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Examining teen club attendance and viral load suppression among adolescents under differentiated HIV care in Malawi: a sub-optimal scenario

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Abstract

Background In Malawi, compared to adults, adolescents have higher rates of high HIV viremia and poorer antiretroviral therapy (ART) outcomes. The Ministry of Health, supported by the Elizabeth Glaser Pediatric AIDS Foundation (EGPAF), implemented the provision of differentiated care clubs for adolescents living with HIV (ALHIV), called "teen clubs," to provide psychosocial support and an HIV care package to improve clinical outcomes. We evaluated teen club attendance and factors associated with unsuppressed viral load (VL) in ALHIV enrolled in these teen clubs.

Methods This cross-sectional study used program data from 35 health facilities in four districts that offered teen club services. We enrolled all ALHIV receiving ART ages 10–19 years who attended teen clubs between July 2018-September 2019 and had documented viral load results. Unsuppressed VL was defined as HIV RNA = > 1000 copies/mL, and optimal ART adherence was defined as having an expected pill count suggesting that between 95 and 105% of pills prescribed were consumed. We used multivariable logistic regression to identify factors associated with unsuppressed VL, adjusting for sex, age, education, district, adherence assessment, disclosure of one's HIV status, and teen club attendance.

Results Our analysis included 1,162 ALHIV with a median age of 15 years (IQR 13–17). The majority were female ($n=614$, 53%) and attended one or two teen club visits ($n=665$, 57%). Unsuppressed VL was identified in 28% of ALHIV. ALHIV with sub-optimal ART adherence were twice as likely to have unsuppressed VL (adjusted odds ratio [aOR] 2.0, 95% confidence interval (CI): 1.42–2.62) compared to those with optimal ART adherence. ALHIV on second-line treatments, were nearly four times more likely to have unsuppressed VL (aOR 3.7, 95% CI: 1.64–9.09) compared with those on first-line ART. ALHIV who had attained secondary school education were less likely to have unsuppressed VL (aOR 0.42, 95% CI 0.21–0.81) than those who only attained primary school education.

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Conclusion Even amongst adolescents enrolled in teen clubs, teen club attendance is low and high HIV viremia prevails. A continual focus on adolescents is needed to promote consistent teen club attendance and consistent ART adherence among the adolescents enrolled in differentiated service delivery.

Introduction

About 1.7 million adolescents aged 10–19 are living with HIV (ALHIV) globally, and this number is increasing as children perinatally born with HIV live longer [1]. However, ALHIV have poorer antiretroviral therapy (ART) treatment outcomes than adults [2, 3].

Non-adherence to ART is a significant cause of high HIV viremia in adolescents. Reasons for poor adherence include forgetting to take their tablets; traveling away from home, which can result in them not taking their ART drugs; and battling depression [4, 5]. Additionally, studies attribute lack of caregiver support, substance abuse, and increased pill burden as critical barriers to treatment adherence [6]. Furthermore, demographic characteristics such as age and sex are also determinants of adherence, with males more likely to have an unsuppressed viral load (VL) (HIV RNA > 1,000 copies/mL) compared to females; and older adolescents aged 16–19 years more likely to have unsuppressed VL than those age 13–15 years. Lastly, having parents alive, having daily meals, and belonging to a support group have been associated with higher rates of suppressed VL [7].

Targeted interventions for ALHIV can improve retention in care and VL suppression compared to standard of care [8–10]. However, Munyayi et al. showed that group-tailored interventions among adolescents did not improve retention or VL suppression compared to the standard of care in Namibia [11, 12]. A key issue was the extent of exposure to the adolescent-tailored interventions, with those attending more "teen club" sessions being more likely to be retained in care at 24 months of follow-up [13].

