG eligibility, 75% of the patients were female; the median initial CD4 cell count was 367 [IQR 213-557] cells/mm^3. Thirty percent of all patients were receiving care in Quelimane district, 70% in rural districts. For patients from rural districts, 23% participated in a CAG, while for Quelimane, this was 3% in the peri-urban (urban) and 16% in semi-urban (i.e., the more rural areas in the provincial capital district) neighborhoods.

The median time from enrollment to ART care to CAG eligibility was 243 days [IQR 180-595], 279 days [IQR 193-639] for CAG members and 237 days [IQR 180-578] for non-CAG members. For CAG members, the median time of membership was 532 days [IQR 229-804]. The median

time between two consecutive clinical visits was 42 [33-63] days for CAG members and 37 [32-61] days for non-CAG members (data not shown).

Table 1. *Patient characteristics of those who ever enrolled and those who never enrolled in CAG but eligible for CAG and compare their sociodemographic characteristics (n=90,008).*

	All	Non-CAG	CAG	p-value
	N=90008	N=72990	N=17018	
Sex				0.005
Female	67103 (74.6%)	54561 (74.8%)	12542 (73.7%)	
Male	22905 (25.4%)	18429 (25.2%)	4476 (26.3%)	
Age at eligibility, years (IQR)	30.3 [24.4;37.4]	29.6 [23.9;36.5]	32.6 [26.5;40.5]	<0.001
Age at eligibility, years (categorical)				<0.001
15-19 years	5933 (6.6%)	5312 (7.3%)	621 (3.7%)	
20-24 years	18937 (21%)	16294 (22.3%)	2643 (15.5%)	
25-49 years	59269 (65.8%)	47035 (64.4%)	12234 (71.9%)	
50+ years	5869 (6.5%)	4349 (6%)	1520 (8.9%)	
Marital Status				<0.001
Cohabitating with partner	32880 (36.5%)	27010 (37%)	5870 (34.5%)	
Married	11698 (13%)	9573 (13.1%)	2125 (12.5%)	
Separated/divorced/widowed/single	21122 (23.5%)	17228 (23.6%)	3894 (22.9%)	
Missing	24308 (27%)	19179 (26.3%)	5129 (30.1%)	
Highest education level				<0.001
None	15472 (17.2%)	11887 (16.3%)	3585 (21.1%)	
Post-secondary	14063 (15.6%)	12458 (17.1%)	1605 (9.4%)	
Primary school	38791 (43.1%)	31006 (42.5%)	7785 (45.7%)	
Missing	21682 (24.1%)	17639 (24.2%)	4043 (23.8%)	
District				0.000
Quelimane	27267 (30.3%)	24927 (34.2%)	2340 (13.8%)	
Gilé	4001 (4.5%)	2816 (3.9%)	1185 (7%)	
Ile	4755 (5.3%)	4009 (5.5%)	746 (4.4%)	
Inhassunge	5580 (6.2%)	4059 (5.6%)	1521 (8.9%)	
Maganja da Costa	10258 (11.4%)	8281 (11.3%)	1977 (11.6%)	
Mocubela	10576 (11.8%)	8366 (11.5%)	2210 (13%)	
Alto Molócuè	4063 (4.5%)	3268 (4.5%)	795 (4.7%)	
Namacurra	12470 (13.9%)	9886 (13.5%)	2584 (15.2%)	
Pebane	11038 (12.3%)	7378 (10.1%)	3660 (21.5%)	
Site location*				0.000
Rural Districts	62741 (69.7%)	48063 (65.8%)	14678 (86.2%)	
Peri-urban Quelimane	16398 (18.2%)	15837 (21.7%)	561 (3.3%)	
Semi-urban Quelimane	10869 (12.1%)	9090 (12.5%)	1779 (10.5%)	
Year of CAG eligibility				<0.001
≤ 2013	8536 (9.5%)	6792 (9.3%)	1744 (10.2%)	
2014	14083 (15.6%)	11192 (15.3%)	2891 (17%)	
2015	18600 (20.7%)	14872 (20.4%)	3728 (21.9%)	
2016	21985 (24.4%)	17921 (24.6%)	4064 (23.9%)	
≥ 2017	26804 (29.8%)	22213 (30.4%)	4591 (27.0%)	
CD4 cell count, initial (cells/mm³) (median, IQR)	367 [213;557]	368 [210;560]	365 [222;545]	0.641

	All	Left CAG during evaluation period	Remained in CAG at end of period	p-value
CD4 cell count, initial (cells/mm³), (categorical)				<0.001
<200 cells/mm³	13544 (15.0%)	10993 (15.1%)	2551 (15.0%)	
200-349 cells/mm³	14128 (15.7%)	10966 (15.0%)	3162 (18.6%)	
350-499 cells/mm³	12548 (13.9%)	9838 (13.5%)	2710 (15.9%)	
≥500 cells/mm³	18377 (20.4%)	14768 (20.2%)	3609 (21.2%)	
Missing values	31411 (34.9%)	26425 (36.2%)	4986 (29.3%)	
Body mass index (median, IQR)	20.4 [18.5;22.5]	20.5 [18.6;22.6]	20.2 [18.4;22.1]	<0.001
Tuberculosis infection status (at time of enrollment into HIV services)				<0.001
No	76706 (85.2%)	61776 (84.6%)	14930 (87.7%)	
Yes	12063 (13.4%)	10048 (13.8%)	2015 (11.8%)	
Missing	1239 (1.4%)	1166 (1.6%)	73 (0.43%)	

Peri-urban=urban health facilities in Quelimane District; semi-urban= peripheral health facilities in Quelimane District.

At the end of the evaluation period (September 2018), 3,169 patients remained CAG members out of a total of 17,018 who were ever a CAG member. No difference in gender or in immunological status was seen between those remaining in CAG and those who had left, though differences were seen in age, marital status at enrollment to HIV services and level of education (**Table 2**).

Table 2. *Characteristics of patients in CAG at the end of the period versus those who left CAG during the period of evaluation (n=17,018).*

	All	Left CAG during evaluation period	Remained in CAG at end of period	p-value
	N=17018	*N=13849*	*N=3169*	
Sex				0.858
Female	12542 (73.7%)	10211 (73.7%)	2331 (73.6%)	
Male	4476 (26.3%)	3638 (26.3%)	838 (26.4%)	
Age at eligibility ,years (median, IQR)	32.6 [26.5;40.5]	32.8 [26.7;40.7]	31.5 [25.6;39.1]	<0.001
Age at eligibility, years (categorical)				<0.001
15-19 years	621 (3.7%)	479 (3.5%)	142 (4.5%)	
20-24 years	2643 (15.5%)	2065 (14.9%)	578 (18.2%)	
25-49 years	12234 (71.9%)	10023 (72.4%)	2211 (69.8%)	
50+ years	1520 (8.9%)	1282 (9.26%)	238 (7.5%)	
Marital Status at enrolment				<0.001
Living with partner	5870 (34.5%)	4617 (33.3%)	1253 (39.5%)	
Married	2125 (12.5%)	1762 (12.7%)	363 (11.5%)	
Separated/Divorced/Widowed/Single	3894 (22.9%)	3180 (23.0%)	714 (22.5%)	
Missing	5129 (30.1%)	4290 (31.0%)	839 (26.5%)	
Highest education level at enrolment				<0.001
None	3585 (21.1%)	2972 (21.5%)	613 (19.3%)	

