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The Outcome of Operation Triple Zero Clubs on Viral Load Outcomes among Adolescents Living with HIV: An Interventional Study of ICHSSA-2 Project in Lagos State

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Abstract

Background: In Nigeria, the total number of AIDS-related deaths among children and adolescents was 16,200 in 2020. The Integrated Child Health and Social Services Award 2 (ICHSSA-2) project supports Operation Triple Zero (OTZ) clubs in 13 health facilities in Lagos State with support from PEPFAR through the United States Agency for International Development (USAID). The initiative aimed at ensuring zero missed appointments, zero missed drugs, and zero viral load among adolescents living with HIV (ALHIV).

Methodology: A quasi-experimental study design was used to evaluate the impact of the OTZ intervention on viral suppression rates among 237 adolescents aged 10–20 years enrolled in OTZ clubs from October 2021 to September 2023. Data from the OTZ club register and electronic medical records from the health facilities were used. The study analyzed data from 237 ALHIV enrolled on OTZ clubs between 12 to 24 months. Chi-square statistics was used to compare proportional differences in viral load change using STATA version 14 at $p<0.05$.

Results: The mean age of participants was 16 ± 2.5 years comprising 55% females and 45% males. The baseline data showed that 80.2% (Female-81.5%; Male- 78.5%) of participants had suppressed viral load. The viral load suppression performance increased to 95.4% (Female 95.4%; Male- 95.3%). Overall, there was 15.2% increase in viral load suppression with 16.8% and 13.9% among male and female participants respectively. Further analysis showed an increase in proportion of those with undetectable viral load (<20 copies/ml) from 40% at baseline to 70% at the end of this study.

Conclusion: The study revealed that OTZ club intervention has proven effective in improving retention and viral load suppression among ALHIV. Government and Implementing Partners might consider prioritizing and sustaining the implementation of OTZ club intervention. Scaling up OTZ club intervention could improve viral suppression among adolescents.

Keywords: HIV, Operation Triple Zero, Adherence, ART, Adolescents living with HIV

Abbreviations: ALHIV: Adolescent Living with HIV; ART: Antiretroviral Therapy; VL: Viral load; EAC: Enhanced Adherence Counselling; HIV: Human Immunodeficiency Virus; ARFH: Association for Reproductive and Family Health; USAID: United States Agency for International Development; OTZ: Operation Triple Zero; ICHSSA-2: Integrated Child Health and Social Services Award; LGA: Local Government Area

Introduction

HIV/AIDS continues to represent a global public health challenge [1]. In 2022, it claimed the lives of 630,000 [480,000–880,000], and 1.3 million people were newly infected with HIV [2]. The majority of the burden of the infection and the disease occurs in Africa, specifically in sub-Saharan countries [2,3]. Nigerian adolescents are a significant part of HIV cases and management, with an estimated 0.04% incidence among older adolescents and young adults and 0.2% among older adolescents aged 15-19 years [NAIIS 2018] [4]. Adolescents and young people make up 31% of Nigeria's population, with adolescents aged 10-14 making up the largest proportion [4,5]. Adolescents constitute 40% of new HIV infections worldwide, rendering them a socially and economically vulnerable demographic. In sub-Saharan Africa alone, approximately 1.7 million adolescents are living with HIV (ALHIV) [6].

Despite the availability of antiretroviral therapy (ART), which has dramatically improved survival and quality of life for people living with HIV, viral load suppression remains an ongoing challenge, particularly among adolescents [6]. In 2021, around 800,000 children living with HIV were not treated. Though only 5% of the people with HIV are children, they account for 15% of all AIDS-related deaths [7]. Nigeria faces significant burdens, with 16,200 HIV-related deaths reported among children and adolescents [8]. The gap in HIV treatment coverage between children and adults is widening, with adolescents facing increased risks due to social stigma, lack of prevention strategies, and limited access to treatment, underscoring the need for strengthened interventions to support this demographic [9].