In Malawi, adolescents have been shown to have high rates of unsuppressed VL (26%) compared to adults (9%) [14]. The Malawi Ministry of Health released its National Youth Friendly Health Services Strategy of 2015–2020, which advocated for providing youth-friendly health services in alternative spaces such as teen clubs [15]. Through this strategy, the Malawi government, supported by implementing partners, began rolling out teen clubs as a differentiated service for youth; as of 2017, there were teen clubs across 28 districts [16]. A study by Mackenzie et al. in Malawi showed improved retention outcomes among adolescents enrolled in these teen clubs compared to those not [8]. McBride et al. noted age-specific differences in ART adherence among adolescents enrolled in teen clubs in Malawi, with older adolescents aged 15–19 years less likely to have unsuppressed VL compared to those aged 10–14 years, and advocated for age-specialized programming [17].

However, there is limited information on VL outcomes among adolescents receiving "teen club" differentiated care in Malawi especially to see if adolescents enrolled in the differentiated service are able to achieve the targeted UNAIDS 90% HIV suppression [18]. Thus, we sought to evaluate ALHIV teen club attendance and factors associated with unsuppressed VL among adolescents enrolled in teen clubs.

Methods

Study design

This cross-sectional study used routinely collected program data from 35 health facilities across four districts in Malawi in ALHIV that attended teen clubs between July 2018 and September 2019.

Study setting

The teen clubs were established before Elizabeth Glaser Pediatric AIDS Foundation (EGPAF) support and were run by Ministry of Health clinic staff. From January 2018, EGPAF provided additional support to facilitate the implementation of the teen clubs with the establishment of individual forms to document attendance and also provided food during the club meeting [19]. Previously, there was no formal individual level documentation of teen club attendance which would track an individual's teen club attendance as only aggregated data was collected.

Monthly, the adolescents came on Saturday clinic dates where a multidisciplinary team comprised of clinicians, nurses, and a psychosocial counselor provided services such as taking anthropometry measurements, medical history reviews, clinical and adherence assessments, screening foropportunistic infections (OIs) , VL sample collections; provision of ART and referrals to psychosocial counselors [19]. Due to variations in rolling out the individual teen club forms, sites reported teen club attendance for an average five months with other sites reporting teen club attendance for all fourteen months; as such we expected an average of five teen club visits for the adolescents included in the study.

At the time of the evaluation, the primary ART regimen was tenofovir/lamivudine/efavirenz, a non-nucleoside reverse transcriptase (NNRTI)-based regimen. Dolutegravir (DTG)-based ART was in the early implementation phases and was restricted to being provided to males who weighed 30 kg or more. Lopinavir/ritonavir, a

protease inhibitor (PI), was the second-line ART regimen for those with treatment failure on first-line ART.

Study population

We included all ALHIV aged 10–19 years who were confirmed to be on ART and who had at least one teen club visit and had a documented VL result between July 1, 2018, to September 30, 2019.We excluded those who we could not confirm information about their ART use and ART duration from the National Electronic Medical Records System (EMRS).

Data collection

We triangulated data from 2 sources: PowerBi data upload by program staff and data from the National Electronic Medical Records System (EMRS). Program staff conducting the teen clubs completed individual paper-based attendance forms at each visit that the adolescent reported for a teen club. The teen club attendance form had various demographic and clinical variables. Program staff entered data from the paper-based forms into a Power Bi database . Deidentified patient-level data were pulled from Power BI on 29 Nov 2019 and the authors had no access to information which could identify individual participants during or after the study. The database contained the following variables: facility name, district, dates of teen club visits, participant age, sex, date started ART, current ART regimen, the highest level of education, disclosure of their HIV status, adherence assessment (pill count), and VL test result. Disclosure status was considered partial if the adolescent was told the truth about their HIV status but withheld the name of HIV. In contrast, full disclosure involved providing all information about their status and knowledge about HIV.

We triangulated this data with data from the EMRS to confirm the patient's demographics and ART history.

Outcome variables

The primary outcome variable was unsuppressed VL, an HIV RNA measurement =>1000 copies/mL. At the time of the evaluation, VL was collected at 6 months post ART initiation followed by a viral load test every 2 years from the 6-month milestone. However, patients who had a high VL result had a repeat VL test, 3 months after having an initial high VL result. We used the latest VL result documented for each ALHIV during this period for analysis. The VLs documented were collected in the years of 2018–2019.A key covariate of interest was ART adherence, measured by pill count at each visit: optimal adherence was defined as a pill count that suggested between 95 and 105% of pills prescribed were consumed [20, 21]. Measurement of percent adherence was calculated by the following formula: (the number of ART pills administered at the last visit- number of ART pills that are remaining) / (number of ART pills administered at last visit - number of ART pills expected) X 100. For analysis, we used the adherence assessment documented on the date the VL result was recorded.