Primary school	1605 (9.4%)	1252 (9.0%)	353 (11.1%)	
Post-secondary	7785 (45.7%)	6334 (45.7%)	1451 (45.8%)	
Missing	4043 (23.8%)	3291 (23.8%)	752 (23.7%)	
District				<0.001
Quelimane	746 (4.4%)	597 (4.3%)	149 (4.7%)	
Gilé	1521 (8.9%)	1059 (7.7%)	462 (14.6%)	
Ile	1977 (11.6%)	1501 (10.8%)	476 (15.0%)	
Inhassunge	2210 (13.0%)	1760 (12.7%)	450 (14.2%)	
Maganja	795 (4.7%)	659 (4.8%)	136 (4.2%)	
Mocubela	2584 (15.2%)	2076 (15.0%)	508 (16.0%)	
Alto Molócuè	3660 (21.5%)	3395 (24.5%)	265 (8.4%)	
Namacurra	2340 (13.8%)	1903 (13.7%)	437 (13.8%)	
Pebane	1185 (7.0%)	899 (6.5%)	286 (9.0%)	
Sub-district				<0.001
Rural	14678 (86.2%)	11946 (86.3%)	2732 (86.2%)	
Peri-urban Quelimane	561 (3.3%)	398 (2.9%)	163 (5.1%)	
Semi-urban Quelimane	1779 (10.5%)	1505 (10.9%)	274 (8.7%)	
Year of CAG eligibility				<0.001
<= 2013	1744 (10.2%)	1228 (8.9%)	516 (16.3%)	
2014	2891 (17.0%)	2199 (15.9%)	692 (21.8%)	
2015	3728 (21.9%)	3006 (21.7%)	722 (22.8%)	
2016	4064 (23.9%)	3433 (24.8%)	631 (19.9%)	
>= 2017	4591 (27.0%)	3983 (28.8%)	608 (19.2%)	
First CD-4 cell count (median, cells/mm3)	365 [222;545]	363 [221;542]	370 [224;556]	0.354
First CD-4 cell count (cells/mm3) (categorical)				0.077
<200	2551 (15.0%)	2072 (15.0%)	479 (15.1%)	
200-349	3162 (18.6%)	2554 (18.4%)	608 (19.2%)	
350-499	2710 (15.9%)	2207 (15.9%)	503 (15.9%)	
500+	3609 (21.2%)	2898 (20.9%)	711 (22.4%)	
Missing	4986 (29.3%)	4118 (29.7%)	868 (27.4%)	
BMI at enrolment	20.2 [18.4;22.1]	20.2 [18.4;22.1]	20.2 [18.3;22.0]	0.599
Tuberculosis at enrollment				<0.001
No	14930 (87.7%)	12255 (88.5%)	2675 (84.4%)	
Yes	2015 (11.8%)	1540 (11.1%)	475 (15.0%)	
Missing	73 (0.43%)	54 (0.39%)	19 (0.60%)	

Retention – 6 months

We excluded 18,714 people who transferred out, suspended treatment or died, and those who did not have a minimum of six months of follow-up by the end of the evaluation period, resulting in a dataset of 71,294 patients. The flow chart (**Figure 1**) describes the retention at six months.
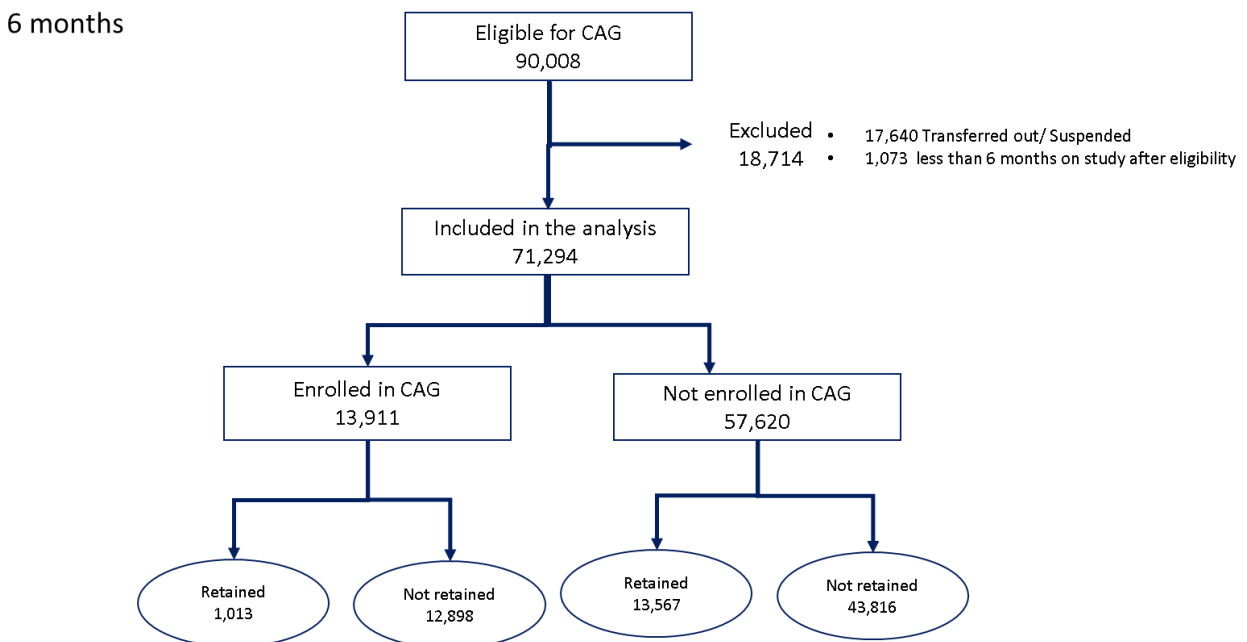
6 months

```
                          ┌─────────────────────┐
                          │   Eligible for CAG   │
                          │       90,008         │
                          └─────────────────────┘
                                     │
                                     │──────────────►  Excluded    •  17,640 Transferred out/ Suspended
                                     │                 18,714       •  1,073 less than 6 months on study after eligibility
                                     ▼
                          ┌─────────────────────┐
                          │ Included in the analysis │
                          │       71,294         │
                          └─────────────────────┘
                                     │
                      ┌──────────────┴──────────────┐
                      ▼                              ▼
           ┌──────────────────┐          ┌──────────────────┐
           │  Enrolled in CAG │          │ Not enrolled in CAG │
           │      13,911      │          │      57,620       │
           └──────────────────┘          └──────────────────┘
             │            │                  │            │
             ▼            ▼                  ▼            ▼
        (Retained)  (Not retained)    (Retained)   (Not retained)
          1,013        12,898           13,567         43,816
```

Figure 1. Flowchart of patients enrolled in the study, as per 6-month retention. ART = antiretroviral therapy; CAG = Community Adherence Support Group.

Table 3 below shows some underlying characteristics of the study population stratified by whether a person was retained at 6-months. Chi-square tests were used to compare categorical variables and the Mann-Whitney-Wilcoxon test was used to compared continuous variables. The overall 6-month retention was estimated at 78.5% among non-CAG members and 94.6% among CAG members (p-value < 0.001). Women were slightly more likely to be retained than men (79.8% versus 78.7%). There was a difference in retention to care between districts, meaning that retention differed in at least one of them. There also seems to be a trend of increasing 6-month retention rates among patients CAG-eligible, as the proportion of those retained increased from 74.7% to 84.8%, among CAG members eligible in 2013 and on or after 2017, respectively.

Table 3. *Comparison of six-month retention among CAG members versus non-CAG members (n=71,294).*