Adolescent viral load suppression is crucial for HIV management, as it reduces disease progression and transmission. Viral load suppression among ALHIV minimizes the risk of new HIV infection among the sexually active adolescent population [10]. However, suboptimal ART adherence among adolescents often leads to persistently high viral loads in many regions [11,12]. The World Health Organization (WHO) defines virological failure as a viral load exceeding >1000 copies/ml after 6-12 months of ART [6]. WHO further recommends that HIV viral load monitoring be done 4-8 weeks post-ART initiation or modification to confirm adequate virologic response and appropriate regimen selection. Although the Nigeria guideline is 6 months after ART initiation. For stable ART regimens, monitoring may be extended to every 6 months. For virologically suppressed patients, those whose ART was modified, and those with virologic failure, the frequency of monitoring depends on adherence [2,6]. Despite these guidelines and substantial progress made in ART accessibility, only 50% of adolescents in sub-Saharan Africa currently receive adequate treatment, with many failings to achieve sustained viral suppression [13]. Maintaining undetected viral suppression or low viral load is a crucial goal of treatment for people living with HIV (PLHIV) for both clinical and transmission prevention benefits [3,6].

In Nigeria, adolescents face ongoing challenges in HIV care, including adherence issues and stigma, despite progress for adults. The United Nations Children's Fund (UNICEF) and United States Agency for International Development (USAID) are working to improve access to ART and foster peer support. Operation Triple Zero (OTZ) is an innovative program designed to support ALHIV in achieving three key goals: zero missed clinic appointments, zero missed medications, and zero viral load [14]. It has been successfully implemented in several regions to address the specific barriers faced by adolescents, such as stigma, peer pressure, and a lack of comprehensive health education [15]. The OTZ club involves ALHIV whose HIV positive status has been disclosed to them. Major features include self-introduction by members, group activities, health therapy sessions, life skills and career counselling, play therapy and orientation on 7 OTZ modules namely adolescent participation in their health; treatment literacy; leadership; peer to peer mentorship; OTZ logos, pledge and anthem; PHDP and positive living and adolescent transition from OTZ into adult clinic. OTZ meetings also include coordination of activities by an OTZ champion and a pledge to defend health and avoid missed appointments and missed drugs. Success can inform scale-up efforts, advocating for the expansion of OTZ to other regions or countries facing similar challenges [14]. OTZ, a peer-based HIV treatment program, has demonstrated effectiveness in reducing viral loads among adolescents. Research conducted in Kenya and Zambia indicates that adolescents enrolled in OTZ experience higher rates of adherence to treatment and viral suppression, which can be attributed to its peer-centered structure [3].

Similarly, Project YES! in Zambia, which also incorporates peer mentorship akin to OTZ, revealed significant enhancements in viral suppression and a decrease in internalized stigma among youth receiving ART at pediatric clinics [16]. In South Africa, programs that provide peer support and continuous ART counselling have been shown to improve adherence among HIV-positive adolescents [12]. Additionally, adolescents with strong support systems exhibited better viral suppression rates [12]. The integration of point-of-care HIV viral load testing, combined with task shifting, has streamlined adherence to ART by reducing clinic wait times and improving retention rates. Accessible and simplified testing positively impacts long-term ART adherence and suppression rates, further emphasizing the advantages of adolescent-centered care models such as OTZ [17].

A study by Audi *et al.* (2021) highlights that adolescent support groups, like OTZ, foster adherence to HIV treatment by equipping individuals with knowledge and confidence across age groups. These groups provide a platform for sharing information, advice, and insights regarding ART, medication adherence, and the consequences of skipping doses. They also serve to educate adolescents about HIV and sexual and reproductive health, offering support for health-related inquiries and empowering them to become advocates for HIV awareness in their communities [18].