Data analysis

The deidentified patient-level data from Power BI were downloaded into Excel sheets. After data cleaning, data were analyzed using STATA v17. The independent variables included in the analysis were age, sex, current ART regimen, adherence assessment, ART duration, age at ART initiation, the highest level of education, disclosure status, and number of teen club visits.

Teen club attendance was treated as a categorical variable and classified as ≤ 2 visits or >2 visits. The categorization was made based after reviewing the distribution of the number of visits. A Chi-square test was used to look at associations between the number of visits and demographic characteristics.

We used frequencies to describe the demographic and clinical characteristics of the adolescents. The Chi-square test was also used to compare associations between the independent variables and outcomes. Multivariable logistic regression was used to determine factors associated with unsuppressed VL using the variables with a $p \leq 0.20$ in the Chi-square analysis. These variables included sex, districts, adherence assessment, current ART regimen, number of teen club visit, disclosure status, duration on ART and age at ART initiation. We also included age as it is considered significant based on literature. *P* values of <0.05 were considered statistically significant.

Ethical approval

The study was conducted under the umbrella protocol called "Evaluation of Outcomes achieved through integrated HIV/AIDS and TB Prevention, Care and Treatment Programs in Malawi" that allows for use of secondary data collected through Elizabeth Glaser Pediatric AIDS Foundation and Ministry of Health data collection tools, registers and databases. There was no consent or assent required for this study as this study used secondary data which had been de-identified. The umbrella protocol was approved by the Malawi National Health Sciences Research Committee (NHSRC) and the US-based Advarra Institutional Review Boards. This activity was reviewed by CDC and was consistent with applicable federal law and CDC policy.

Results

Data for 3,329 adolescents were available for analysis. The viral load coverage in our population was 40% with 1345 out 3,329 having a documented viral load result. Those who had a viral load result: were older with 59% compare to 48% of those age 15–19 years having a viral load result

(*p*-value < 0.01)(Table 1); were from Blantyre compared to the other districts (59% vs. 40%, *p* value < 0.01); had attained secondary education (14% vs. 8%) (*p*-value 0.01); and most of them were on NNRTI regimen (83% vs. 78%) (*p*-value 0.01). There was however no difference in viral load coverage by sex. (Table 1) Adolescents with missing data on ART duration were excluded (*n* = 213). The final sample size for analysis was 1,162.

Of 1,162 adolescents, 614 (53%) were females; the median age was 15 years (IQR 13–17) (Table 2). Most adolescents (53%, *n* = 624) were from Blantyre District. Most adolescents (88%, *n* = 967) had attained primary school as their highest level of education. More than half the adolescents (54%, *n* = 628) had initially started ART between 0 and 9 years old. The median ART duration was six years (IQR 3–9). Only 45% (*n* = 382) of the adolescents had optimal ART adherence based on pill counts. 4% (*n* = 41) of the adolescents were on a second-line, PI-based ART. regimen. More than half (57%, *n* = 663) of the adolescents were documented to have achieved full disclosure of their HIV status and attended only one or two teen club visits (57%, *n* = 665), with median teen club visits being two (IQR 1–4). Overall, 28% (*n* = 323) had unsuppressed VL.

Table 3 shows the number of visits by demographic characteristics. There was no difference in attending > 2 visits by age, sex, adherence assessment and duration on ART. Significant variations in teen club attendance occurred by district with those in Blantyre having more visits compared to other districts ; with those with secondary education or higher having more visits than in primary education; as well as those on NNRTI regimen having more visits compared to those on other regimens and lastly those who had partial disclosure had more visits compared to those with full disclosure.