	All	Not retained at 6 months	Retained at 6 months	p-value
	N=71294	*N=14552*	*N=56742*	
CAG member				<0.001
No	66307 (93%)	14281 (21.5%)	52026 (78.5%)	
Yes	4987 (7%)	271 (5.5%)	4716 (94.6%)	
Sex				0.002
Female	53792 (75.5%)	10851 (20.2%)	42941 (79.8%)	
Male	17502 (24.5%)	3729 (21.3%)	13773 (78.7%)	
Age at eligibility (years, median, IQR)	30.2 [24.3;37.3]	28.4 [23.0;34.9]	30.6 [24.7;37.9]	<0.001
Age at eligibility, years (categorical)				<0.001
15-19 years	4810 (6.8%)	1478 (30.7%)	3332 (69.3%)	
20-24 years	15054 (21.1%)	3642 (24.2%)	11412 (75.8%)	
25-49 years	46816 (65.7%)	8774 (18.7%)	38042 (81.3%)	
50+ years	4614 (6.5%)	686 (14.9%)	3928 (85.1%)	
Marital Status				<0.001
Cohabitating with partner	26378 (37%)	5469 (20.7%)	20909 (79.3%)	
Married	9281 (13%)	1784 (19.2%)	7497 (80.8%)	
Single/divorced/widow	16605 (23.3%)	3206 (19.3%)	13399 (80.7%)	
Missing	19030 (26.7%)	4121 (21.7%)	14909 (78.3%)	
Highest education level				<0.001
None	12084 (16.9%)	2441 (20.2%)	9643 (79.8%)	
Post-secondary	11538 (16.2%)	2192 (19%)	9346 (81%)	
Primary school	30541 (42.8%)	6245 (20.4%)	24296 (79.6%)	
Missing	17131 (24%)	3702 (21.6%)	13429 (78.4%)	
District				<0.001
Quelimane	22564 (31.6%)	3724 (16.5%)	18840 (83.5%)	
Gilé	3230 (4.5%)	622 (19.3%)	2608 (80.7%)	
Ile	3343 (4.7%)	710 (21.2%)	2633 (78.8%)	
Inhassunge	4186 (5.9%)	933 (22.3%)	3253 (77.7%)	
Maganja da Costa	8085 (11.3%)	2063 (25.5%)	6022 (74.5%)	
Mocubela	7925 (11.1%)	2183 (27.5%)	5742 (72.5%)	
Alto Molócuè	3231 (4.5%)	659 (20.4%)	2572 (79.6%)	
Namacurra	10006 (14%)	2177 (21.8%)	7829 (78.2%)	
Pebane	8724 (12.2%)	1509 (17.3%)	7215 (82.7%)	
Site location				<0.001
Rural	48730 (68.4%)	10856 (22.3%)	37874 (77.7%)	
Peri-urban Quelimane	13825 (19.4%)	2238 (16.2%)	11587 (83.8%)	
Semi-urban Quelimane	8739 (12.3%)	1486 (17%)	7253 (83%)	
Year of CAG eligibility				<0.001
≤ 2013	6234 (8.7%)	1579 (25.3%)	4655 (74.7%)	
2014	11089 (15.6%)	2715 (24.5%)	8374 (75.5%)	
2015	14729 (20.7%)	2921 (19.8%)	11808 (80.2%)	
2016	17876 (25.1%)	4113 (23%)	13763 (77%)	
≥ 2017	21366 (30%)	3252 (15.2%)	18114 (84.8%)	
First CD4 cell count (median, IQR)	376 [221;564]	374 [214;570]	377 [224;562]	0.159
First CD4 cell count (categorical)				<0.001

<200	10091 (14.2%)	2082 (20.6%)	8009 (79.4%)
200-349	11092 (15.6%)	2105 (19%)	8987 (81%)
350-499	10162 (14.3%)	1912 (18.8%)	8250 (81.2%)
500+	14953 (21%)	2944 (19.7%)	12009 (80.3%)
Missing	24996 (35.1%)	5537 (22.2%)	19459 (77.8%)
BMI at enrollment	20.5 [18.6;22.6]	20.6 [18.6;22.7]	20.5 [18.6;22.6]	0.759
Tuberculosis infection status (at time of enrollment into HIV services)				<0.001
No	60819 (85.3%)	12106 (19.9%)	48713 (80.1%)
Yes	9512 (13.3%)	1984 (20.9%)	7528 (79.1%)
Missing	963 (1.4%)	490 (50.9%)	473 (49.1%)

The adjusted regression analysis (**Table 4**) showed that the odds that a person enrolled in a CAG would be retained six months after CAG eligibility was 4.65 (95% CI: 4.06-5.34) higher than that of a person who was not enrolled in CAG, while holding all other covariates constant. Males were also 25% less likely to be retained at six months (aOR 0.75, 95% CI: 0.72-0.79). Age and marital status did not show association with retention at the 5% level. Participants from Quelimane district were, on average, more likely to be retained after 6-months compared to any other district.

Table 4. *Adjusted regression analysis of 6-month retention**

	aOR (95% CI)	p-value
(Intercept)	2.49 (2.25-2.75)	<0.001
CAG member		
No	Ref.	
Yes	4.65 (4.06-5.34)	<0.001
Age		
20 years of age	Ref	
40 years of age	1.08 (0.94-1.24)	0.123
60 years of age	1.16 (0.89-1.53)	0.136
Sex		
Female	Ref.	
Male	0.76 (0.72-0.79)	<0.001
Highest education level		
None	Ref.	
Primary school	1.02 (0.98-1.06)	0.350
Post-secondary	0.94 (0.90-0.98)	0.009
Marital Status		
Cohabitating with partner	Ref.	
Married	1.04 (0.97-1.10)	0.260
Separated/Divorced/Widowed/Single	1.02 (0.97-1.07)	0.700
District		
Quelimane	Ref.	
Gilé	0.79 (0.71-0.87)	<0.001
Ile	0.71 (0.65-0.78)	<0.001
Inhassunge	0.66 (0.61-0.72)	<0.001

Maganja	0.55 (0.51-0.58)	<0.001
Mocubela	0.49 (0.46-0.52)	<0.001
Alto Molócuè	0.76 (0.69-0.84)	<0.001
Namacurra	0.68 (0.64-0.73)	<0.001
Pebane	0.87 (0.82-0.94)	<0.001
Tuberculosis infection status (at time of enrollment into HIV services)		
No		
Yes	0.84 (0.79-0.89)	<0.001

*Adjusted for sex, age, education, marital status, TB status, districts

Retention – 12 months

A total of 21,125 participants who transferred out, suspended treatment or died, and those who did not complete 12 months of follow-up by the end of the evaluation period, were excluded from the 12-month retention analysis. It is important to highlight that patients who were included in the 6-months retention analysis, irrespective of their 6-months retention results, were also considered for the 12 months retention analysis, as long as the inclusion criteria above were satisfied. The analysis was thus done with 68,883 patients (**Figure 2**).
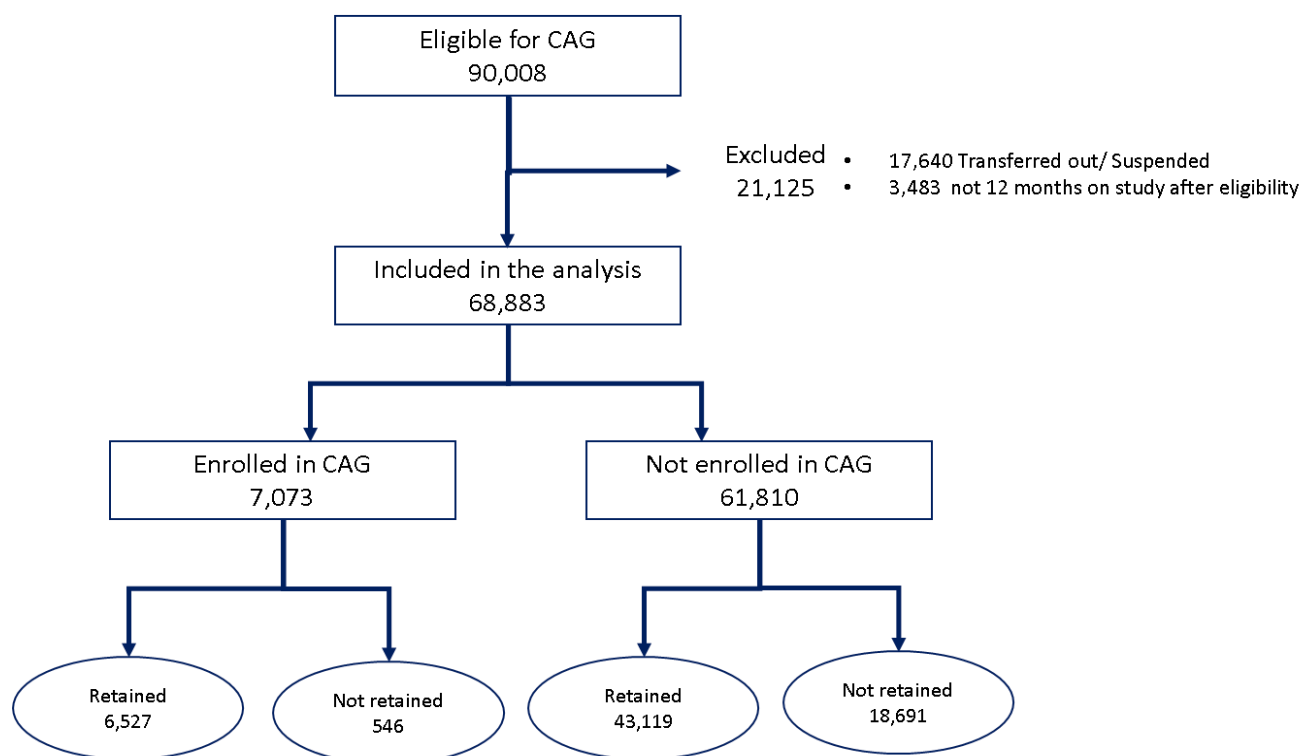
Figure 2. Flowchart of patients enrolled in the study, as per 12-month retention. ART antiretroviral treatment; CAG Community Adherence Support Group.