The success of the OTZ program in Kenya and other sub-Saharan countries has prompted its consideration in Nigeria. A study on adolescents with HIV in Kwara State evaluates OTZ, which offers support primarily through youth-friendly centers, focusing on mental health and psychosocial support during meetings [9]. Nigeria, with high adolescent HIV cases in West and Central Africa [13], has benefited from implementing a model like OTZ to improve ART adherence and viral suppression outcomes. The Integrated Child Health and Social Services Award 2 (ICHSSA-2) project, focusing on comprehensive healthcare for vulnerable populations, offered an ideal framework for integrating OTZ into ICHSSA-2, providing a structured environment for adolescents. This approach, along with peer support, mentorship, and a community framework, can significantly improve viral suppression rates in Lagos, thereby enhancing overall health outcomes [19].

There is a critical need for targeted interventions for adolescents living with HIV in Nigeria, who face distinct social, psychological, and economic challenges. While ART has greatly improved treatment outcomes, it is vital to achieve sustained viral suppression. Evidence of the OTZ initiative implemented in other countries and recently in Nigeria has shown promise in promoting peer support and enhancing ART adherence among ALHIV. This study aims to assess the impact of OTZ on viral load suppression among ALHIV in Lagos by analyzing changes in pre- and post-OTZ participation. This analysis will inform future intervention strategies and support Nigeria in achieving global HIV management targets, particularly the UNAIDS 95-95-95 goals.

Methods

Study design

A quasi-experimental research design was utilized for the study. This study evaluates the relationship between OTZ and viral load suppression among ALHIV who participate in the intervention. The study evaluates the outcome of intervention after 6-12 months of participation in OTZ club which was part of the ICHSSA-2 project funded by USAID, across various health facilities in Lagos.

Key components of the intervention included treatment literacy training, individualized treatment plans, support groups, peer support via OTZ graduates called OTZ champions, financial literacy and directly observed therapy. The study captioned viral load rates at enrollment, as well as at 6 and 12 months, and assessed the significance of these changes. The adolescents were categorized into three age groups: 10-14 years, 15-17 years, and 18-20 years.

Study setting

Lagos state is located in the South–Western part of Nigeria, on the narrow plain of the Bight of Benin. Lying approximately on longitude 20º 42'E and 32º 2'E respectively, and between latitude 60º 22'N and 60º 2'N, Lagos State is bounded in the North and East by the Ogun State of Nigeria, in the West by the Republic of Benin, and stretches over 180 kilometers along the Guinea Coast of the Bight of Benin on the Atlantic Ocean. Its territorial extent encompasses an area of 358,862 hectares or 3,577 sq. km [20]. According to the NAIIS 2018 report, Lagos is one of the red states in Nigeria in terms of HIV burden due to its population density, commercial hub activities, seaports, and high mobility. The Association for Reproductive and Family Health (ARFH) is implementing the USAID-supported ICHSSA-2 project in Lagos State, Nigeria, with the aim of mitigating the impact of HIV/AIDS on vulnerable children and their households. The ICHSSA-2 project supports the provision of HIV and social services in 53 USAID-supported health facilities across 11 focused local government areas (LGAs)-Ajeromi, Apapa, Agege, Badagry, Kosofe, Ikorodu, Lagos Island, Lagos Mainland, Ojo, Shomolu, and Surulere in Lagos State. This project currently supports 1,016 adolescents eligible for OTZ clubs in the 11 USAID-supported LGAs in Lagos State.

Sample size determination

The sample size was calculated using the following formula for the studies:

$$\text{Sample size} = \frac{\frac{(z)^2 p(1-p)}{e^2}}{1+\frac{(z)^2 p(1-p)}{e^2 N}}$$

Where:

N= Population size (1016)

Z= z-score (1.96)

e = margin of error (0.005)

p = standard deviation (0.5)

$$\frac{\frac{(1.96)^2 \times 0.5(1-0.5)}{0.05^2}}{1+\frac{(1.96)^2 \times 0.5(1-0.5)}{0.05^2 \times 1016}} = 237$$

Accounting for 10% potential loss to follow-up

The calculation yielded a minimum required sample size of 237 participants.