In the bivariate analysis, the factors that were associated with unsuppressed VL included: coming from the Zomba district [cOR 1.56 (1.13–2.17)]; having sub-optimal ART adherence as measured by pill count [cOR 2.12 (1.56–2.94)]; being male [cOR 1.40 (1.08–1.81)] and being on a second-line PI-based regimen [cOR 4.29 (2.27–8.3)]) (Table 4). Factors which were protective of unsuppressed VL included: attaining secondary or higher education [cOR 0.49 (0.30–0.78)] and initiating ART between 15 and 19 years [cOR 0.54 (0.33–0.90)]. Attending > 2 teen club visits was also marginally protective against unsuppressed VL compared to those who had participated in, ≤ 2 teen club visits [cOR 0.77 (0.58-1.00)]. There was no significant association between unsuppressed VL and age [cOR 0.89 (0.68–1.15)] or disclosure status [cOR 0.80 (0.60–1.04)].

In the multivariable analysis, sub-optimal adherence was associated with unsuppressed VL [aOR 2.0 95% CI 1.42–2.62](Table 4). Those who had attained secondary school education were less likely to have unsuppressed VL than those who only had primary school education [aOR 0.42 95% CI 0.21–0.81]. Those on second-line, PI-based ART had more than three-fold increased odds of having unsuppressed VL compared to those on first-line NNRTI-based ART [aOR 3.7 95% CI 1.64 to 9.09].

Discussion

In this study, 28% of the adolescents had unsuppressed VL, with poor adherence being a key determinant of unsuppressed VL among this study population, the majority of whom also had low teen club attendance. Other studies in Malawi have reported rates of

Table 1 Comparison of difference in demographic and clinical characteristics between those who had a viral load and those who did not have a viral load

Factor	Characteristic	Total 3,329	VL result available *N* = 1,345	VL not available *N* = 1,984	*p*-value
District	Blantyre	1,577	789(59)	788(40)	< 0.001
	Mchinji	96	69(5)	27(1)	
	Thyolo	543	219(16)	324(16)	
	Zomba	1,113	268(20)	845(43)	
Current age (years)	10–14	1,591	551(41)	1040(52)	< 0.001
	15–19	1,738	794(59)	944(48)	
Sex	Females	1,748	712(53)	1036(52)	0.684
	Males	1,581	633(47)	948(48)	
Highest Level of Education	Primary	2,850	1075(80)	1775(89)	< 0.001
	Secondary or more	342	190(14)	152(8)	
	Missing	137	80(6)	57(3)	
ART Regimen	NNRTI based	2,670	1120(83)	1550(78)	< 0.001
	PI-based	131	67(5)	64(3)	
	DTG based	246	64(5)	182(9)	
	Missing	282	94(7)	188(10)	

Table 2 Distribution of the study population by demographic characteristics*

Factor	Characteristic	*N* (%)
District	Zomba	256 (22)
	Thyolo	214 (18)
	Blantyre	624 (54)
	Mchinji	68 (6)
Current age (years)	10–14	511 (44)
	15–19	651 (56)
Sex	Females	614 (53)
	Males	548 (47)
Highest Level of Education	Primary	967 (88)
	Secondary or more	134 (12)
	Missing	61
ART Regimen	NNRTI based	976 (91)
	PI-based	41 (4)
	DTG based	60 (5)
	Missing	85
ART Regimen line	First Line	1036 (96)
	Second Line	41 (4)
	Missing	85
Age at ART initiation (years)	0–9	628 (54)
	10–14	417 (36)
	15–19	117 (10)
ART duration (years)	< 1	101 (9)
	2–5	439 (38)
	6–10	471 (40)
	> 10	151 (13)
ART Adherence (Pill count)	Adherent (95–105% pills consumed)	382 (45)
	Non-adherent	463 (55)
	Missing	317
Disclosure of HIV status	Completed	663 (57)
	Partial	499 (43)
Number of teen club visits	≤ 2	665 (57)
	> 2	497 (43)

unsuppressed VL of 32% among adolescents attending teen clubs [22]. However, a study in Tanzania, which had less than half of adolescents attend teen clubs regularly over two years, reported higher proportions of unsuppressed VL of 45%s.