Results for univariable comparisons between retained and not retained at 12-months of eligibility are displayed in **Table 5**. A total of 92.3% of the patients who were CAG members 12 months after CAG eligibility were retained, while non-members had a retention of 69.8% (p-value < 0.001). Women had a higher retention ratio (72.7% vs. 70.2%) and older patients were more retained than younger (78% among 50+ years vs. 62.7% among 15-19 years). Similar differences, as those observed for the 6-month retention, were seen among district, as well as for retention over time (**Table 5**).

Table 5. *Comparison of one-year retention among CAG members versus non-CAG members (n=68,883).*

	All	Not retained at 12 months	Retained at 12 months	p-value
	N=68883	*N=19237*	*N=49646*	
CAG member				<0.001
No	61810 (89.7%)	18691 (30.2%)	43119 (69.8%)	
Yes	7073 (10.3%)	546 (7.7%)	6527 (92.3%)	
Sex				<0.001
Female	51990 (75.5%)	14196 (27.3%)	37794 (72.7%)	
Male	16893 (24.5%)	5041 (29.8%)	11852 (70.2%)	
Age at eligibility (years, median, IQR)	30.2 [24.3;37.4]	28.7 [23.3;35.4]	30.6 [24.8;38.2]	<0.001
Age at eligibility, years (categorical)				<0.001
15-19 years	4705 (6.8%)	1754 (37.3%)	2951 (62.7%)	
20-24 years	14452 (21%)	4677 (32.4%)	9775 (67.6%)	
25-49 years	45258 (65.7%)	11822 (26.1%)	33436 (73.9%)	
50+ years	4468 (6.5%)	984 (22%)	3484 (78%)	
Marital Status				<0.001
Cohabitating with partner	25583 (37.1%)	7187 (28.1%)	18396 (71.9%)	
Married	8880 (12.9%)	2326 (26.2%)	6554 (73.8%)	
Single/divorced/widow	16107 (23.4%)	4291 (26.6%)	11816 (73.4%)	
Missing	18313 (26.6%)	5433 (29.7%)	12880 (70.3%)	
Highest education level				<0.001
None	11667 (16.9%)	3270 (28%)	8397 (72%)	
Post-secondary	11141 (16.2%)	2881 (25.9%)	8260 (74.1%)	
Primary school	29408 (42.7%)	8065 (27.4%)	21343 (72.6%)	
Missing	16667 (24.2%)	5021 (30.1%)	11646 (69.9%)	
District				<0.001
Quelimane	21797 (31.6%)	4915 (22.5%)	16882 (77.5%)	
Gilé	3077 (4.5%)	749 (24.3%)	2328 (75.7%)	
Ile	3146 (4.6%)	869 (27.6%)	2277 (72.4%)	
Inhassunge	4068 (5.9%)	1192 (29.3%)	2876 (70.7%)	
Maganja da Costa	7832 (11.4%)	3029 (38.7%)	4803 (61.3%)	

Mocubela	7802 (11.3%)	3036 (38.9%)	4766 (61.1%)	
Alto Molócuè	3072 (4.5%)	809 (26.3%)	2263 (73.7%)	
Namacurra	9634 (14%)	2861 (29.7%)	6773 (70.3%)	
Pebane	8455 (12.3%)	1777 (21%)	6678 (79%)	
Site location				<0.001
Rural	47086 (68.4%)	14322 (30.4%)	32764 (69.6%)	
Peri-urban Quelimane	13511 (19.6%)	3027 (22.4%)	10484 (77.6%)	
Semi-urban Quelimane	8286 (12%)	1888 (22.8%)	6398 (77.2%)	
Year of CAG eligibility				<0.001
≤ 2013	6232 (9.1%)	1995 (32%)	4237 (68%)	
2014	11089 (16.1%)	3431 (30.9%)	7658 (69.1%)	
2015	14729 (21.4%)	4416 (30%)	10313 (70%)	
2016	17876 (26%)	5652 (31.6%)	12224 (68.4%)	
≥ 2017	18957 (27.5%)	3743 (19.7%)	15214 (80.3%)	
First CD4 cell count (median, IQR)	374 [220;561]	363 [206;560]	378 [225;562]	<0.001
First CD4 cell count (categorical)				<0.001
<200	9916 (14.4%)	2934 (29.6%)	6982 (70.4%)	
200-349	10848 (15.7%)	2895 (26.7%)	7953 (73.3%)	
350-499	9842 (14.3%)	2539 (25.8%)	7303 (74.2%)	
500+	14392 (20.9%)	3851 (26.8%)	10541 (73.2%)	
Missing	23885 (34.7%)	7018 (29.4%)	16867 (70.6%)	

In the adjusted analysis (**Table 7**), adjusting for sex, age, marital status, education, TB status, district, and treating CAG membership as a cluster variable, suggested that the odds of being retained 12-months after being eligible for CAG was 4.53 (95% CI: 4.16-4.94) higher if a person was in effect enrolled in CAG within 12-months of eligibility, compared to a person that did not enter in any CAG. As with 6-month retention, men were approximately 30% less likely to be retained at 12-months (aOR 0.71; 95% CI: 0.68-0.74).

Table 7. *Adjusted regression – 12-month retention*.*

	aOR (95% CI)	p-value
(Intercept)	2.05 (1.87-2.25)	<0.001
CAG member		
No	Ref.	
Yes	4.53 (4.16-4.94)	<0.001
Age		
20 years of age	Ref	
40 years of age	0.96 (0.85-1.09)	0.264
60 years of age	0.92 (0.73-1.18)	0.264
Sex		
Female	Ref.	
Male	0.71 (0.68-0.74)	<0.001
Marital Status at HIV service enrollment		
Cohabitating with partner	Ref.	
Married	1.0 (0.95-1.05)	0.948
Separated/Divorced/Widowed/Single	0.97 (0.93-1.02)	0.194

Highest education level at HIV service enrollment		
None	Ref.	
Primary school	1.04 (1.0-1.08)	0.052
Post-secondary	0.94 (0.90-0.98)	0.004
District		
Quelimane	Ref.	
Gilé	0.76 (0.73-0.87)	<0.001
Ile	0.72 (0.66-0.79)	<0.001
Inhassunge	0.63 (0.58-0.69)	<0.001
Maganja	0.41 (0.39-0.44)	<0.001
Mocubela	0.41 (0.38-0.43)	<0.001
Alto Molócuè	0.78 (0.71-0.84)	<0.001
Namacurra	0.62 (0.59-0.66)	<0.001
Pebane	0.93 (0.87-0.99)	0.030
Tuberculosis infection status (at time of enrollment into HIV services)		
No	Ref.	
Yes	0.85 (0.80-0.89)	<0.001