Sampling procedure

Systematic random sampling was used to enroll 237 ALHIV aged 10 to 20 years in OTZ clubs between 6 and 12 months preceding the study and those on ART for 12-24 months. ALHIV who had been on ART for six months or less and had missed the OTZ clubs in the last six months were excluded from the study.

Participants

Adolescents included in the study were ALHIV aged 10 to 20 years on ICHSSA-2 project; adolescents on ART for 12-24 months; enrolled in OTZ clubs and actively participated between 6 and 12 months preceding the study. However, ALHIV who are not up to 12 months on ART and those who had missed OTZ club meetings more than 2 twice in the last 6-12 months were excluded.

Data collection and management

A secured Excel template was developed to extract anonymized sociodemographic and clinical data from the folders of 237 eligible adolescents. The OTZ attendance register across the health facilities was retrieved, and the line list of 1,016 adolescents who were eligible for the study was generated by facility case managers (FCMs). The project engaged FCMs embedded within the supported USAID facilities who were trained on the OVC Case Management system to OVC support at the health facilities and monitor the OTZ clubs of adolescents enrolled on the ICHSSA-2 project.

The ICHSSA-2 project does not conduct viral load tests; this aspect is managed by the project's treatment partners. However, the project does have access to test results from health facilities, provided these results are documented in the medical folder with the consent of the ALHIV or their caregivers.

The Excel template was secured, handled fairly, and protected against any unauthorized or illegal access. The ICHSSA-2 project Strategic Information (SI) team verifies and validates all the data entered into the Excel template. Thereafter, both internal and external Data Quality Assessment were conducted by the FCMs and SI team of the ICHSSA-2 project. The data were routinely checked for accuracy and quality.

Data analysis

The extracted data were cleaned and imported into STATA statistical software version 15.1 for analysis. Incomplete ALHIV information was reviewed and completed by the FCMs. Descriptive, univariate and bivariate statistics were used to analyze the frequency and percentage distributions of the demographic factors such as the age of the child at OTZ start, sex, and current age of the child. Cross-tabulation of the dependent variables with explanatory variables such as the missed attending OTZ in the past 6 months and the socio-demographics. Pearson's chi-square test was used to test the association between the dependent and independent variables at the bivariate level.

Ethical considerations

The ICHSSA-2 project is being implemented by the ARFH through the USAID Cooperative Agreement (720-620-20-CA-00004). Written informed consent was obtained from the caregivers of the adolescents before enrollment in the ICHSSA-2 project. A thorough explanation of the project and assurance of confidentiality were provided by the project's FCMs. Ethical approval for this manuscript has been given in the proposal that findings from the project will be published.

Results

Demographics characteristics of adolescents

The study included 237 ALHIV who were actively receiving ART. Adolescent OTZ attendance in the last 6 months shows more than half (54.8%) of the adolescents had never missed the OTZ meeting, 23.2% had missed it twice, and 22.0% had missed it once in the last 6 months **(Table 1)**. A little above half, (51.4%) were females, and 48.5% were males. The age distribution of the adolescents shows that 26.5% were 10-14 years old, 26.5% were 15-17 and 36.0% were 18-20 years.

Table 1. Demographics characteristics of adolescents.

Variables	Frequency (N=237)	Percentage
The age of the child at OTZ start		
10-14 years	153	64.5
15-17 years	77	32.5
18-20 years	7	3.0
Sex		
Female	130	54.8
Male	107	45.2
Current age of the child		
10-14 years	63	26.5
15-17 years	89	37.5
18-20 years	85	36.0
Age at ART start		
1-4 years	58	24.5
5-9 years	69	29.1
10-14 years	87	36.7