In this study, adolescents reported few teen club visits than the anticipated average of five. Low teen club attendance has been shown to occur in adolescents for several reasons, including adolescents reporting they had to attend regular ART clinic days (not Saturdays) to receive medication, having caregivers collect medication on their behalf, and generally missing their study visits [13]. A case study of four adolescents attending teen clubs in Malawi also noted that most of them did not attend all the scheduled teen club sessions for two years. Most of them were facing life adversities, such as being juvenile detained, facing economic hardships, and battling stigma which may have affected their teen club attendance [23]. However, there is a need for qualitative research targeting adolescents to understand the reasons for the non-attendance of teen clubs and how the teen clubs could be improved to generate more attendance.

Nevertheless, low attendance of teen clubs (only one or two visits) was marginally associated with unsuppressed VL in the bivariate analysis; however, this association became insignificant after adjusting for potential confounding variables in the multivariable analysis. A study done in Malawi showed similar findings, where teen club attendance was not associated with viral load suppression, as viral load suppression was similar between those enrolled in teen clubs and those not enrolled in teen clubs [22]. A recent study from Tanzania evaluated the association between teen club attendance and unsuppressed VL over more extended periods, up to 24 months [13]. However, even in this study, teen club attendance was not associated with VL suppression [13]. However, a study done in South Africa showed reduction in unsuppressed VL among adolescents attending even one adolescent-friendly clinic visit [10]. The reasons why there is no association between teen club attendance and viral

Table 3 Demographic characteristics of participants by number of visits

Characteristic	Description	Number of visits < 2 *N* = 665	> 2 Number of visits *N* = 497	*P*-value
District	Blantyre	320 (48)	304 (61)	< 0.001
	Mchinji	68 (10)	0 (0.0)	
	Thyolo	119 (18)	95 (19)	
	Zomba	158 (24)	98 (20)	
Sex	Male	314 (47)	234 (47)	0.963
	Female	351 (53)	263 (53)	
Age group (years)	10–14	295 (44)	216 (44)	0.760
	15–19	370 (56.)	281 (56)	
Education level	Primary	571 (90)	396 (85)	0.03
	Secondary or higher	66 (10)	68 (15)	
Adherence assessment (Pill count)	Optimal adherence (95–105% pills consumed)	205 (45)	177 (46)	0.83
	Sub-optimal adherence	252 (55)	211 (54)	
Current ART regimen	NNRTI-based	531 (87)	445 (95)	< 0.01
	PI-based	32 (5)	9 (2)	
	DTG-based	45(8)	15 (3)	
Disclosure status	Complete	409 (62)	254 (51)	< 0.01
	Partial	256 (38)	243 (48)	
Duration on ART	< *1* year	63 (9)	38 (8)	0.320
	2–5 years	261 (39)	178 (36)	
	6–10 years	257 (39)	214 (43)	
	> 10 years	84 (13)	67 (13)	

suppression need to be understood and should be an area for further research.

Our findings confirm that sub-optimal adherence based on pill counts is a crucial predictor of unsuppressed VL; this association has also been shown in studies conducted in adolescents aged 10–19 years from Kenya and Uganda [5, 24, 25]. Nakutunda et al. showed that adolescents with an adherence rate of > 95% were two-fold more likely to be virally suppressed than those with poor adherence in Uganda [5]. Mwangi et al. also showed that good adherence was strongly associated (2.3-fold increase) with viral suppression in Kenya [24]. These findings support that addressing non-adherence among adolescents is essential for suppression of viremia in ALHIV.

In our study, higher educational level was protective against unsuppressed VL. Some studies have not found that educational level was associated with VL suppression [4], but others have shown that unsuppressed VL was more common in those with no education or those with only primary education; this may be because adolescents with more education are more likely to understand the importance of taking the ART medication [26, 27].