*Adjusted for sex, age, education, marital status, TB status, districts

Viral Suppression

Considering only VL analyses done after August 2016 (when VL was introduced as routine monitoring in HIV/ART services), 72,414 patients were eligible for VL analysis. Of these patients, a total of 37,130 (51%) had a VL test result registered for routine monitoring (42% among CAG members, and 54% among non-CAG members) (**Figure 3**).
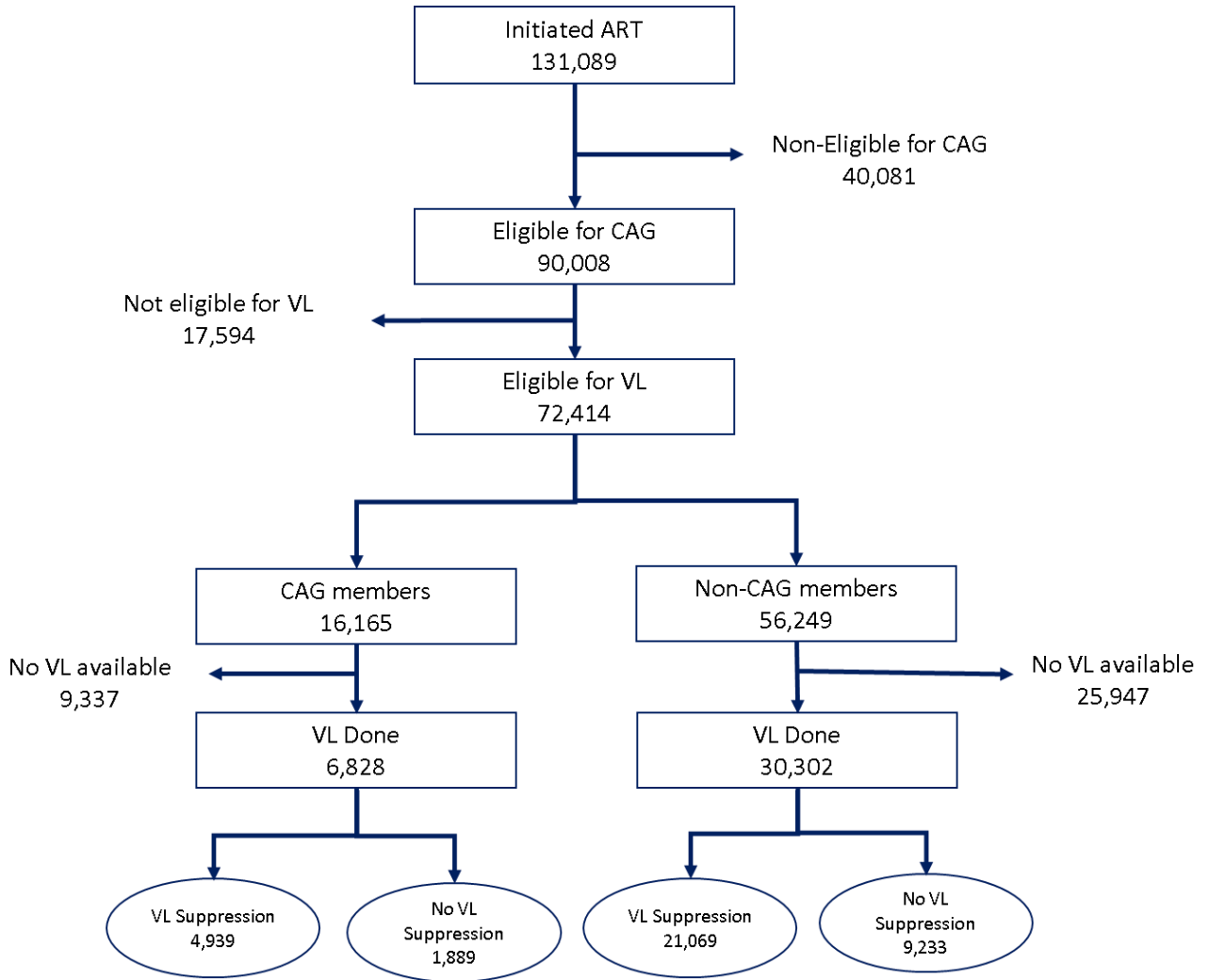
Figure 3. *Flowchart of patients enrolled in the study. ART antiretroviral treatment; CAG Community Adherence Support Group; VL Viral Load; *Eligibility for VL as routine monitoring, after 2016. Note: CAG members are those that were ever on CAG, before Viral Load date. Some patients became CAG members after VL measurement. These are considered Non-CAG members in the flowchart.*

Table 8 below shows the comparison between patients virally suppressed versus not. The viral suppression rate overall was 69.5%, 70% among non-CAG members and 72.3% among CAG members (p<0.001). Among those that were not virally suppressed, the median VL was 7,193 copies/mL [IQR: 1403, 62845].

Heterogeneity in terms of the proportion of patients virally suppressed was seen when evaluated by district. Overall, females had higher viral suppression rates when compared to males (71% vs. 67%). When looked at by age disaggregation, those persons that were the youngest (15-19 years

of age) had the lowest viral suppression rate (65.9%), with older persons (≥50 years of age) having the highest viral suppression rate at 77.4%.

Table 8. *Comparison of patients with viral suppression versus no viral suppression among patients having routine VL monitoring (n=37,130).*

	All	Not virally suppressed	Virally suppressed	p-value
	N=37130	*N=11122*	*N=26008*	
CAG member				<0.001
No	30302 (81.6%)	9233 (30.5%)	21069 (69.5%)	
Yes	6828 (18.4%)	1889 (27.7%)	4939 (72.3%)	
Sex				<0.001
Female	29079 (78.3%)	8469 (29.1%)	20610 (70.9%)	
Male	8051 (21.7%)	2653 (33%)	5398 (67%)	
Age at eligibility (years, median, IQR)	30.1 [24.4;37.4]	29.0 [23.7;35.7]	30.5 [24.6;38.1]	<0.001
Age at eligibility, years (categorical)				<0.001
15-19 years of age	2423 (6.5%)	827 (34.1%)	1596 (65.9%)	
20-24 years of age	7946 (21.4%)	2683 (33.8%)	5263 (66.2%)	
25-49 years of age	24366 (65.6%)	7070 (29%)	17296 (71%)	
50+ years of age	2395 (6.5%)	542 (22.6%)	1853 (77.4%)	
Marital Status				<0.001
Cohabitating with partner	14206 (38.3%)	4437 (31.2%)	9769 (68.8%)	
Married	5056 (13.6%)	1531 (30.3%)	3525 (69.7%)	
Single/divorced/widow	8876 (23.9%)	2534 (28.5%)	6342 (71.5%)	
Missing	8992 (24.2%)	2620 (29.1%)	6372 (70.9%)	
Highest education level				<0.001
None	5928 (16%)	1807 (30.5%)	4121 (69.5%)	
Primary school	16125 (43.4%)	5219 (32.4%)	10906 (67.6%)	
Post-secondary	6800 (18.3%)	1846 (27.1%)	4954 (72.9%)	
Missing	8277 (22.3%)	2250 (27.2%)	6027 (72.8%)	
District				<0.001
Quelimane	14149 (38.1%)	3167 (22.4%)	10982 (77.6%)	
Gilé	2024 (5.5%)	833 (41.2%)	1191 (58.8%)	
Ile	1949 (5.3%)	792 (40.6%)	1157 (59.4%)	
Inhassunge	2336 (6.3%)	1174 (50.3%)	1162 (49.7%)	
Maganja da Costa	3201 (8.6%)	1176 (36.7%)	2025 (63.3%)	
Mocubela	2632 (7.1%)	551 (20.9%)	2081 (79.1%)	
Alto Molócuè	1917 (5.2%)	635 (33.1%)	1282 (66.9%)	
Namacurra	5218 (14.1%)	1812 (34.7%)	3406 (65.3%)	
Pebane	3704 (10%)	982 (26.5%)	2722 (73.5%)	
Site location				<0.001
Rural	22981 (61.9%)	7955 (34.6%)	15026 (65.4%)	
Peri-urban Quelimane	9216 (24.8%)	1982 (21.5%)	7234 (78.5%)	
Semi-urban Quelimane	4933 (13.3%)	1185 (24%)	3748 (76%)	
Year of CAG eligibility				<0.001
≤ 2013	2878 (7.8%)	925 (32.1%)	1953 (67.9%)	
2014	5067 (13.6%)	1424 (28.1%)	3643 (71.9%)	
2015	6873 (18.5%)	2029 (29.5%)	4844 (70.5%)	
2016	9317 (25.1%)	2741 (29.4%)	6576 (70.6%)	

≥ 2017	12995 (35%)	4003 (30.8%)	8992 (69.2%)	
Initial CD4 cell count (median, IQR)	386 [230;574]	357 [204;543]	399 [241;589]	<0.001
Initial CD4 cell count (categorical)				
<200 cells/mm³	29313 (78.9%)	3305 (11.3%)	26008 (88.7%)	
200-349 cells/mm³	2280 (6.1%)	2280 (100%)	0 (0%)	
350-499 cells/mm³	2203 (5.9%)	2203 (100%)	0 (0%)	
≥500 cells/mm³	3334 (9%)	3334 (100%)	0 (0%)	

An unadjusted regression showed that persons enrolled in CAG were 14% more likely to be virally suppressed (OR 1.14; 95% CI: 1.06-1.21). For the adjusted regression, after 20 multiple imputations, the odds of being virally suppressed were 1.33 (95% CI: 1.24-1.42) (**Table 9**). Males were ~ 30% less likely to be virally suppressed (aOR 0.71; 95% CI: 0.67-0.76) compared to females. The odds of being virally suppressed increased with age (aOR [1.26; 95% CI: 1.05-1.51] and [1.58; 95% CI: 1.10-2.27] as seen among patients 40 and 60 years of age, respectively, compared to patients 20 years of age.