15-17 years	20	8.4
18-20 years	3	1.3
Adolescent's OTZ attendance in the last 6 months		
Missed twice	55	22.2
Never missed	130	54.8
Once	53	22.0
What is the ART status of the last 12 months?		
Active	237	100
Pre-OTZ 2022		
Suppressed	195	82.3
Not suppressed	42	17.7
Post-OTZ 2023		
Suppressed	226	95.4
Not suppressed	11	4.6
Suppressed Pre-OTZ		
Suppressed (<1000)	49	25.1
Undetectable (≤ 20)	146	74.9
Suppressed Post-OTZ		
Suppressed (<1000)	54	23.9
Undetectable (≤ 20)	172	76.1
Ever on EAC		
No	185	78.1
Yes	52	219
Legends: OTZ: Operation Triple Zero; ART: Antiretroviral Therapy; EAC: Enhanced Adherence Counselling		

The OTZ club gender chart: Figure 1 illustrates the changes in viral load suppression rates among adolescents' pre- and post- OTZ clubs, stratified by gender, focusing on the "Suppressed" and "Unsuppressed" categories. The Y-axis represents the percentage of viral load suppression. Pre-OTZ, 83.9% of females and 80.4 males were in the "Suppressed" category, while 16.1% females and 19.6% males were unsuppressed respectively. Post-OTZ, 95.4% of females were in the "Suppressed" category, and only 4.6% were unsuppressed. On the other hand, there was a 14.9% increase in suppression rate post-OTZ for males with 95.3% "Suppressed" and 4.7% unsuppressed **(Figure 1)**.

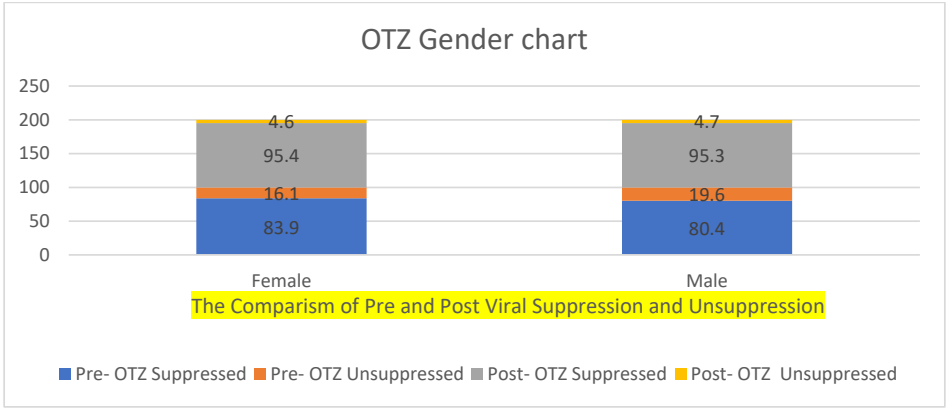

Figure 1. The OTZ gender chart.

ART and adherence status

Table 2 revealed that 95.8% of children are on an optimized therapy regimen, with only 4.2% on a non-optimized regimen. The mean regimen status is 2.0, indicating a highly optimized regimen. Among the ALHIV, 88.6% did not miss any appointments or drug pickups in the last six months, with a mean of 1.1. The confidence interval for missed appointments ranges from 1.073 to 1.155, indicating minimal variation around the mean. The mean for treatment status change over the last three years was 1.1, showing a stable maintenance of active status among most of the ALHIV. The table also shows minimal variation around the mean for missed appointments/ drugs pick up and treatment status changes over the last three years.

The relationship between adherence and socio-demography

Table 3 presents a breakdown of social demographic variables related to adolescents who have missed drug pick-ups or appointments within the past six months. It further revealed that among the ALHIV, females (56.1%) were less likely to miss attendance at the OTZ, while males (53.3%) had a higher rate of missing meetings. Attendance in the last six months indicated that participants aged 18-20 years most often (57.6%) attended the OTZ. ALHIV aged between 10-14 (55.0%) and 15-17 (53.0%) had a good attendance record.

Paired t-test results for viral load before and after intervention

The study compares the viral load of children living with HIV before and after a cash transfer intervention. The results show a significant improvement in viral load levels post-intervention, with a mean difference of 2.4473 compared to 2.0759. The 95% confidence interval ranges from 2.3359 to 2.5586, and the mean difference is 0.3713 **(Table 4.1)**. The t-statistic is 4.9929. The degrees of freedom for this test is 236, typical for a paired t-test with 237 observations.