We found that ALHIV on second-line PI-based ART were likely to have unsuppressed VL. Similar findings have been reported in other studies done in Kenya and Uganda [5, 24, 26]. Nakutunda et al. noted that adolescents with an initial unsuppressed VL were more likely to experience virologic failure upon a repeat VL assessment [5]. Maena et al. attributed the unsuppressed VL in those on second-line ART to be due to lack of ART adherence which may be the reason why they failed the first-line ART in the first place [26]. We also noted that the proportion of ALHIV with unsuppressed VL was comparable between those on DTG-based and NNRTI-based regimens. However, recent studies have shown improved viral suppression among adolescents who switched to DTG-based ART [28]. However, the proportion of adolescents who transitioned to DTG was small, and as per national guidelines at the time, were primarily boys > 30 kg. Lastly, due to the cross-sectional design of the study, we were unable to ascertain the timelines of the events, as to whether lack of viral suppression preceded the ART regimen switch to either PI-based second line or to DTG-based regimens (i.e., patients had unsuppressed VL and in response, they were switched to different regimens) or whether the regimen switch preceded the unsuppressed VL measurement.

Clinic location was not associated with unsuppressed VL in the multivariable analysis. However, differences in lack of viral suppression across regions have been observed in the Malawi Population HIV Impact Assessment (MPHIA), showing higher levels of unsuppressed VL in Blantyre compared to other districts [29]. A study in Kenya also noted differences in the proportion of people with unsuppressed VL across various country regions, which advocates for more targeted regional interventions to improve national viral suppression rates [25].

Sex was not associated with unsupressed VL in the multivariable analysis of our study. However, other studies have shown that the male sex is associated with higher

Table 4 Factors associated with unsuppressed viral load among adolescents living with HIV aged 10–19 years

Variable	Characteristic	Suppressed VL (HIV RNA < 1,000)	Unsuppressed VL (HIV RNA > = 1,000)	Crude Odds Ratio (cOR) (95% CI)	*p*-value	Adjusted Odds Ratio (aOR)[a] 95% CI	*p*-value
District	Blantyre	467 (75%)	157 (25%)	Ref	-	Ref	
	Mchinji	55 (81%)	13 (19%)	0.70 (0.38–1.33)	0.17	0.52 (0.23–1.19)	0.12
	Thyolo	149 (70%)	65 (30%)	1.30 (0.95–1.85)	0.06	1.02 (0.60–1.69)	0.95
	Zomba	168 (66%)	88 (34%)	1.56 (1.13–2.17)	0.01	1.23 (0.71–2.13)	0.45
Sex	Female	463 (75%)	151 (25%)	Ref	-	Ref	
	Male	376 (69%)	172 (31%)	1.40(1.08-1.81-)	0.01	1.28 (0.92–1.81)	0.14
Age group (years)	10–14	362 (71%)	149 (29%)	Ref	-	Ref	
	15–19	477 (73%)	174 (27%)	0.89 (0.68–1.15)	0.4	1.14 (0.76–1.69)	0.63
Education level	Primary	679 (70%)	288 (30%)	Ref	-	Ref	-
	Secondary or higher	111 (83%)	23 (17%)	0.49 (0.30–0.78)	0.01	0.42 (0.21–0.81)	0.01
Adherence assessment (Pill count)	Optimal adherence (95–105% pills consumed)	305 (80%)	77(20%)	Ref	-	Ref	
	Sub-optimal adherence	302 (65%)	161 (35%)	2.12 (1.56–2.94)	0.00	2.0 (1.42–2.86)	0.00
Current ART regimen	NNRTI-based	715 (73%)	261 (27%)	Ref		Ref	
	PI-based	16 (39%)	25 (61%)	4.29 (2.27–8.3)	0.00	3.7 (1.64–9.09)	0.00
	DTG-based	43 (72%)	17 (28%)	1.08 (0.60–1.96)	0.81	0.59 (0.25–1.35)	0.21
Disclosure status	Complete	466 (70%)	197 (30%)	Ref	-	Ref	
	Partial	373 (75%)	126 (25%)	0.8 (0.60–1.04)	0.09	0.92 (0.59–1.49)	0.76
Number of Teen Club Visits	≤ 2	465 (70%)	200 (30%)	Ref	-	Ref	-
	> 2	374 (75%)	125 (25%)	0.77 (0.58-1.00)	0.045	0.80 (0.50–1.27)	0.14
Duration on ART.	< *1* year	72 (71%)	29 (29%)	Ref	-	Ref	
	2–5 years	314 (72%)	125 (28%)	0.99 (0.61–1.58)	0.96	1.00(0.51–1.96	0.50
	6–10 years	353 (75%)	118 (25%)	0.83 (0.51–1.35)	0.44	0.84 (0.38–1.85)	0.50
	> 10 years	100 (66%)	51 (34%)	1.28 (0.73–2.22)	0.40	1.33 (0.51–3.44)	0.30
Age at initial ART initiation	0–9	448 (71%)	180 (29%)	Ref		Ref	
	10–14	295 (71%)	122 (29%)	1.03 (0.78–1.37)	0.84	1.03 (0.62–1.72)	0.92
	15–19	96 (82%)	21 (18%)	0.54 (0.33–0.90)	0.02	0.61 (0.24–1.51)	0.28