Table 9. *Adjusted regression analysis on Viral Suppression*.*

	aOR (95% CI)	p-value
(Intercept)	2.75 (2.4-3.16)	<0.001
CAG member		
No	Ref.	
Yes	1.33 (1.241.42)	<0.001
Age		
20 years of age	Ref	
40 years of age	1.26 (1.05-1.51)	0.002
60 years of age	1.58 (1.10-2.27)	0.007
Sex		
Female	Ref.	
Male	0.71 (0.67-0.76)	<0.001
Marital Status		
Cohabitating with partner	Ref.	
Married	1.02 (0.95-1.1)	0.695
Separated/Divorced/Widowed/Single	1.02 (0.95-1.09)	0.482
Highest education level		
None	Ref.	
Primary school	1.0 (0.95-1.05)	0.945
Post-secondary	0.86 (0.81-0.91)	<0.001
District		
Quelimane	Ref.	
Gilé	0.38 (0.34-0.43)	<0.001
Ile	0.40 (0.36-0.46)	<0.001

Inhassunge	0.27 (0.25-0.30)	<0.001
Maganja	0.45 (0.41-0.50)	<0.001
Mocubela	1.05 (0.93-1.18)	<0.001
Alto Molócuè	0.58 (0.52-0.65)	<0.001
Namacurra	0.51 (0.47-0.55)	<0.001
Pebane	0.81 (0.74-0.89)	<0.001
Tuberculosis infection status (at time of enrollment into HIV services)		
No	Ref.	
Yes	0.87 (0.80-0.93)	<0.001

*Adjusted for sex, age, education, marital status, TB status, and district

Attrition

Among the study population, 30% (n=20,286) of participants were lost to follow-up (LTFU) (**Table 10**) by the end of the study period, with LTFU rates being considerably lower (10%) among ART-treated patients ever joining a CAG compared to patients who never joined a CAG (36%). The median time for patients becoming LTFU overall was 698 days [IQR 421-1145], and 639 days for those patients who never entered in CAG versus a considerably longer 936 days for those patients ever joining a CAG.

Table 10. *Comparison of patients lost-to-follow up versus not (n=67,286).*

	All	Not LTFU	LTFU	p-value
	N=67286	*N=47000*	*N=20286*	
CAG member				
No	53385 (79.3%)	34427 (73.2%)	18958 (93.5%)	<0.001
Yes	13901 (20.7%)	12573 (6%)	1328 (6.6%)	
Sex				<0.001
Female	50913 (75.7%)	36054 (76.7%)	14859 (73.2%)	
Male	16373 (24.3%)	10946 (23.3%)	5427 (26.8%)	
Age at eligibility (years, median, IQR)	30.3 [24.4;37.5]	30.6 [24.7;38.1]	29.3 [23.6;35.9]	<0.001
Age at eligibility, years (categorical)				<0.001
15-19 years of age	4401 (6.5%)	2801 (6%)	1600 (7.9%)	
20-24 years of age	14069 (20.9%)	9407 (20%)	4662 (23%)	
25-49 years of age	44402 (66%)	31545 (67.1%)	12857 (63.4%)	
≥50 years of age	4414 (6.6%)	3247 (6.9%)	1167 (5.8%)	
Marital Status				<0.001
Cohabitating with partner	24906 (37%)	17255 (36.7%)	7651 (37.7%)	
Married	8842 (13.1%)	6591 (14%)	2251 (11.1%)	
Single/divorced/widow	15629 (23.2%)	10943 (23.3%)	4686 (23.1%)	
Missing	17909 (26.6%)	12211 (26%)	5698 (28.1%)	
Highest education level				<0.001

None	11417 (17%)	8119 (17.3%)	3298 (16.3%)	
Post-secondary	10935 (16.3%)	7693 (16.4%)	3242 (16%)	
Primary school	28922 (43%)	20600 (43.8%)	8322 (41%)	
Missing	16012 (23.8%)	10588 (22.5%)	5424 (26.7%)	
District				<0.001
Quelimane	21597 (32.1%)	16342 (34.8%)	5255 (25.9%)	
Gilé	3129 (4.7%)	2452 (5.2%)	677 (3.3%)	
Ile	3175 (4.7%)	2368 (5%)	807 (4%)	
Inhassunge	3956 (5.9%)	2841 (6%)	1115 (5.5%)	
Maganja da Costa	7412 (11%)	4145 (8.8%)	3267 (16.1%)	
Mocubela	7075 (10.5%)	2906 (6.2%)	4169 (20.6%)	
Alto Molócuè	3106 (4.6%)	2406 (5.1%)	700 (3.5%)	
Namacurra	9478 (14.1%)	6887 (14.7%)	2591 (12.8%)	
Pebane	8358 (12.4%)	6653 (14.2%)	1705 (8.4%)	
Sub-district				<0.001
Rural	45689 (67.9%)	30658 (65.2%)	15031 (74.1%)	
Peri-urban Quelimane	13120 (19.5%)	9371 (19.9%)	3749 (18.5%)	
Semi-urban Quelimane	8477 (12.6%)	6971 (14.8%)	1506 (7.4%)	
Year of CAG eligibility				<0.001
≤ 2013	5765 (8.6%)	3124 (6.7%)	2641 (13%)	
2014	10337 (15.4%)	6112 (13%)	4225 (20.8%)	
2015	13906 (20.7%)	8462 (18%)	5444 (26.8%)	
2016	16362 (24.3%)	11594 (24.7%)	4768 (23.5%)	
≥ 2017	20916 (31.1%)	17708 (37.7%)	3208 (15.8%)	
Initial CD4 cell count (median, IQR)	378 [224;566]	391 [237;576]	347 [194;541]	<0.001
Initial CD4 cell count (categorical)				<0.001
<200 cells/mm^3	9385 (13.9%)	5926 (12.6%)	3459 (17.1%)	
200-349 cells/mm^3	10497 (15.6%)	7174 (15.3%)	3323 (16.4%)	
350-499 cells/mm^3	9625 (14.3%)	6921 (14.7%)	2704 (13.3%)	
≥500 cells/mm^3	14218 (21.1%)	10268 (21.8%)	3950 (19.5%)	
Missing	23561 (35%)	16711 (35.6%)	6850 (33.8%)	
BMI at enrollment	20.5 [18.7;22.6]	20.6 [18.7;22.6]	20.4 [18.5;22.6]	0.009
Tuberculosis infection status (at time of enrollment into HIV services)				<0.001
No	57637 (85.7%)	40368 (85.9%)	17269 (85.1%)	
Yes	8965 (13.3%)	6347 (13.5%)	2618 (12.9%)	
Missing	684 (1%)	285 (0.6%)	399 (2%)	