Table 2. Adherence among adolescents' status.

Variables	Frequency (N=237)	Percentage	Mean	Std. Err	95% Confidence Interval	
The child's current regimen						
Not Optimized	10	4.2	2.0	0.01	1.932026	1.983586
Optimized	227	95.8				
Missed appointment/drug pickup in the last 6 months						
No	215	90.7	1.1	0.02	1.055613	1.130041
Yes	22	9.3				
Has the client attained any other treatment status aside from being active in the last 3 years?						
No	220	92.8	1.1	0.01	1.038639	1.104821
Yes	17	7.2				
Missed OTZ meetings in the last months						
Missed twice	55	23.2	2.0	0.04	1.90119	2.073494
Never missed	130	54.9				
Once	52	21.9				

Table 3. Relationships between adherence and socio-demographics.

Variables	Missed OTZ meeting in the past 6 months			Total
	Missed Twice	Never Missed	Once	
The child's sex				
Female	30 (23.1)	73 (56.1)	27 (20.8)	130
Male	25 (23.4)	57 (53.3)	25 (23.3)	107
Pearson chi2(2) = 0.2712 Pr = 0.873				
Current child's age				
10-14 years	17 (27.0)	34 (55.0)	12 (19.0)	63

15-17 years	19 (21.2)	47 (53.0)	23 (25.8)	89
18-20 years	19 (22.4)	49 (57.6)	17 (20.0)	85
Pearson chi2(4) = 1.7481 Pr = 0.782				
Age at ART start				
1-4 years	10 (17.2)	41 (70.7)	7 (12.1)	58
5 – 9 years	21 (30.3)	33 (47.3)	15 (21.4)	69
10-14 years	14 (16.1)	52 (59.8)	21 (21.1)	87
15-17 years	8 (40.0)	3 (15.0)	9 (45.0)	20
18-20 years	2 (66.7)	1 (33.3)	0	3
Pearson chi2(8) = 27.1874 Pr = 0.001				
Age of the child at OTZ start				
10-14 years	33 (21.6)	86 (56.2)	34 (22.2)	153
15-17 years	20 (26.0)	40 (52.0)	17 (22.1)	77
18-20 years	2 (28.6)	4 (57.1)	1 (14.3)	7
Pearson chi2(4) = 0.8874 Pr = 0.926				
Missed drug pickup/appointment in the last 6 Months				
No	44 (20.5)	123 (57.2)	48 (22.3)	215
Yes	11 (50.0)	7 (31.8)	4 (18.2)	22
Pearson chi2(2) = 10.0038 Pr = 0.007				
Legends: OTZ: Operation Triple Zero; ART: Antiretroviral Therapy				

Table 4.1. Paired t-test results for viral load before and after intervention.

Variables	Mean	Std. Err	Std.Dev	95% Conf. Interval	
Pre- OTZ 2022	**2.447257**	**0.0565066**	**0.8699082**	**2.335936**	**2.558579**
Post OTZ 2023	**2.075949**	**0.0589899**	**0.9081386**	**1.959735**	**2.192163**
Diff	**0.371308**	**0.0743665**	**1.144858**	**0.2248011**	**0.517815**

mean(diff) = mean (post OTZ 2023 – post OTZ 2022) t = 4.9929

Ho: mean(diff) = 0 degrees of freedom = 236

Ha: mean(diff) < 0 Ha: mean(diff) != 0 Ha: mean(diff) > 0

Pr(T < t) = 1.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

The multiple regression analysis model of viral load suppression and related factors

The regression analysis table **(Table 4.2)** summarizes the results of a study examining factors influencing post-OTZ 2023. The model includes the sum of squares (SS), degrees of freedom (DF), mean square (MS), F-statistic, R-squared, adjusted R-squared, and root mean square error (RSE).