a.Adjusted for variables with a ^{p} value of <0.20 in the Chi-square analysis. These variables included sex, districts, adherence assessment, current ART regimen, number of teen club visit, duration on ART, disclosure status and age at ART initiation.We also include age based on literature

levels of unsuppressed VL due to poorer health-seeking behaviors amongst males than females [26, 30].

This study had the following limitations. Due to the use of routine data for our analysis, we encountered missing data which required us to exclude adolescents from the analysis. Our viral load coverage was low with only a third of the study population having viral load data available; with some differences between those who had viral load data and those that did not which would suggest that we had biased sample. The low viral load coverage is not a surprising finding in Malawi.The viral load coverage in Malawi has been low with other studies reporting rates as low as 27% [31]. Other studies have reported viral load coverage rates of 39% among children < 20 kg [32]. We note that the fact that viral loads were collected at more spaced out intervals of every 2 years, could have contributed to some adolescents not having a result as they were not eligible for a viral load collection in our years of interest of 2018–2019. Also, even though there were differences between those who had a viral load and those who did not; we were able to adjust for these differences in our analyses. However, the low teen club attendance limited our power to detect any "dose-response" between clinic attendance and viral suppression. Other variables of interest, such as CD4 counts and occurrence of opportunistic infections, which have been shown to impact the lack of viral suppression, were unavailable as they are not routinely collected. As the study is cross-sectional, we cannot establish causality because exposure and outcome variables were measured at the same time.

The study's strength was that we shared a real word representation of the differentiated service of teen clubs including challenges in viral load coverage. The study had a large sample size from four districts in Malawi and findings could potentially be generalizable to these districts.

Conclusion

This study has shown that many ALHIV enrolled in a differentiated service delivery had low attendance in teen clubs and high rates of unsuppressed VL. Lack of viral suppression was associated with suboptimal adherence, low level of education, and being on second-line ART. A continuing focus on adolescents attending differentiated service is necessary to improve their viral load outcomes, especially those that are non-adherent and those on second-line ART.

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Author contributions
RC, TM, FG conceptualized research concept and wrote main manuscript text. LK and HN conducted data analysis and reviewed the manuscript. KK, AM, VB, DK reviewed and contributed to the manuscript. GW and TM provided guidance to the main author in research concept design , data analysis and reviewed the manuscript. All authors reviewed the manuscript.

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Data availability
The STATA base which support the findings of this study have been stored in the EGPAF server. The dataset is available upon reasonable request to the corresponding author. Please email the corresponding author rkanyenda@pedaids.org.

Declarations

The findings and conclusions in this manuscript are those of the authors and do not necessarily represent the official position of the funding agencies.

Ethics approval and consent to participate
The National Health Science Research Committee and the Advarra Research Committee approved this study. The Centers for Disease Control and Prevention also reviewed and cleared the data collection protocol. There was no consent or assent required for this study as this study used secondary data which had been de-identified. The informed consent was waived by the National Health Science Research Committee and the Advarra Research Committee.

Consent for publication
N/A.

Competing interests
The authors declare no competing interests.

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