The survival analysis (**Figure 4**) shows that patients who never enrolled in a CAG group had a higher cumulative incidence of becoming LTFU when compared to those who were ever a CAG member, specifically, six years after being CAG eligible, the cumulative incidence of becoming LTFU was 60% versus 20%, for the respective groups.
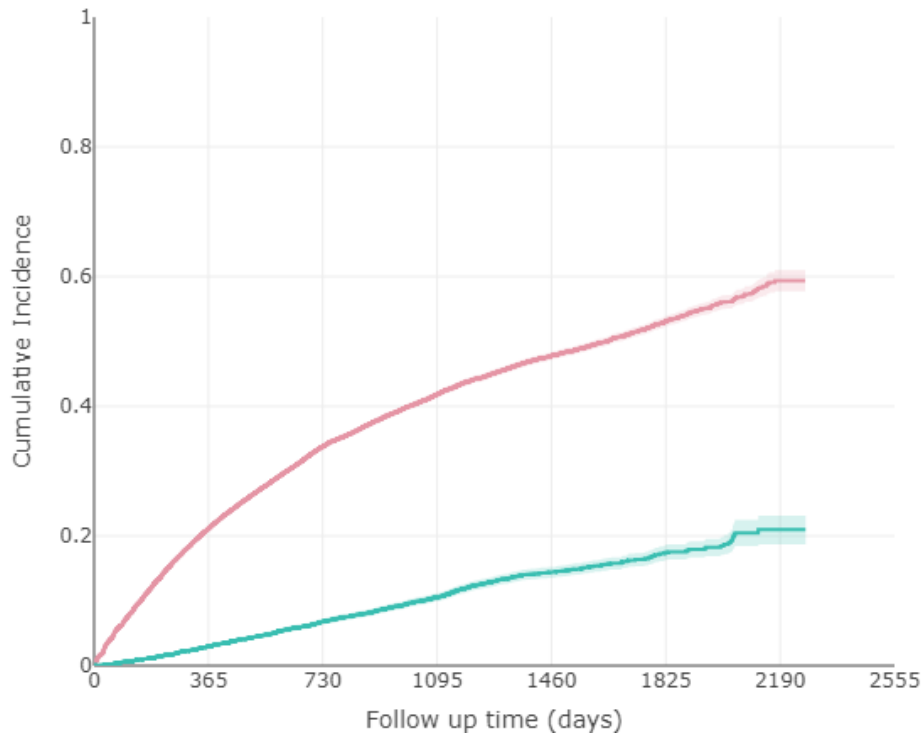
Figure 4. *Survival analysis – cumulative incidence of LTFU. Green line: CAG members (ever); red line to no-CAG members.*

Patients receiving ART via CAG support were ~ 83% less likely to become LTFU when compared to ART-treated patients not receiving ART via CAG support; with an unadjusted hazard ratio of 0.17 (95% CI: 0.16, 0.18). The adjusted hazard ratio (aHR), calculated using a Cox regression model using the same covariates as before for adjustment, showed that the risk of being LTFU was ~84% lower for persons ever joining a CAG compared to those never having been in a CAG (aHR 0.16; 95% CI: 0.15, 0.17) (**Table 11**).

Table 11. *Adjusted regression analysis time to LTFU.*

	aHR (95% CI)	p-value
CAG member		
No	Ref.	
Yes	0.16 (0.15-0.17)	<0.001

Age	0.99 (0.99-0.99)	<0.001
Sex		
Female	Ref.	
Male	1.45 (1.39-1.5)	<0.001
Age at eligibility	0.99 (0.99-0.99)	<0.001
Marital Status		
Cohabitating with partner	Ref.	
Married	0.97 (0.92-1.02)	0.165
Separated/Divorced/Widowed/Single	1.11 (1.07-1.16)	<0.001
Highest education level		
None	Ref.	
Primary school	0.98 (0.95-1.01)	0.251
Post-secondary	1.01 (0.97-1.05)	0.586
District		
Quelimane	Ref.	
Gilé	1.17 (1.08-1.28)	<0.001
Ile	1.24 (1.14-1.34)	<0.001
Inhassunge	1.65 (1.54-1.77)	<0.001
Maganja	2.79 (2.65-2.93)	<0.001
Mocubela	4.26 (4.06-4.47)	<0.001
Alto Molócuè	1.06 (0.97-1.15)	0.185
Namacurra	1.45 (1.38-1.53)	<0.001
Pebane	1.17 (1.10-1.24)	<0.001
Tuberculosis infection status (at time of enrollment into HIV services)		
No	Ref.	
Yes	0.99 (0.95-1.04)	0.767

Discussion & Conclusions

The cohort study included mainly females, and almost a third were receiving care at health facilities in Quelimane district (semi-urban and peri-urban). The characteristics of the general population in Zambézia province are reflected in the patients included in the study.

Characteristics of the CAG members included in this evaluation were similar as those identified in the study in Tete, another Mozambican province, a few years back, which suggests that characteristics among patients with a preference for enrolling in a community-level support group remain consistent (6).

Six-month retention was excellent overall (80%) and reached 93% among CAG members. The study showed that after adjustment for sex, baseline TB co-infection status, year of CAG

eligibility, and age at ART initiation, the probability of being retained at 6-months was nearly five times greater when a patient was receiving ART via CAG support versus not during this evaluation period. A continued trend was seen for one-year retention with a rate of 92% for CAG members. The odds of being retained at one year was 4.5 times greater when enrolled in CAG. These results are similar to the Tete study (6) that was implemented in the initial years of the CAG model implementation, where monitoring was more intensive. The program evaluation, with a larger cohort and longer follow-period, showed that after initial implementation, sustained positive results were obtained.

During the period of evaluation, 30% of the eligible patients were lost to follow-up. Patients enrolled in CAG were less likely to be LTFU when compared to those not enrolled in CAG (HR 0.16). Jobbarteh et al. reported a hazard rate of 2.36 of being LTFU among eligible non-CAG members (5). In the earlier years of CAG implementation, it was documented that persons receiving ART via CAG support had a 35% lower LFTU rate compared to those not receiving (2004-2013) (7).

In a qualitative study from 2014, time and financial benefits were found to be important factors for patients entering a CAG (10). More women adhere to the community support groups, while men usually refer to time constraints due to work as a barrier to going to the health facility. Additional health education benefits, and psychosocial benefits (for members and their family) were noted by Kun et al. (11).

A challenge seen in this study was the low coverage of viral load testing among all patients (51%). However, the majority (70%) of the patients undergoing routine viral load testing were virally suppressed at the time of their initial VL being obtained. Additionally, patients enrolled in CAG were more likely to be virally suppressed than those not enrolled. The Mozambique Ministry of Health (MOH)'s semi-annual report showed 62% viral suppression in the first semester of 2020, lower than the study results (4). The entire cohort preceded introduction and scale up of the integrase inhibitor Dolutegravir (DTG) as part of first-line ART in Mozambique. As DTG has a high genetic barrier, patients on a regimen containing DTG have shown higher VL suppression rates in comparison to patients receiving a treatment containing a non-nucleoside reverse transcriptase inhibitor (NNRTI) instead. During the evaluation period, the recommended first line regimen for adults still consisted of two nucleoside reverse transcriptase inhibitor (NRTI) in

combination with one non-nucleoside reverse transcriptase inhibitor (NNRTI) being Efavirenz or Nevaripine.

Although from the 17,018 patients who were ever enrolled in CAG, 13,792 were still active on ART by the end of the study period, only 2,048 patients were still on CAG by the end of the evaluation period, September 2018, which only represents 12% of the patients who ever entered a CAG group. Many reasons for a low retention to CAG participation can be hypothesized, such as change in pregnancy status or family structure, clinical reasons for CAG interruption, intragroup dynamics, etc. Potentially, patients could have been transferred to another differentiated care model that began being implemented at the end of the study period; but there was no formal registration captured in the electronic database at the time of the study. However, as CAG membership showed a positive effect on 6- and 12-month retention, and on viral suppression, motivational activities/CAG adherence counseling could be piloted for improved retention to CAG, aiming at a longer-term positive effect on retention to HIV/ART care. Sustainability of CAG is therefore crucial and requires involvement of different levels (12).

The study had several limitations. Routinely collected data were used that are sensitive to data entry errors and/or missing data. The suboptimal data quality did not allow us to measure the median number of members per group, which could possibly explain why the median time between clinic visits is short. The analysis was done comparing patients who ever participated in a CAG and those who did not (during evaluation period), however, the duration of CAG membership was not taken into account to more robustly evaluate its effect on outcomes of interest. Some patients could have left CAG groups because of pregnancy or other clinical reasons. While CAG eligibility criteria are defined by the MOH's standards for program implementation, the definition of CAG eligibility used in this analysis was simplified to all patients ≥15 years who initiated ART and had at least four medication pick-ups in the first six months after ART initiation. Some selection bias may have occurred as not all inclusion criteria according to the national guidelines could be used. Viral load coverage remains a challenge and the low coverage can potentially under- or overestimate the results of viral suppression among the studied population.