The F-statistic measures the model's significance, with a higher F value indicating a stronger relationship between predictors and outcome variables. The R-squared value explains 4.58% of post-OTZ 2023 variance, indicating a low explanatory power. The adjusted R-squared value adjusts for the number of predictors, providing a more accurate measure of goodness-of-fit.

The study reveals a significant negative relationship between Ever on EAC and lower post-OTZ 2023, while Missed appointments drug pickup and Child's Current Regimen do not significantly impact the outcome. The model is statistically significant, but low R-squared values suggest other factors may also influence viral load outcomes.

Table 4.2. The multiple regression analysis model of Viral load suppression and related factors.

Source	**SS**	**DF**	**MS**	**F(4,234)**	**Prob>F**	**R-squared**	**Adj R-squared**	**Root MSE**
Model	8.1720	4	2.7240	3.72	0.0121	0.0458	0.0335	.8552
Residual	170.4186	233	0.7314					
Post OTZ 2023			**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf. Interval]**	
Ever on EAC			-.4195632	.1350778	-3.11	0.002	-.6856933	-.1534332
Missed appointments drug pickup			-.0883798	.1930639	-0.46	0.648	-.4687538	.2919943
Childs Current Regimen			.2752174	.2769645	0.99	0.321	-.2704575	.8208923
_con			2.516638	.5877137	4.28	0.000	1.358726	3.67455

Legends: EAC: Enhanced Adherence Counselling

Discussion

Our study found improved viral load outcomes among ALHIV because they participated in the OTZ club suggesting that OTZ club intervention plays a crucial role in improving treatment adherence to ART and viral suppression while achieving better health outcomes for ALHIV.

The implementation of the OTZ club across the sites showed an increase in the proportion of females (95.4%) and males (95.3%) with viral suppression post-intervention when compared with the pre-intervention (83.9%, 80.4%) females and males respectively. The post-intervention viral load suppression number is in line with UNAIDS 3rd 95 goal, which states that "at least 95% of people living with HIV have suppressed viral load. Previous studies however have shown that males were more likely to achieve viral load suppression when compared with females. Consequently, other studies found that males ALHIV were more likely to achieve viral non-suppression which may be a result of poor adherence when compared to females [10,24,30]. It has also been reported that males have poor treatment-seeking behaviors and as such to get males to test for HIV, link and retain them to ART care remains a challenge. Interestingly, Harrison *et al.* (2024) found that older adolescent females were more likely to attain viral suppression compared to males [26].

In terms of OTZ members' attendance of meetings, our study found a significant proportion of ALHIV never missed OTZ meetings (54.9%). Therefore, through the continuous attendance of OTZ meetings, ALHIV integrates continuous monitoring through structured meetings. This regular engagement further encourages that adherence remains a priority among OTZ members. This finding is in line with previous studies, that highlighted regular assessments and timely interventions including how OTZ helps mitigate treatment interruptions, which are common among ALHIV [12,18,24,30].

Our study also found that a significant proportion of the ALHIV never missed their drug pickup in the last 6 months (90.7%). One of the peculiarities of the OTZ club as operated by the ICHSSA-2 project is that drug pick-up dates are usually fixed on the OTZ meeting days. This approach is critical to ensure sustained drug pick while providing other peer support activities to address the unique challenges faced by ALHIV. Some of the support activities provided at the OTZ club include peer-to-peer support through experience sharing, motivational messaging, mentorship, treatment literacy and support in adhering to the treatment regimen (understanding medication, managing side effects, and recognizing the importance of consistent adherence). The project links new OTZ members with OTZ champions - graduates of the program who mentor new participants - creating a relatable and motivational environment. The finding is also suggestive that the ALHIV have overcome stigma and discrimination associated with living with HIV. The study from ICAP corroborates this finding as it states that the OTZ club offers comprehensive youth-friendly HIV services, a treatment literacy package, motivational messages, and counselling [22]. Furthermore, peer influence has also been found to significantly impact adolescent's behavior, and in the context of OTZ, this influence translates into improved adherence and engagement with HIV care [23,29].

Additionally, the percentage of participants with an unsuppressed viral load decreased from 17.7% pre-OTZ to 4.6% post-OTZ. This shows other factors such as Enhanced Adherence Counseling (EAC) could be the reason for improved adherence rates. The virally unsuppressed participants of the OTZ club are encouraged to set and commit to specific goals, such as zero missed appointments, zero missed doses of medication, and achieving an undetectable viral load. These goals are reinforced during EAC sessions and through peer interactions. Adolescents who achieve their goals are celebrated as "heroes" within the OTZ clubs. This positive reinforcement motivates others to strive for similar achievements. By integrating EAC into the OTZ initiative, adolescents receive the support and education they need to adhere to their treatment regimen and effectively manage their treatment outcomes. This result aligns with findings from Oryokot *et al.* (2023) and other previous studies. The studies

highlighted that EAC sessions, combined with peer support and comprehensive HIV treatment literacy, empowered adolescents to manage their HIV effectively, leading to better adherence and health outcomes [7,21,24,26].

As of the time the study was conducted in 2023, there was a 30% increase (from 146 to 172) in the proportion of ALHIV with undetectable viral loads among virally suppressed adolescents. This is an indication that the OTZ intervention effectively addressed barriers to ART adherence. This outcome is crucial, as maintaining an undetectable viral load is essential for preventing disease progression and reducing the risk of HIV transmission. The findings are consistent with the findings by Okonji *et al.* (2020), which demonstrated that comprehensive support programs significantly enhance ART adherence and lead to improved viral suppression outcomes in adolescents [12].

The success of OTZ club intervention in improving viral load suppression among ALHIV in Lagos, Nigeria, has significant implications for adolescents' health programming and HIV epidemic control. Scaling up the implementation of OTZ club intervention could contribute to UNAIDS 95-95-95 targets.

Conclusion

This study concluded that the OTZ club intervention significantly improved ART adherence and viral suppression among ALHIV. It resulted in a notable rise in viral load suppression rates, in line with the UNAIDS 95:95:95 goal. The club's emphasis on peer support, mentorship, and strategies focused on adherence nurtured a sense of community, lowered stigma, and improved treatment literacy, achieving zero missed appointments, zero missed medications, and a zero viral load. The fixed drug pickup schedule and Enhanced Adherence Counseling further solidified treatment objectives, resulting in proactive measures and better treatment outcomes for ALHIV.

Recommendations

This study recommends that future studies should be tailored to support training peer mentors and advocates who can help provide support and disseminate information. Incorporating OTZ club intervention into national HIV management policy for adolescents may improve health outcomes in our society.

Limitations

This study highlights the impact of OTZ club intervention on improving treatment outcomes among ALHIV. However, further research is needed on its long-term effectiveness and scalability in various settings and contexts.

Conflict of Interest

The authors have not declared any conflicts of interest.

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Author Contributions Statement

Conceptualization: Association for Reproductive and Family Health, ICHSSA-2 Project, Lagos; Formal analysis: Association for Reproductive and Family Health, ICHSSA-2 Project, Lagos, Nigeria., investigation Association for Reproductive and Family Health, ICHSSA-2 Project, Lagos, Nigeria; Methodology: Association for Reproductive and Family Health, ICHSSA-2 Project, Lagos, Nigeria; Software: Association for Reproductive and Family Health, ICHSSA-2 Project, Lagos, Nigeria; Validation: Association for Reproductive and Family Health, ICHSSA-2 Project, Lagos, Nigeria: Visualization: Association for Reproductive and Family Health, ICHSSA-2 Project, Lagos, Nigeria; Writing original draft: Association for Reproductive and Family Health, ICHSSA-2 Project, Lagos, Nigeria; Writing review & editing: Association for Reproductive and Family Health, ICHSSA-2 Project, Lagos, Nigeria & Office of HIV & TB, United States Agency for International Development (USAID), Abuja, Nigeria. All authors contributed to the article and approved the submitted version accordingly based on the above descriptions.

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