In conclusion, community adherence groups have higher uptake rates among HIV-positive, ART-treated adults residing in rural areas, females, and older individuals. Six- and twelve-month retention from CAG-eligibility is high in Zambézia and participating in CAG increases the

likelihood of being retained in care even more. The slightly higher viral suppression rates among those in CAG further highlight the possible benefits of this differentiated care model. While Mozambique is currently progressing towards an aggressive scale-up of three-monthly drug dispensation (3MDD) for individuals on ART, this study indicates that the historically proven DMC models, like CAG, may continue to have a role in maintaining long-term retention in rural parts of Zambézia.

Dissemination plan

FGH has shared these results with provincial-level MOH authorities and plan to share with national-level MOH partners/stakeholders as well. In an effort to share best practices and lessons learned, we also aim to submit the findings in the format of an abstract presentation for a national or international conference or as a manuscript for a peer-reviewed journal.

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Appendices

Approved protocol with instruments and informed consent forms

This evaluation is covered by and was approved by CDC-MZ Associate Director for Science (ADS) under the VUMC/FGH blanket protocol for secondary data analyses to evaluate and improve program outcomes using routinely collected HIV Care and Treatment data (CGH HSR #: 2016-163a).

Informed consent was not required for use of data in this evaluation, as it was a secondary analysis of routinely collected, de-identified, programmatic data. A waiver of informed consent was approved, as the evaluation involved no more than minimal risk.

Data sources used were the NHS routine clinical files, entered in the electronic patient tracking system (OpenMRS).

Biosketches

Not applicable.

Conflict of interest statement

The collaborators in this evaluation have no conflicts of interest to declare.

Evaluation costs

Evaluation costs were limited to the personnel time required for extraction and analysis of routine secondary data, results review and discussion, and report preparation.

Results or Logical Framework

Please see below (**Figure 5**) a framework demonstrating the causal pathway for the intended outcomes of improved retention and viral suppression.
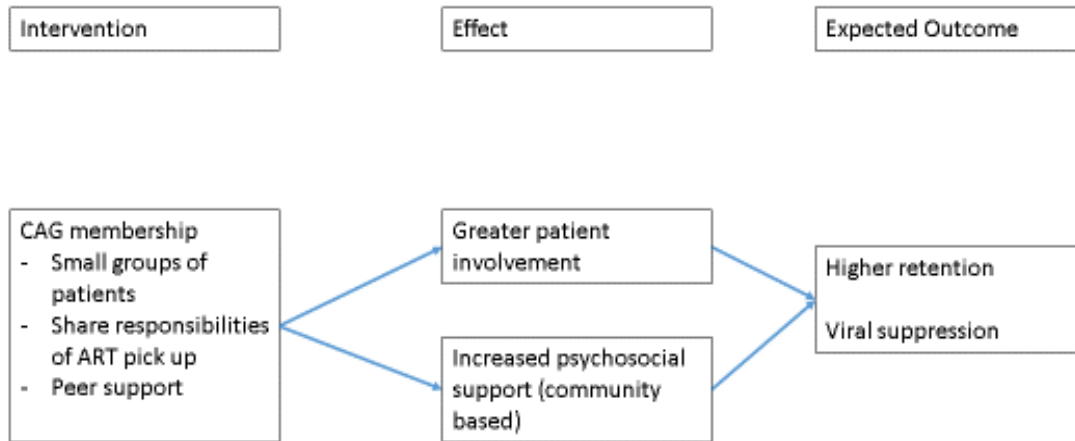

Figure 5. Logic framework for intended causal pathway for improved retention and HIV viral suppression

Additional analysis – disaggregated

Additional Table 1. *Comparison of six months' retention among CAG members versus non-CAG members, disaggregated (n=71,294).*

	All	Not retained at 6 months	Retained at 6 months	p-value
	N=71294	*N=14580*	*N=56714*	
CAG membership				<0.001
No CAG membership	66307 (93%)	14281 (21.5%)	52026 (78.5%)	
CAG membership	4987 (7%)	271 (5.4%)	4716 (94.6%)	
Age at eligibility, years; per category				<0.001
15-19 Years				
Non-CAG	4666 (6.5%)	1461 (31.3%)	3205 (68.7%)	
CAG	144 (0.2%)	11 (7.6%)	133 (92.4%)	
20-24 Years				
Non-CAG	12863 (18%)	3463 (26.9%)	9400 (73.1%)	
CAG	721 (1%)	41 (5.7%)	680 (94.3%)	
25-49 Years				
Non-CAG	43231 (60.6%)	8559 (19.8%)	34672 (80.2%)	
CAG	3585 (5%)	199 (5.6%)	3386 (94.4%)	
50+ years				
Non-CAG	4077 (5.7%)	663 (16.3%)	3414 (83.7%)	
CAG	537 (0.8%)	20 (3.7%)	517 (96.3%)	
Sex				<0.001
Female				
Non-CAG	50300 (70.6%)	10657 (21.2%)	39643 (78.8%)	
CAG	3492 (4.9%)	176 (5%)	3316 (95%)	
Male				
Non-CAG	16007 (22.5%)	3624 (22.6%)	12383 (77.4%)	
GAC	1495 (2.1%)	95 (6.4%)	1400 (93.6%)	
Site Location				<0.001
Rural				
Non-CAG	44539 (62.5%)	10579 (23.8%)	33960 (76.2%)	
CAG	4191 (5.9%)	253 (6%)	3938 (94%)	
Peri-urban Quelimane				
Non-CAG	13666 (19.2%)	2231 (16.3%)	11435 (83.7%)	
CAG	159 (0.2%)	6 (3.8%)	153 (96.2%)	
Semi-urban Quelimane				
Non-CAG	8102 (11.4%)	1471 (18.2%)	6631 (81.8%)	
CAG	637 (0.9%)	12 (1.9%)	625 (98.1%)	

Additional Table 2. *Comparison of one-year retention among CAG members versus non-CAG members, disaggregated (n=68,883).*

	All	Not retained at 12 months	Retained at 12 months	p-value
	N=68883	*N=19237*	*N=49646*	
CAG Membership				<0.001
No	55222 (80.2%)	18077 (32.7%)	37145 (67.3%)	
Yes	13661 (19.8%)	1160 (8.5%)	12501 (91.5%)	
Age at eligibility, years; per category				<0.001
15-19 Years				
Non-CAG	4480 (6.5%)	1730 (38.6%)	2750 (61.4%)	
CAG	225 (0.3%)	24 (10.7%)	201 (89.3%)	
20-24 Years				
Non-CAG	13432 (19.5%)	4588 (34.2%)	8844 (65.8%)	
CAG	1020 (1.5%)	89 (8.7%)	931 (91.3%)	
25-49 Years				
Non-CAG	40140 (58.3%)	11436 (28.5%)	28704 (71.5%)	
CAG	5118 (7.4%)	386 (7.5%)	4732 (92.5%)	
50+ years				
Non-CAG	3758 (5.5%)	937 (24.9%)	2821 (75.1%)	
CAG	710 (1%)	47 (6.6%)	663 (93.4%)	
Sex				<0.001
Female				
Non-CAG	46995 (68.2%)	13836 (29.4%)	33159 (70.6%)	
CAG	4995 (7.3%)	360 (7.2%)	4635 (92.8%)	
Male				
Non-CAG	14815 (21.5%)	4855 (32.8%)	9960 (67.2%)	
GAC	2078 (3%)	186 (9%)	1892 (91%)	
Site Location				<0.001
Rural				
Non-CAG	41107 (59.7%)	13816 (33.6%)	27291 (66.4%)	
CAG	5979 (8.7%)	506 (8.5%)	5473 (91.5%)	
Peri-urban Quelimane				
Non-CAG	13305 (19.3%)	3015 (22.7%)	10290 (77.3%)	
CAG	206 (0.3%)	12 (5.8%)	194 (94.2%)	
Semi-urban Quelimane				
Non-CAG	7398 (10.7%)	1860 (25.1%)	5538 (74.9%)	
CAG	888 (1.3%)	28 (3.2%)	860 (96.8%)	